INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

Bell & Howell Information and Learning
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
800-521-0600





Université d'Ottawa · University of Ottawa

ITALIAN WOMEN IN SCIENCE FROM THE RENAISSANCE TO THE NINETEENTH CENTURY

by

Gabriella Berti Logan

Thesis submitted to the School of Graduate Studies and Research in partial fulfilment for the Ph.D. degree in History

Université d' Ottawa / University of Ottawa

c 1998 Gabriella Berti Logan

National Library of Canada
Acquisitions and Bibliographic Services
395 Wellington Street
Ottawa ON K1A 0N4
Canada

Bibliothèque nationale du Canada
Acquisitions et services bibliographiques
395, rue Wellington
Ottawa ON K1A 0N4
Canada

Your file Votre référence

Our file Notre référence

The author has granted a non-exclusive licence allowing the National Library of Canada to reproduce, loan, distribute or sell copies of this thesis in microform, paper or electronic formats.

L'auteur a accordé une licence non exclusive permettant à la Bibliothèque nationale du Canada de reproduire, prêter, distribuer ou vendre des copies de cette thèse sous la forme de microfiche/film, de reproduction sur papier ou sur format électronique.

The author retains ownership of the copyright in this thesis. Neither the thesis nor substantial extracts from it may be printed or otherwise reproduced without the author's permission.

L'auteur conserve la propriété du droit d'auteur qui protège cette thèse. Ni la thèse ni des extraits substantiels de celle-ci ne doivent être imprimés ou autrement reproduits sans son autorisation.

0-612-46531-4

Canada

ITALIAN WOMEN IN SCIENCE FROM THE RENAISSANCE TO THE NINETEENTH CENTURY

Abstract

by

Gabriella Berti Logan

This study attempts to present a comprehensive history of Italian women in science from the Renaissance to the second half of the nineteenth century, when Italian universities welcomed women as students. Most of the women discussed were active in the eighteenth and early nineteenth centuries, at a time when the sciences enjoyed great popularity. Then, some women were members of publicly-funded scientific academies, were university graduates and lecturers at institutes of sciences, and/ or universities, and published in learned journals. Since many important women natural philosophers operated during the eighteenth century, there has been a tendency to see their learning in the sciences, degrees, memberships to scientific academies, and lectureships solely as the product of the Enlightenment. However, tradition played a role in their scientific education, in the granting of degrees, memberships and lectureships, and even in the scientific activities some women felt they were entitled to follow. The belief Pope Benedict XIV had that women had played a role at the University of Bologna in past centuries was pivotal in his decision to grant them degrees and positions at the university and its institutions of higher learning in the eighteenth century. Women belonged to publicly-funded academies of sciences in the eighteenth and nineteenth centuries because literary and philosophical academies, from which various scientific academies would

spring, had not been adverse to welcoming women in their midst. Some women were active in astronomy, botany, medicine, natural philosophy, mathematics, teaching, patronage, and translation during the eighteenth and nineteenth century, as some of their sisters had been during the Renaissance and Baroque periods. Of course, the way women carried out these scientific activities modified in later centuries to reflect the popularity and the development of the sciences, university reforms, censorship of the Copernican system, and social changes. Often families and teachers educated women in science in order to increase their own prestige. Nevertheless, there was a widespread belief amongst Italian men that some women were exceptional, and raised above their sex, and therefore could receive an education at par with men, and go further than the rest of their sex. This attitude on the part of the male elite allowed a few women to continue to be associated with institutions of higher learning in the second half of the nineteenth century, when the sciences became professionalized. Most of the Italian women studied were followers of scientific trends. However, there were some notable exceptions at the local and national level. Some women such as Laura Bassi, Elisabetta Fiorini Mazzanti, Caterina Scarpellini, Anna Morandi Manzolini, and Maria Gaetana Agnesi carried out some pioneering work in the Italian context.

PREFACE

When I began my research, I intended to concentrate my efforts on women who are known to have received degrees from the universities of Padua and Bologna from the late seventeenth to the early nineteenth centuries, and/or were associated with institutions of higher learning. Since most of these women were associated with the University of Bologna, its Institute of Sciences, and the Academy of Sciences of Bologna, I had come across several of them when I was engaged in researching the life and career of the natural philosopher Laura Bassi for my masters degree. However, I could not explain the degrees, and positions awarded to women during the eighteenth and nineteenth centuries as products of a more liberal attitude towards women's intellectual pursuits that existed during the Enlightenment. A similar attitude existed in France, and England, and it did not lead to the awarding of degrees, lectureships, and/or memberships to the Paris Academy of Sciences, or the Royal Society of London. Laura Bassi herself pointed me in the direction of Italian learned women of the Renaissance, when she referred to their accomplishment, and of how they could serve as an example to her in one note found amongst her manuscript papers. Although the medieval women physicians of Salerno are generally well known to historians of science, the scientific learning and activities of women from the Renaissance and early Baroque periods have been almost totally ignored by them. Consequently, Gian Ludovico Masetti-Zannini's *Motivi storici della educazione femminile (1500-1650): scienza, lavoro, giuochi* (1982) was pivotal for my research of the scientific activities of women of the earlier period. The chapter which deals with the scientific education of women of the period serves as an important

springboard to further research. It led me to investigate the surviving publications of women writers of the fifteenth, sixteenth, and early seventeenth centuries, some mentioned by Masetti-Zannini, others not, for indications of their interest, education, and participation in the sciences. It was at the suggestion of Prof. A. Braccesi of the Department of Astronomy of the University of Bologna that I investigated the writings of Christine de Pizan. Prior to my meeting with Prof. Braccesi, I had only read De Pizan's *The Book of the City of Ladies*, a work which gives little indication of De Pizan's interest in cosmology and astrology. A perusal of De Pizan's remaining works clearly show her knowledge of Aristotelean-Ptolemaic cosmology. My interest in the pedagogical works of a sixteenth century humanist, Alessandro Piccolomini led me to a woman astronomer of the period, Laudomia Forteguerri. A review of a work on learned women by the eighteenth century journalist, Elisabetta Caminer Turra led me to another woman astronomer, Teodora Danti. Elissa B. Weaver's short article on Sister Fiammetta Frescobaldi (1523-1586) caused me to read her never published diary, which showed her to have been a keen observer of astronomical and meteorological phenomena.. Sister Fiammetta's works, and some of Ulisse Aldrovandi's papers are the only manuscript material I have used in the investigation of women's interests in science during the Renaissance and early Baroque periods. The other primary sources are all publications of the period, or of later dates.

I found Pietro Ferri's *Biblioteca femminile italiana* (1842) an invaluable guide to women's publications from the advent of printing to 1842. Ginevra Canonici Fachini's *Prospetto biografico delle donne italiane rinomate in letteratura dal secolo decimo quarto fino a' giorni nostri* (1824) provided useful biographical information on women

in science, some of them active at the time of its publication. Other useful publications from the nineteenth century, regarding women's interest in science, are, for instance, Bartolomeo Gamba's *Donne italiane del secolo decimosesto* (1832), O. Greco, *Bibliobiografia femminile italiana del secolo XIX* (1875), and a French publication, Alphonse Rebière's *Les femmes dans les sciences* (1897). The articles in *Alma Mater Studiorum: la presenza femminile dal XVIII al XX secolo* (1988) provide a great deal of information on women associated with the University of Bologna from the eighteenth to the late twentieth century.

I have made use of many manuscript sources in order to gauge the activities of women in the sciences during the eighteenth and nineteenth century. The many volumes of Mazzantinti's *Manoscritti delle biblioteche italiane* are an essential guide to the manuscripts found in many Italian libraries. I have also resorted to writing to many Italian archives requesting information on specific women in science. My request for information on the botanist Elisabetta Fiorini Mazzanti to the Accademia dei Georgofili of Florence, of which she had been a member in the nineteenth century, led to the discovery of the important dissertation on the nature of lichens she had read to the academy in 1852. On the other hand, I was unable to obtain any information on the availability of manuscript material from the Neapolitan libraries. Most of the information I was able to gather on Neapolitan women in science was derived from publications, and from material found in Northern Italian, and French archives. Consequently, I could provide little biographical information on these women. I could also provide little biographical detail on Caterina Scarpellini because she was not eulogized after her death, and I was unable to trace her residence in Rome. Finally, I was also unable to get access

to manuscript material on Maria Gaetana Agnesi and Clelia Grillo Borromeo found at the Biblioteca Ambrosiana of Milan. The library remained closed throughout the period I was doing my research; therefore my data on Borromeo and Agnesi came from publications, and from manuscript material found elsewhere in Northern Italy.

Although I have attempted to cover as many women as possible in this study, my list of Italian women interested in science is far from complete. For instance, I found out during the course of my research that scientific material entered convents far more than previously imagined. I have only discussed four nuns in this thesis. There must have been more than four nuns with some knowledge of the sciences in Renaissance, Baroque, and Enlightenment Italy. Scientific education in Italian convent is still unexplored territory. After having perused the archives belonging to the Medical Faculty of the University of Bologna, I found out that several degrees in the health sciences were awarded to women during the French revolutionary period. The mother of one of these women was a properly qualified surgeon, who had graduated from the University of Ferrara. A perusal of archives belonging to the medical faculties of other Italian universities might unearth other women with degrees in surgery, medicine, pharmacy, and dental surgery. Finally, the surviving correspondence of the naturalist Lazzaro Spallanzani indicates that there were women interested in natural history, of whom we know little. A thorough study of the surviving correspondence of other natural philosophers might unearth other women who were interested, and knowledgeable in the sciences, but who failed to publish any scientific material. Much work still remains to be done in the field of Italian women in science. This study only contributes in a small way to the field.

ACKNOWLEDGEMENTS

A project such as this one requires the assistance of numerous persons. First of all, I would like to thank my supervisor, Prof. Beatrice Craig for her guidance, and for helping me organize an overwhelming amount of material. I would also like to thank Prof. Toby Gelfand for allowing me to participate in the History of Medicine Journal Club, and for donating the Italian periodical in the history of medicine, *Medicina nei secoli*. The journal club kept me well informed on the history of medicine in general, and the periodical on Italian history of medicine in particular. I am grateful to prof. A. Braccesi, and Prof. Marta Cavazza of the University of Bologna, and Prof. Paula Findlen from Stanford University for their advice on sources, and for providing me with material. I am also particularly grateful to the staff of the Archivio Arcivescovile di Bologna, Archivio della Parrocchia di Santa Maddalena, Archivio di Stato di Bologna, Archivio della Specola dell" Istituto di Astronomia dell' Università di Bologna, Archivio di Santa Maria Novella di Firenze, Biblioteca Apostolica Vaticana, Biblioteca Comunale del Archiginasio di Bologna, Biblioteca Civica Angelo Mai di Bergamo, Biblioteca Civica di Bassano del Grappa, Biblioteca Civica Berio di Genova, Biblioteca Civica V. Joppi di Udine, Biblioteca Gambalunga di Rimini, Biblioteca G. Taroni di Bagnacavallo, Biblioteca del Museo Correr di Venezia, Bibliothèque Municipale de Soissons, Biblioteca Nazionale Centrale Vittorio Emanuele II di Roma, Biblioteca Nazionale di Firenze, Bibliothèque de l' Observatoire de Paris, Biblioteca Riccardiana di Firenze, Biblioteca Universitaria di Bologna, Biblioteca Universitaria di Genova, Opera Pia Davia-Bargellini di Bologna, Pontificia Academia Scientiarum della Città del Vaticano, Rubiconia

Accademia dei Filopatridi di Savignano sul Rubicone for allowing me to consult their manuscript material. I am particularly grateful to the staff of the Archivio dell' Accademia delle Scienze di Bologna, Accademia dei Concordi di Rovigo, Accademia Economico-Agraria dei Georgofili di Firenze, and the Biblioteca Comunale di Foligno for providing me with photocopies of manuscript material. I would like to thank my mother and uncles for providing me with free bed and board while in Bologna, and my husband and two daughters Silvia and Angela for their assistance and patience.

Last, but not least, I would like to thank the Social Sciences and Research Council of Canada and the University of Ottawa for their financial support.

TABLE OF CONTENTS

Page

INTRODUCTION..... 1

CHAPTER I. SCIENTIFIC TRENDS AFFECTING ITALIAN WOMEN'S EDUCATION FROM THE RENAISSANCE TO THE NINETEENTH CENTURY..... 29

CHAPTER II. THE DEBATE OVER WOMEN'S EDUCATION AND FEMALE SCIENTIFIC EDUCATION..... 64

CHAPTER III. WOMEN AND SCIENCE BEFORE GALILEO'S TRIAL AND CONDEMNATION..... 103

CHAPTER IV. WOMEN AS PATRONS OF SCIENCES..... 187

CHAPTER V. FEMALE SCIENTIFIC TRANSLATORS..... 256

CHAPTER VI. WOMEN IN TRADITIONAL SCIENTIFIC FIELDS: ASTRONOMY.....362

CHAPTER VII. WOMEN IN TRADITIONAL SCIENTIFIC FIELDS: BOTANY....437

CHAPTER VIII. FROM LEARNED LADIES TO TEACHERS OF MEN: DOCTORS OF PHILOSOPHY.....492

CHAPTER IX. FROM LEARNED LADIES TO TEACHERS OF MEN: EXPERTS WITHOUT DEGREES.....576

EPILOGUE.....632

CONCLUSION.....658

ABBREVIATIONS.....662

BIBLIOGRAPHY.....663

Introduction

Before the complete unification of Italy in 1870, the Italian States could boast of having had not only women who studied the sciences, but also who had practiced them. Some of these states could claim to have had women with degrees in philosophy, who then held positions of lecturers within public institutions. There were properly qualified women physicians, surgeons, and pharmacists who practiced their arts, as there were women members of publicly-funded scientific academies. Several women published and had published in learned scientific journals. Others were responsible for the dissemination of new scientific knowledge to the reading public at large through their own scientific publications in the vernacular, translation into the Italian of important foreign scientific treatises, and the founding and editing of periodicals that presented both foreign and Italian scientific materials of new extraction. Women of the upper classes could not only act as patrons to men of science, but a few of them were responsible for founding philosophical and scientific academies. Furthermore, as it occurred in France, Germany and England, Italian women also acted, and had acted as assistants to their male relatives involved in the sciences.[1]

In spite of all the scientific activities described above on the part of Italian women of past centuries, as Londa Schiebinger points out in *The Mind Has No Sex?* (1989), there is no comprehensive history of Italian women in science written in Italian historiography.[2] This study is intended as a contribution to fulfilling that need. It discusses the scientific education and activities of Italian women, and the social conditions within which they operated from the Renaissance to the second half of the nineteenth century, when Italian universities opened to the female public at large.[3] Most

of the women discussed were active in the eighteenth and nineteenth centuries. Women of the earlier centuries will be considered in terms of the precedents they set to the women who followed.

Prior to 1950, Italian historiography discussed Italian women involved in the sciences under the general heading of Italian learned women. These works, written by both women and men, can be traced to the fifteenth-century when Christina de Pisan in *The Book of the City of Ladies* (1405) and Laura Cereta in her letter to Bibulus Sempronius entitled " The Defense of the Liberal Instruction of Women " (1488) added some contemporary women, and women from the recent past to their lists of learned women dating mostly from the Greek and Roman past. For instance, Cereta added Isotta Nogarola of Verona (b. 1418), and Cassandra Fedele (b. 1465), both learned in philosophy to her list of learned women.[4] The works tended also to be cumulative in nature, with each generation adding their own list of contemporary learned women to the list of learned women from past centuries. Thus, in 1729, Guglielmo Camposampiero, a patrician from Padua, added the names of Elena Cornaro Piscopia, who had received a degree in philosophy from the University of Padua in 1678, and Clelia Borromeo, who had recently founded the Clelia Academy of Milan, to his list of learned women, when arguing in favour of women being admitted to the study of science and the arts.[5]

The works mentioned above were part of a larger body of literature in defense of women's abilities, and the rights they had to higher education and participation in academic life. As the debate intensified in the nineteenth-century the works on learned women past and present proliferated. The most relevant works of the period were

Ginevra Canonici Fachini's *Prospetto biografico delle Donne Italiane rinomate in letterature dal secolo decimoquarto fino a' giorni nostri* (1824), Pietro Ferri's *Biblioteca femminile italiana,* (1842), and Emma Tettoni's " Le scienziate italiane " (1890). The importance of Canonici Fachini's *Prospetto* rests in the fact that the author included among her biographical sketches of Italian women learned in literature and the sciences many women still living at the time of publication, thus providing us with unique and current information on these women.[6] Ferri's book, short on biographical details, was, and still remains, one of the most important sources of Italian women's published works since the advent of printing. The list of women provided by Ferri was very extensive, as was the list of their publications in the sciences, literature, history, philosophy and other subjects.[7] Tettoni's " Le scienziate italiane ", as the title indicates, was the first work solely dedicated to women whose main interests were scientific. But following a very narrow definition of what constituted valid science, as befitted someone writing in the nineteenth-century, Tettoni refused to deal with Renaissance women, because, as far as she was concerned, they were erudites rather than scientists, and really belonged to the history of women's literature. Therefore the women she considered were active in the sciences in the eighteenth and early nineteenth centuries, and included such luminaries as Laura Bassi, Maria Gaetana Agnesi, Maria Angela Ardinghelli, Cristina Roccati, Maria dalle Donne and Anna Morandi Manzolini, amongst others. However, Tettoni's list of women scientists left out some important names, such as the astronomer and meteorologist Caterina Scarpellini; and the author never came to terms with the scientific activities of the women she discussed.[8]

If Italian historiography prior to 1950 is short on works solely dedicated to Italian women in science, it offers plenty of examples of works directed towards individual women. The most popular format of these works consisted of eulogies, written soon after the woman's death, such as, for example, the botanist Francesco Castracane's eulogy (1879) of his friend and adviser, the botanist Countess Elisabetta Fiorini Mazzanti.[9] If the works were by their nature complimentary, they provided, nevertheless, useful, and quite often, sole information on the woman's life. Several biographies of individual women who had been involved in the sciences also appeared in the Italian historiography in the late 1800s and early 1900s. These works presented no unifying theme to them. They also tended, on the whole, not to analyse the woman's scientific activities. However, several of the works redeemed themselves by publishing hitherto unpublished information on the subject, and by reminding readers of the woman's existence. The most important of these biographies remains Luisa Anzoletti's scholarly study of the mathematician Maria Gaetana Agnesi's life published in 1900.[10]

Italian women in science were included together with women in science from other countries in works published outside Italy, such as Alphonse Rebière's *Les femmes dans les sciences*, (Paris, 1897), E. Lagrange's *Les femmes astronomes* (1885), Gino Loria's *Les femmes mathématiciennes* (1903), Kate Hurd-Mead's, *History of Women in Medicine from the Earliest Times to the Beginning of the Nineteenth-Century* (1938), and H.J. Mozans' *Women in Science with an Introductory Chapter on Women's Long Struggle for Things of the Mind* (1913). Mozans and Rebière, who presented a very extensive list of Italian women in science, complemented by an equally extensive list of Italian secondary sources, are the most influential of the historians mentioned so far.

They became a source of information for later historians of women and science who referred to Italian women. Most importantly, Mozans over-optimistic belief that women in Italy had access to universities and academies of sciences, and were at liberty to follow any courses of study they might have elected, prior to the Bonghi law of 1874 which opened the universities to women in general, has been inherited by English-language historians of women in science such as M. Ogilvie in *Women in Science, Antiquity through the Nineteenth-Century* (1986) and Margaret Alic in *Hypatia's Heritage: A History of Women in Science from Antiquity to the Late Nineteenth-Century* (1986).[11]

As the titles and contents of many of the works mentioned above indicate, women from the Italian peninsula, and elsewhere, had had an interest in the sciences for a number of centuries. Thus it might be expected that historians dedicated to the study of the development of modern science might have considered the role women played in such a development. However, authors, such as E. Zilsel in " The Sociological Roots of Modern Science (1942), H. Butterfield in *The Origins of Modern Science 1300-1800* (1945), Marie Boas Hall in *The Scientific Renaissance 1450-1630* (1962), A.R Hall in *From Galileo to Newton* (1963), Alexander Koyré in " The Significance of the Newtonian Synthesis " (1965), Richard S. Westfall in *The Construction of Modern Science: Mechanisms and Mechanics* (1971) and Paolo Rossi in *La nascita della scienza moderna* (1997), who expound that from the sixteenth to the eighteenth centuries Europe experienced some sort of scientific revolution, or those who do not expound such a revolution, such as the contributors to D.C. Lindberg's and R.S. Westman's *Reappraisals of the Scientific Revolution* (1991), all ignore the contributions women made to the sciences. Women's scientific contributions are equally irrelevant to Thomas

S. Kuhn's thesis found in his *The Structures of Scientific Revolutions* (1962) which states that not one, but several revolutions occurred through several centuries.[12] The theses the authors mentioned above present can vary; for instance, Zilsel believes that the scientific revolution occurred when the arts of the artisan were absorbed and adopted by academically trained scholars. On the other hand, A.R. Hall and Marie Boas Hall see the scientific revolution primarily as a revolution in theory and explanation; to them modern science emerged around 1630 through a general process of purification from the revival of learning which began by the middle of the fifteenth-century. However different their theses might be, the examples they use to prove their points can be found, for instance, amongst the greatest names in science, men like Galileo, Francis Bacon, Isaac Newton, Copernicus, William Gilbert, René Descartes, and their scientific achievements.[13] Paolo Rossi sees the need to add the names of engineers such as Vannoccio Biringuccio, Niccolò Tartaglia, Georg Agricola and Simon Stevin to the list of male natural philosophers--some mentioned above--who contributed to the scientific revolution. Women are irrelevant to this thesis, since one has to wait until the twentieth century for the first female engineers to appear in Italy.[14] T. Kuhn states that a scientific revolution occurs when an older paradigm--a major scientific achievement--is replaced in whole, or in part by an incompatible new one. Since he chooses to emphasize the paradigm, and not the community of practioners who functioned within it, women are again largely irrelevant to the thesis.[15] However, if one accepts M. Alic's and Carolyn Merchant's thesis that Leibniz's concept of nature as composed of monads endowed with a vital force was derivated from Ann Conway's own concept of monads, then at least one paradigm should have been attributed to a woman by Kuhn. Under this aegis, all the practioners

who functioned within the Leibnizian paradigm of nature during the late 1600s and 1700s were really functioning within Ann Conway's paradigm.[16]

As seen above, historians who deal with the origins of modern science tend to ignore the role of women in this process. However, in recent years, this neglect has been addressed in part, because of a tendency by historians to concentrate on scientific communities at large and their activities, rather than on important philosophers and their outstanding contributions. Thus, William Eamon in *Science and the Secrets of Nature. Books of Secrets in Medieval and Early Modern Culture* (1994) takes into consideration the part one woman--Isabella Cortese--had in articulating a novel concept of experimentation by the publication in 1561 of her alchemical work *I secreti delle signore di Isabella Cortese nei quali si contengono cose minerali et medicinali, artificiose et alchimiche, et molte dell' arte profumatoria appartemnenti a ogni gran signora.* To Eamon, the treatises which inundated Europe--of which Cortese's work was one--professing to reveal the " secrets of nature " to anyone who could read, were more than purveyors of artisanal and medicinal recipes to natural philosophers, but were also instrumental in shaping scientific culture in the early modern era.[17]

Both Nancy G. Siraisi in *Medieval & Early Renaissace Medicine. An Introduction to Knowledge and Practice* (1990) and Paula Findlen in *Possessing Nature. Museums, Collecting, and Scientific Culture in Early Modern Italy* (1994) take into consideration the role women played repectively in early medical practice, and as visitors to recently-founded museums of natural history and botanical gardens, as collectors of natural objects, and as patrons to naturalists. From both studies we can draw that the activities of women in medicine (Siraisi), and natural history (Findlen) were insignificant as

compared to those of men. To Siraisi, the medical works of Trota or Trotula--whose status as an author has been confirmed--and of Abbess Hildegard of Bingen were highly unusual even for the twelfth century. Matters were made worse once university faculties of medicine were established during the thirteenth century. Then women were excluded from higher medical education, and the most prestigious practice. They could be found, however, at the lowest level of medical activity, but never in the same numbers as men.[18] Siraisi in her study fails to take into consideration how widespread was the knowledge of the medicinal properties of plants, amongst the literate, and even the illiterate, female population of the Italian pensinsula. In her turn, Findlen emphasizes the importance of Pliny the Elder's *Natural History* to Renaissance male naturalists, but seems unaware that Pliny's influence can also be found in the writings of Italian women of the period.[19]

Italian historians of science, who have studied the activities of various scientific communities in Italy in recent years, have, like their American counterparts, taken more often into consideration the role of women within these communities. Thus several of the authors who contributed to Walter Tega's *Anatomie Accademiche.* II: *L' Enciclopedia scientifica dell' Accademia delle Scienze di Bologna* (1987) have referred to the scientific activities of Laura Bassi, Maria Agnesi and Faustina Pignatelli, all members of the Academy of Sciences of Bologna, as recorded in the acts of the academy, the *Commentarii.*[20] By the same token, P. Nastasi and A. Brigaglia, who have studied a community of eighteenth century Neapolitan natural philosophers in 1984, looked into the roles two women, Maria Angela Ardinghelli and Faustina Pignatelli, played within this community.[21] However, there are some notable exceptions to the recent trend amongst Italians of including women within the larger community of scientific

practioners in Italy: both Paolo Casini in " Les débuts du newtonianisme en Italie, 1700-1740 " (1978) and Vincenzo Ferrone, *Scienza, natura, religione. Mondo newtoniano e cultura italiana nel primo settecento* (1982), who have studied how Newtonian science spread in the Italian peninsula, fail to take into consideration the roles teachers like Laura Bassi and Cristina Roccati, and a translator of Stephen Hales' works, like Maria Angela Ardinghelli, had in the spread of that science.[22]

In the 1980s and 1990s there appeared a series of works, of which Carolyn Merchant's *The Death of Nature: Women, Ecology, and the Scientific Revolution* (1980), Evelyn Fox-Keller's *Reflections on Gender and Science* (1985), Londa Schiebinger's *The Mind Has No Sex?* (1989) and David F. Noble's *A World without Women: The Christian Clerical Culture of Western Science* (1993) are the most relevant, intent on explaining why modern science developed as it did with women largely absent from the scientific revolution and its aftermath. Both Merchant and Fox-Keller place in the Greek past the association of mind, reason and activity with maleness, and nature, matter and passivity with femaleness. These Aristotelean and Platonic concepts of the passivity of matter, and therefore of the female, were fused and incorporated in the new mechanical philosophy of the scientific revolution in the form of a passive, female nature composed of dead atoms, which could be controlled and dominated by external forces. According to Merchant, such a view of nature--which was fully compatible with the directions taken by commercial capitalism--allowed its exploitation and rape, the domination of male over female, and the creation of a new socio-economic order that subordinated women, confining them to the domestic sphere, or to the lowest rank in industry.[23] To Fox-Keller the view of nature encompassed by the mechanical philosophy of the scientific revolution

also contributed greatly toward the elimination of all the feminine traits, and therefore females, from science. To both Merchant and Fox-Keller the scientific revolution had also the adverse effect of destroying hermetic philosophy, which for a time had existed alongside its mechanical counterpart, and propounded an animistic and organic view of nature, within which female and male principles co-existed. By inference, one might assume then that had such philosophy survived, the domination of nature, and women by men would not have occurred. Merchant also adds that Italy does not fit her thesis, because in there the differentiation between male and female roles occurred earlier, during the Renaissance.[24]

Schiebinger states in the sections of *The Mind Has No Sex?* dedicated to the relation between gender and science, that in earlier times both science and philosophy were viewed and portrayed as feminine. From Francis Bacon's time onwards, there was a tendency to see both philosophy and science as masculine. Bacon, himself, had defined the philosophy taught at the schools as passive, weak and expectant, all female characteristics according to the Aristoteleans; he had therefore called for a male philosophy which was virile, active and generative. By the early nineteenth century the images of a female science were replaced by images of the scientist as a male. Even earlier, in the late eighteenth century, to call something feminine was to imply its unsuitability for science. According to Schiebinger, during the eighteenth century there also appeared the theory of the sexual complementary that defined women's role as mothers and nurturers. Ultimately this ideological construct of gender together with the professionalization of science acted as real barriers to women's continued progress in the sciences during the eighteenth century. If women were to continue to participate in the

sciences, this participation would occur in the private sphere, where women would act as invisible assistants to their male relatives, or through university degrees, which were exceptional occurrences in the eighteenth century. It is in this latter group of women belonging to the institutional landscape that Schiebinger places the Italian women in science with whom she is familiar, as she is aware that several of these women were attached to some form of scientific institution, either an university and/or an academy of science. These Italian women associated with institutions did not represent an eighteenth century trend, but were the exception to the rule of exclusion. Ultimately, as far as Schiebinger is concerned, the ability of women to participate in the sciences, which was there in earlier centuries, increasingly deteriorated throughout the eighteenth century.[25]

Noble in *World without Women* does not see the exclusion of women from the sciences as a by-product of the adoption of mechanical philosophy during the scientific revolution, as Merchant and Fox-Keller would have, nor as caused by a combination of the ideological construct of gender and the masculinization of science during the eighteenth century, as Schiebinger states. According to the author, the root of exclusion lays in the Middle Ages, when universities in Europe were formed in the male monastic mould. They were ecclesiatical associations and thus were organized accordingly, excluding women from their midst. Science, finding its chief institutional home in universities from the twelfth-century onwards, was also bound to exclude women. The influence of Aristotelean philosophy in the universities' curricula provided a scientific basis for this exclusion, since Aristotle and his followers viewed women as inferior to men biologically and intellectually.

Noble is aware that Italian universities had a large percentage of lay masters, unlike their northern counterparts. This "lay influence" did "apparently allow for some female participation in higher learning, especially on the part of wives and daughters of lay medical masters", however, "the extent and significance of this participation remains unclear". Noble refers that women such as Elena Piscopia and Laura Bassi were known to have received degrees from Italian universities, and that Maria Agnesi had held a position in mathematics at Bologna. But he feels that these women were few in number, and exceptions to the rule of exclusion of women from university degrees and other academic professions. According to the author, the exclusion of women from Italian universities was not only the result of "Aristotelean prejudice and ecclesiastical and lay academic traditions, but also of the rise of the Italian despotic state and a renewed Renaissance emphasis upon marriage ".[26]

As the excerpts above indicate, Merchant, Schiebinger and Noble have difficulty explaining the Italian cases in the context of their different theses. No one disputes, that once university medical faculties began to be established in the Italy in the course of the thirteenth century, women experienced greater difficulties in acquiring an advanced medical education than their sisters in the guild-like system of the school of Salerno of the twelfth and early thirteenth centuries. But to simply state, like Merchant and also Noble, that the differentiation between female and male roles in Italian society, and thus women's exclusion from the sciences, occurred during the Renaissance, due to a renewed emphasis on marriage, is to fail to explain why in later centuries several Italian women received degrees from Northern Italian universities, were given positions within institutions of learning, became members of scientific academies and/ or published in

learned journals. To conclude, like Schiebinger, that conditions worsened for women desiring to practice science by the late eighteenth century, is perhaps to explain German conditions. It does not explain why several women were awarded degrees in the health fields by the University of Bologna during the Napoleonic period, or why some women continued to be members of prestigious Italian scientific academies in the nineteenth century. To say, like Merchant and Fox-Keller, that the adoption of the mechanical philosophy during the scientific revolution led to the domination of nature by men and the exclusion of women from the new scientific knowledge, is not to explain why a book of secrets' author, Isabella Cortese, was advocating the domination of nature in 1561, the date of Francis Bacon's birth, or why most of the Italian women in the sciences accepted the new mechanical philosophy.[27] Although no one disputes that Italian women in science involved with institutions were exceptional cases, to simply dismiss them as exceptions as Schiebinger and Noble have done, is not "to account for historical diversity in women's scientific experience" as Pnina G. Abir-Am and Dorinda Outram state in *Uneasy Careers and Intimate Lives: Women in Science, 1789-1979* (1987), and, most importantly, is to ignore the fact that a fair number of Italian men in science were willing to accept at least some women amongst their ranks.[28]

The problem historians of gender and science encounter when dealing with Italian women in science might arise from the fact that they use almost exclusively secondary sources, often of English extraction, and not by historians of science, for their analysis.[29] Historians like Gian Ludovico Masetti-Zannini in *Motivi storici della educazione femminile (1500-1650): scienza, lavoro, giuochi* (1982), the authors who contributed to *Alma Mater Studiorum: la presenza femminile dal secolo XVIII al XX secolo.*

Ricerche sul rapporto Donna/ Cultura Universitaria nell' Ateneo Bolognese (1988) and Paula Findlen in " Translating the New Science: Women and the Circulation of Knowledge in Enlightenment Italy " (1995) have done much to correct the problem by their greater use of primary sources.[30]

Unlike the authors in *Alma Mater Studiorum* and Paula Findlen, Masetti-Zannini is interested in the education of Italian women prior to 1650, and he dedicates a chapter to their philosophical and scientific education . Using the definition of the sciences as they were defined in the period under discussion, Masetti-Zannini looks at the women's education in the disciplines of the *trivium* (grammar, rhetorics and dialectics) and of the *quadrivium* (music, arithmetics, geometry and astronomy). The author concludes that many women were directed towards the study of grammar and music, but very few were introduced to the other subjects in the *trivium* and *quadrivium.* In the end, unlike the men, most of the so-called learned women received a rather generic and mnemonic information which rarely went beyond the superficial. It is probably true that the knowledge of most women of the elite might have been superficial for the period under consideration. However, there were women of real learning in the sciences at the time, whose presence and/or knowledge escape Masetti-Zannini's detection, due, mostly, to the primary sources he uses, which are not extensive enough. For instance, learned women like Laudomia Forteguerri, Isabella Cortese, Teodora Danti, Fiammetta Frescobaldi, Moderata Fonte and others are not considered by the author; and Margherita Sarrocchi's knowledge in physics escapes him by his failure to make full use of Sarrocchi's correspondence with Galileo.[31]

A third of the articles in *Alma Mater Studiorum* are dedicated to statistical studies on the presence of women at the University of Bologna after it opened to the general female public in 1874. The remaining articles, however, consist usually of individual biographies of women who were associated with the University of Bologna and its institutions prior to 1874; some of these women, such as Maddalena and Teresa Manfredi, Laura Bassi, Maria Gaetana Agnesi, Anna Morandi Manzolini and Maria dalle Donne studied, practiced, and/or taught the sciences during the eighteenth and early nineteenth centuries. The unifying thesis to these biographies can be found in Lucia Traversi's article which precedes them. According to Traversi, during the eighteenth century there was a more tolerant attitude towards the participation of women in intellectual activities. Women who studied, took part in debates, carried research, and/ or published were no longer a source of derision and corruption as in the past, but instead became the focus for prestige and social decorum. Thus, the association of various women with the University of Bologna and its related institutions can be seen as the result ot this greater tolerance towards women's intellectual pursuits.[32]

P. Findlen in " Translating the New Science " looks at the role women had in the circulation of new scientific knowledge in eighteenth-century Italy. The author uses the term translation not only in its literal sense, but also figuratively, for she includes Maria Gaetana Agnesi's own mathematics' textbook in finite and infinite analysis, *Instituzioni analitiche* (1748) amongst the translations, since the work contained no original material. According to Findlen, translation was the principal means whereby women from Italy and abroad published works in science during the Enlightenment. It mitigated the perception that authorship was too visible an activity for women, particularly in Italy,

where the accustomed form of printed female expression was not prose--as required in scientific publications--but poetry.[33]

No one disputes, as Traversi suggests, that there might have been a more liberal attitude towards women's intellectual pursuits and personal freedom in Bologna, and in Italy in general, during the eighteenth century, and that this attitude facilitated women's scientific pursuits. But, it can also be said that a similar attitude, perhaps to a greater extent than in Italy, also flourished in France in general, and in Paris in particular. This attitude, however, did not lead to the awarding of degrees, lectureships, and/or memberships to the Paris Academy of Sciences to women like Mme du Châtelet, involved in the sciences.[34] It is more accurate to say that the roots for the association of Italian women with institutions of higher learning, such as universities and academies, and for their scientific activities in the 1700s and 1800s are not to be found in the eighteenth century. These roots are situated instead in the past, within the tradition of Italian learned women, the education these women received, and the activites some carried out. They are situated also in the fact and the belief that some of these learned women of past centuries had been associated with universities, and with earlier literary and philosophical academies, from which several scientific academies stemmed.[35]

Findlen sees the translation of new science by Italian woman as an eighteenth century activity, but, in fact Italian women had been translating scientific texts from the Renaissance onwards. As befitted the period, the texts translated were mostly of Greek and Roman extractions, and usually appeared in part, in works of an essentially literary nature, such as orations, dialogues, poems, and in tracts in moral philosophy, or in defense of women. Although no literal translation of a scientific text by a woman

survives prior to the eighteenth century, these older, partial translations were probably as effective as their later counterparts in circulating, if not new, certainly traditional scientific knowledge. In fact, one can find examples in the past of many of the scientific activities women engaged in during the eighteenth and nineteenth centuries. Italian women were interested in astronomy, cosmology, physics, mathematics, botany, chemistry, medicine and natural history in the Renaissance and Baroque periods, as they would be in later centuries. Some women engaged in patronage and in teaching then, as they would do in the 1700s and 1800s. What changed throughout the centuries was women's approach to the various scientific subjects, which reflected changes that occurred within the sciences themselves. If more women practiced and published exclusively on scientific topics during the Enlightenment than in earlier centuries, it is because science enjoyed greater popularity during that period in Italy. It can be said that some form of scientific knowledge had always been part of the Italian learned woman cultural baggage for centuries, and thus, the activities of learned women of the past provided important precedents to the women attempting to carve a place in the sciences for themselves in later centuries, as well as for the men who were willing to assist them in this enterprise.

Italian pedagogical authors from the Renaissance onwards often stated, as Merchant and Noble appropriately point out, that a woman's education had to be geared towards marriage. Furthermore, humanists such as Leonardo Bruni in the fifteenth century and Alessandro Piccolomini in the sixteenth added also that mathematics, geometry, astronomy and science were not convenient subjects for women to study since they were not likely to use them.[36] Nevertheless, I will show firstly that, in spite of such a

rhetoric, many Italian pedagogical writers, including Piccolomini, exempted the so-called exceptional woman from the general rule of female education and accepted, in addition, that some families educated their women more than the average, and that these women's education might also encompass the sciences. I will discuss also how women were associated with the development of the various regional literary and philosophical academies which mushroomed in the Italian peninsula from the late fifteenth century onwards, and how their association might have had a bearing in women's membership to the public scientific academies of the eighteenth and nineteenth centuries.

Secondly, I will survey the education and activities of women in the sciences prior to Galileo's trial and condemnation in 1633. I chose this demarcation point, as being more relevant to Italian women, since it had a bearing on the scientific topics they chose, and on how they expressed their scientific knowledge in print from 1633 to at least until 1757, when Pope Benedict XIV no longer restricted the publication of new works expounding the Copernican system.[37] My intent is to cover as many women as possible to show how they set a precedent to the women who were to follow in their footsteps not only because they were introduced to a variety of scientific subjects, but because they were active in several fields from mathematics and astronomy to alchemy, natural history, medicine and botany as patrons, translators, collectors, practioners, teachers, and even as harbingers of a new approach to do science.

The second part of the work will consider how several of the scientific activities already carried out by women prior to 1633, such as patronage, translation, astronomy, botany, teaching and medicine would be modified to reflect censorship, the popularity and increased specialization of the sciences during the eighteenth century, university

reforms brought about by political upheavals, and social changes experienced by the women themselves. Of the activities carried out by women, the first two to be discussed, scientific patronage and translation, required less specialization in the sciences on the part of those who undertook them. Thus, they were the most affected, as far as the number of female participants are concerned, by the increased popularity of the sciences during the eighteenth century, and then by their decreased popularity, associated with the rise of the political salon geared towards the unification of Italy, after the collapse of the Napoleonic Empire. Thus the women taken into consideration were active during the 1700s and the first decade of the 1800s.

Wealth, social position, and an interest in science, and not regional differences, determined whether a woman became a patron in Italy to one or more of her favourite natural philosophers, and thus aided them politically in their acquisition of government-controlled positions, and/or financially in their publications, and by means of gifts. In turn, the woman patron, usually barred from a university education, and scientific academy membership, brought scientific knowledge and debate to herself by inviting the men she patronized to her home, her *conversazioni* (salons), or, as in Clelia Borromeo's case, making them members of her own experimental academy. As a group, patrons were also the ones most likely to be affected by fashions in science. I shall then discuss how regional differences affected, however, how women translated scientific knowledge in the eighteenth century. As far as it is known, women from the Kingdom of Naples undertook literal translations, in whole, of scientific works. Their translations, however, represented but a small fraction of the scientific translations carried out by Italian men during the same period. They also had less to do with the circulation of knowledge, and

were more a means by which, through her introduction and notes, a woman could become known as a natural philosopher in an area which was far less amenable to having women associated with public institutions of higher learning than Northern Italy. As I intend to demonstrate, the real circulation of new scientific knowledge from abroad under the control of a woman was to be found within the pages of Elisabetta Caminer Turra's *Giornale enciclopedico* (1768-1796), a Venetian periodical of wide distribution throughout Italy.

The next fields of activity to be covered shall be astronomy and botany. Both fields, and thus the women who practiced them, were affected by scientific developments. The need for more sophisticated instrumentation and mathematical knowledge did much to decrease the number of women who could enter the field of astronomy in the 1700s. However, in Italy the problem was compounded by the Vatican's censorship of the Copernican system in 1616, and by Galileo's condemnation in 1633, events which did much to reduce the number of male amateur astronomers, and thus of women who might have been traditionally associated with them. There were more women who studied, practiced and wrote on cosmology and astronomy prior to 1633 than in the following two centuries, in spite of the increased popularity of the sciences. All the five women to be discussed, wrote and/or practiced in the field. Only one of these women, Caterina Scarpellini who practiced in Rome, and published in the field during the mid 1800s was not affected by this censorship. Scientific developments also affected how botany was expounded and practiced by women in the eighteenth and nineteenth centuries. Prior to 1750 an elite woman's botanical knowledge was pretty much confined to the medicinal properties of plants. I shall demonstrate that after 1750 knowledge of the medicinal

properties of some plants and/or their extracts was confined to women of the lower classes, and to the few women professionals who had received degrees in medicine, surgery and pharmacy from Italian universities in the 1790s and early 1800s. Elite women were instead knowledgeable and published on plant physiology, taxonomy and morphology, and/or agriculture. Reflecting social changes, most of the women discussed, as owners of estates, were knowledgeable in agriculture; whereas very few were active in the more specialized fields of physiology, taxonomy and morphology. None of the women discussed in this latter group had as their aim the popularization of botany.

The final group of women to be discussed were associated by the degrees, and/or positions they were awarded with universities, particularly with the University of Bologna and its institutions of higher learning. The fact that seven out of the eight degrees, and three out of the four positions granted were connected with the University of Bologna, a university with a history--known to many men and women then--of having had women associated with it in the past, is indicative that tradition played a pivotal role in the granting of these degrees and positions. Unfortunately, tradition of another kind--that of keeping women outside the university's gates, except on special occasions--also played a role on how women were to study for these degrees, and how they were to fulfill their teaching mandates later on. The first women to be discussed, Laura Bassi and Cristina Roccati had university degrees and taught physics at public institutions in Bologna (Bassi) and in Rovigo (Roccati) for many years. Having the same qualifications as men did not ensure, however, that Bassi and Roccati would be allowed to carry of their teaching and research on equal footing to their male counterparts. The

next women to be considered, Maria Gaetana Agnesi and Anna Morandi Manzolini, had no degrees, but had achieved such high levels of specialization that their teaching positions at the University of Bologna were awarded in recognition of their expertise. Agnesi did not take up teaching at the institution; however, I intend to demonstrate by means of examples that she taught through her popular mathematics textbook in finite and infinite analyses. As tradition dictated, Morandi's teaching was confined to her home. But like Agnesi's textbook, Morandi's scientific productions--anatomical models in wax--continued to teach when she was no longer active in science. The last women covered had all received degrees in the health sciences. However, if tradition, as well as educational reforms carried out at University of Bologna during the French revolutionary period were behind the granting of most of these degrees, reforms, and not tradition, were also responsible for keeping the women out of the institution after their degrees. If the University of Bologna and its Academy of Sciences no longer welcomed women in the first half of the nineteenth century to the extent it had done in the previous century, tradition allowed some women to be members of public scientific academies, and of institutions of higher learning elsewhere in Italy. These latter women bridged the gap between women associated with institutions of higher learning in past centuries and those who entered universities from 1874 onwards.

It is important to stress that all the women to be examined in this study were born in the Italian states. Therefore Christine de Pizan, born in Venice, but raised in France, is included amongst the women educated in the sciences prior to 1633, and Christina of Sweden is excluded from this group, in spite of the fact that she acted as a patron to natural philosophers while residing in Rome.[38] Furthermore, all the women, no matter

how specialized they would become, shared also in common the fact that they did not attend classes at university on a regular basis.

[1]For examples of women assistants in Germany, England and France see Londa Schiebinger, *The Mind Has No Sex? Women in the Origins of Modern Science*, (Cambridge, Massachussetts: Harvard University Press, 1989), pp. 67-101, 260-63; Margaret Alic, *Hypatia's Heritage. A History of Women in Science from Antiquity through the Nineteenth Century*, (Boston: Beacon Press, 1986), pp.96-98.

[2]Schiebinger, pp. 7-36.

[3]Italian universities opened to women with the law Bonghi of 1874, see Brunella dalla Casa e Fiorenza Tarozzi, " Da 'studentinnen' a 'dottoresse'; la difficile conquista dell' istruzione universitaria tra '800 e '900 " in *Alma Mater Studiorum: la presenza femminile dal XVII al XX secolo. Ricerche sul rapporto Donna/Cultura Universitaria nell' Ateneo Bolognese*, (Bologna: CLUEB, 1988), pp. 159-74; for the importance of printing in science see William Eamon, *Science and the Secrets of Nature. Books of Secrets in Medieval and Early Modern Culture*, (Princeton: Princeton University Press, 1994), pp. 7-11.

[4]For a dating and summary of Cereta's letter see Albert Rabil Jr., *Laura Cereta Quattrocento Humanist*, (Bimghamton, N.Y.: Center for Medieval & Early Renaissance Studies, 1981), pp. 101-102. For the original letter see " Laura Cereta in Bibulum Sempronium: De liberali mulierum Institutione Defensio, Epistola LXV " found in Laura Cereta, *Laurae Ceretae Brixiensis Feminae Clarissimae Epistolae jam Primum è MS in lucem productae à Jacobo Philippo Tomasini*, (Padua: Sebastiano Sarali, 1640), pp. 187-191. For a translation of the letter see Margaret L. King and Albert Rabil Jr. eds., *Her Immaculate Hand. Selected Works By and About The Women Humanists of Quattrocento Italy*, (Binghamton N.Y.: Medieval & Renaissance Texts and Studies, 1983), pp. 80-84. Christine de Pizan mentioned Novella Calderini, whose training in law by her father allowed her to lecture in his place at the University of Bologna in the fourteenth-century, see Christine de Pizan, *The Book of the City of Ladies, Translated by Earl Jeffrey Richards. Foreword by Marina Warner*, (New York: Persea Books, 1982), pp. 154-155.

[5]" Discorso accademico del sig. Guglielmo Camposampiero, Patrizio Padovano da lui recitato nell' Accademia de' Ricovrati nel 16 giugno 1723; che debbono ammetersi le Donne allo studio delle scienze, e delle belle arti " in *Discorsi Accademici di varj autori viventi Intorno gli studi delle donne; la maggior parte recitati nell' Accademia de' Ricovrati di Padova dedicati alla Sig.ra Elisabetta Cornaro Foscarini*, (Padua: Manfrè, 1729), pp. 8-19. Other examples of the genre for the earlier centuries are Lucrezia

Marinelli, *La nobiltà et eccellenza delle donne, et i diffetti, e mancamenti degli huomini*, (Venice: Giovan Battista Ciotti, 1600), pp. 14r-16r; Cristoforo Bronzini, *Della dignità et nobiltà della donna*, (Florence: Pignoni, 1624), Settimana prima, giornata quarta, pp. 82, 112-113; Francesco Agostino della Chiesa, *Teatro delle donne letterate con un breve discorso della preminenza e perfettione del sesso donnesco del Signor Francesco Agostino della Chiesa Dottore di Leggi di Saluzzo*, (Mondovi: Gio. Gissardi, 1620); Elisabetta Caminer's review of " Dizionario storico portabile delle donne celebri, Parigi, 1769, 2 vol. ", *E.L.*, T. II, (novembre 1769), pp. 79-94; for the Clelia academy see Ugo Baldini, " L' attività scientifica nelle accademie lombarde del settecento ', in *Economia, istituzioni, cultura in Lombardia nell' età di Maria Teresa*, Vol. 2: *Cultura e società*, A. de Maddalena, E. Rotelli, G. Barbarisi eds., (Bologna: Il Mulino, 1980), pp. 511-12; for Piscopia's degree see, F.L. Maschietto, *Elena Cornaro Piscopia: la prima donna laureata del mondo*, (Padua, 1978), pp. 88-89.

[6]For the debate on women's abilities in the seventeenth century see Ginevra Conti Odorisio, *Donne e società nel seicento*, (Rome: Bulzoni, 1979); for the debate on women's education in the 1700s and 1800s see Gilberto Zacchè, " Aspetti della questione femminile in Italia nel secolo XVIII " in Carolina Lattanzi, *Schiavitù delle donne*, Gilberto Zacchè ed., (Mantua: Edizioni lombarde, 1979); Dalla Casa e Tarozzi, pp. 159-164; Ginevra Canonici Fachini, *Prospetto biografico delle Donne Italiane rinomate in letteratura dal secolo decimo quarto fino a' giorni Nostri di G.C.F. con una risposta a Lady Morgan risguardante alcune accuse da lei date alle donne italiane nella sua opera L' Italia*, (Venice: Alvisolio, 1824), pp. 32-33, 37, 216-217, 238-39, 244.

[7]Pietro Ferri, *Biblioteca femminile italiana*, (Padua: Crescini, 1842).

[8]Emma Tettoni, ' Le scienziate italiane " in *La donna italiana descritta da scrittrici italiane*, (Florence: Civelli, 1890), pp. 263-88. Some other important works from the nineteenth-century on learned women are Bartolomeo Gamba, *Donne italiane del secolo decimosesto*, (Venice: Alvisolio, 1832); Carolina Bonafede, *Donne bolognesi insigni*, (Bologna: Atesa editrice, 1971), reprint from 1845; O. Greco, *Bibliobiografia femminile italiana del secolo XIX*, (Venice, 1875); *Galleria di giovanette illustri italiane che nel nostro secolo XIX fiorivano ogni genere di virtù*, (Foligno: Tomasini, 1841).

[9]Francesco Castracane, " Cenni biografici della Contessa Elisabetta Fiorini Mazzanti ", *A.A.P.N.L.*, Vol. XXXII, (1878-1879), pp. 307-26. Other examples are Antonio Bertoloni, *Elogi del Cavaliere Ippolito Durazzo e della Nobil Donna Clelia Durazzo Grimaldi*, (Bologna: S. Tommaso d' Aquino, 1840), pp. 6-27; Giovanni Fantuzzi, *Elogio della Dottoressa Laura Maria Caterina Bassi Verati scritto da Giovanni Fantuzzi. Aggiungesi un' orazione del Dott. Matteo Bazzani*, (Bologna: S. Tommaso d' Aquino, 1778); Antonio Francesco Frisi, *Elogio di Donna Maria Gaetana Agnesi Milanese dell' Accademia dell" Istituto delle Scienze e lettrice onoraria di matematiche nell' Università di Bologna*, (Milan: Galeazzi, 1799); Giuseppe Grotto, *Delle lodi della Dottoressa Cristina Roccati. Orazione di Giuseppe Grotto recitata per ordine della letteraria Accademia de' Concordi di Rovigo nell' esequie a lei celebrate nel Tempio della B .V. del Soccorso il di 26 marzo 1814*, (Venice: Fracasso, 1815); Benedetto Bacchini,

Helenae Lucretiae (Quae & Scholastica) Cornelae Piscopae..Opera, (Parma: H. Rosati, 1688); Diego Vitroli, *Elogio di Angela Ardinghelli Napoletana latinamente scritto da Diego Vitrioli e da lui volgarizato,* (Naples: Gaetano Nobile, 1874); R. Buriani, " Necrologia della Dottoressa Anna Maria Dalle Donne " in *Almanaco Statistico Bolognese per l'anno 1842. Dedicato alle donne gentili,* (Bologna: N. Salvardi, 1842).

[10]Luisa Anzoletti, *Maria Gaetana Agnesi,* (Milan: L.F. Cogliati, 1900); G.B. Comelli, *Laura Bassi e il suo Primo trionfo,* (Bologna, 1912); Ugo Cessi, *Una dottoressa rodigina del secolo XVIII,* (Venice: Visentini, 1901); A. Giulini, " Contributo alla biografia della Contessa Clelia Borromeo del Grilli ", *Archivio storico lombardo,* XLVI, (1919), pp. 582-592; A. Garelli, " Biografia " in *Lettere inedite alla celebre Laura Bassi scritte da illustri italiani e stranieri con biografia,* (Bologna, 1885), pp. 3-47; Antonio Favaro, " Amici e corrispondenti di Galileo Galilei: Margherita Sarrocchi ", *Atti del R. Istituto Veneto di Scienze, Lettere ed Arti,* (novembre 1893 all' ottobre 1894), pp. 575-576; Giovanna Pierattini, " Suor Fiammetta Frescobaldi: Cronista al Monastero Domenicano di Sant' Jacopo a Ripoli in Firenze (1523-1586) ", *Memorie Domenicane,* 56 (1939), pp. 101-16, 233-40, 57 (1940), pp. 106-11, 260-69, 58 (1941), pp. 28-38, 74-84, 226-34, 258-68.

[11]E. Lagrange, " Les femmes astronomes ", *Ciel et terre,* Vol. 5, (1885), pp. 513-22; Alphonse Rebière, *Les femmes dans les sciences: notes recuilles,* (Paris: Nony, 1897); H.J. Mozans, *Women in Science with an Introductory Chapter on Women's Long Struggle for Things of the Mind,* (1913), (Cambridge, Mass.: M.I.T. Press, 1974); Gino Loria, " Les femmes mathématiciennes ", *Revue scientifique,* no. 13, 4me. série, T. XX, (26 septembre 1903), pp. 388-391; Kate Hurd Mead, *A History of Women in Medicine from the Earliest Times to the Beginning of the Nineteenth-Century,* (1938), (rept. Boston: Mitford House, 1973); Marilyn Ogilvie, *Women in Science, Antiquity through the Nineteenth-Century,* (Cambridge, Mass.: M.I.T. Press, 1986), pp. 3-20; Margaret Alic, *Hypatia's Heritage: A History of Women in Science from Antiquity through the Nineteenth-Century,* (Boston: Beacon Press, 1986), pp. 1-11, 50-55, 204, 117, 139; see also Schiebinger, pp. 7-36, 119-127; for the Bonghi law see Dalla Casa, Tarozzi, pp. 159-64.

[12]E. Zilsel, " The Sociological Roots of Modern Science ", *American Journal of Sociology,* 47, (1942), pp. 544-62; H. Butterfield, *The Origins of Modern Science 1300-1800,* (London: G. Bell and Sons, 1957), (repr. 1945), pp. 120-138; Marie Boas Hall, *The Scientific Renaissance 1450-1630,* (New York: Dover Publications, 1994), (repr. 1962); A.R. Hall, *From Galileo to Newton,* (New York: Dover Publications, 1981), (repr. 1963); Alexander Koyré, " The Significance of the Newtonian Synthesis ", reprinted in Koyré, *Newtonian Studies,* (London, 1965), 3-24; Thomas S. Kuhn, *The Structure of Scientific Revolutions* (1962), 2d. edn., enl. (Chicago, 1970); D.C. Lindberg and R.S. Westman eds., *Reappraisals of the Scientific Revolution,* (Cambridge: Cambridge University Press, 1990), pp. xvii-xxv; Richard S. Westfall, *The Construction of Modern Science: Mechanisms and Mechanics,* (New York, 1971), pp. 1-80; Paolo Rossi, *La nascita della scienza moderna in Europa,* (Rome: Laterza, 1997), pp. IX-XXI.

[13]Zilsel, pp. 544-62; Boas Hall, pp. 344-49, 120-22, 247-64; A.R.Hall, pp.36-77, 329-43.

[14]Rossi, pp.35-54, 107-63, 231-34, 317-59; Elisa Abati, Anna Barozzi, Vittoria Toschi, " L' ultimi capitolo della storia di una conquista: la facoltà di Ingegneria ", *Alma Mater Studiorum*, pp. 215-45.

[15]Kuhn.

[16]Carolyn Merchant, *The Death of Nature: Women, Ecology, and the Scientific Revolution*, (San Francisco: Harper and Row, 1980), pp.288-89; Alic, pp.5-9.

[17] Eamon, pp. 3-9, 135-37, 164-64, 194, 290.

[18]Nancy G. Siraisi, *Medieval & Early Renaissance Medicine. An Introduction to Knowledge and Practice*, (Chicago: Chicago University Press, 1990), pp. 13, 27, 35, 44-46, 147, 176; Paula Findlen, *Possessing Nature. Museums, Collecting, and Scientific Culture in Early Modern Italy*, (Berkeley: The University of California Press, 1994), pp. 112, 140-145, 364-65, 388-90.

[19]Findlen, pp. 61-70.

[20]Walter Tega ed., *Anatomie Accademiche*, Vol. II: *L' enciclopedia scientifica dell' Accademia delle Scienze di Bologna*, (Bologna: Il Mulino, 1987), pp. 30, 127, 140, 147-48, 173, 178, 193, 242.

[21]Aldo Brigaglia e Pietro Nastasi, " Bologna e il Regno delle Due Sicilie. Aspetti di un dialogo scientifico (1730-1760) " found in *Scienza e letteratura nella cultura italiana del settecento*, Renzo Cremante e Walter Tega eds., (Bologna: Il Mulino, 1984), pp.211-232 and in *Giornale critico della filosofia italiana*, 6ª serie, Vol. IV, anno LXIII, (1984), pp. 145-178.

[22]Paolo Casini, " Les débuts du newtonianisme en Italie, 1700-1740 ", *Dix-huitième siècle*, Vol. 10, (1978), pp. 85-100; Vincenzo Ferrone, *Scienza, natura, religione. Mondo newtoniano e cultura italiana nel primo settecento*, (Naples: Jovene, 1982).

[23]Merchant, *The Death of Nature*, pp. xvii, 5, 168-172, 288-89; Evelyn Fox-Keller, *Reflections on Gender and Science*, (New Haven: Yale University Press, 1985), pp. 3-77; Schiebinger, *The Mind Has No Sex?*, pp. 119-277; Carolyn Merchant, " Isis' Consciousness Raised ", *Isis*, Vol. 73, no. 268, (1982), pp. 398-409; David F. Noble, *A World without Women: The Christian Clerical Culture of Western Science*, (New York: A. A. Knopf, 1993); Elizabeth Fee, " Science and the Woman Problem: Historical Perspectives ' in *Sex Differences: Social and Biological Perspectives*, Michael Teitelbaum ed., (New York: Anchor Books, 1976), pp. 175-223; Fees discusses the problem of gender and science for the period 1860-1890.

[24]Fox-Keller, pp. 3-77; Merchant, *The Death of Nature*, pp. 288-89; Merchant, " Isis' Conciousness Raised ", pp. 398-409..

[25]Schiebinger, pp.14-16, 65-116, 119-275.

[26] Noble, pp. 146-47, 157-59, 163-71.

[27]Boas Hall, p. 185.

[28]Pnina Abir-Am and Outram's work does not deal with Italian women, but their criticism of Merchant's work is also valid in the Italian context, see Pnina Abir-Am and Dorinda Outram eds., *Uneasy Careers and Intimate Lives: Women in Science, 1789-1979*, (New Brunswick: Rutgers University Press, 1987), pp. 3-4.

[29]Merchant and Noble sources are historians of the Renaissance, and not of science, and are respectively Joan Kelly-Gadol and Paul O. Kristeller, see Joan Kelly-Gadol, " Did Women Have a Renaissance? in *Becoming Visible. Women in European History*, R. Bridenthal, C. Koonz, S. Stuard eds., (Boston: Houghton Mifflin Company, 1987), pp. 175-201; Paul O. Kristeller, " Learned Women of Early Modern Italy: Humanists and University Scholars "in *Beyond Their Sex: Learned Women of the European Past*, Patricia H. Labalme ed. (New York, 1980), pp. 95-102. Schiebinger uses Mozans, Rebière, Loria and other English sources , but also three primary sources Charles Burney, *The Present State of Music in France and Italy* (1773), ed. Percy Scholes, (London, 1959), pp. 159-160 for Laura Bassi and for Maria Gaetana Agnesi her *Propositiones Philosophicae*, (Milan 1738) and Maria Gaetana Agnesi, *Instituzioni analitiche* (Milan, 1748), both of which she does not really analyse.

[30]Gian Ludovico Masetti-Zannini, *Motivi storici della educazione femminile (1500-1650): scienza, lavoro, giuochi*, (Naples: M. D' Auria, 1982), p. 9-70; *Alma Mater Studiorum*, pp. 15-156; Paula Findlen, " Translating the New Science: Women and the Circulation of Knowledge in Enlightenment Italy, *Configurations*, 2 (1995), pp. 157-206. I would like to thank Prof. Findlen for providing me with her article.

[31]Masetti-Zannini, pp. 9-70.

[32]Lucia Tosi Traversi, " Verso l'inserimento della donna nel mondo academico ", *Alma Mater Studiorum*, pp. 15-37; see also pp. 39-118, 147-56 for the women in the sciences and pp. 159-258 for the statistical articles.

[33]Findlen, " Translating the New Science ", pp. 172-73, 186-92.

[34]Elizabeth Fox-Genovese, " Introduction " in *French Women and the Age of Enlightenment*, Samia I. Spenser ed., (Bloomington: Indiana University Press, 1984), pp. 1-29; Schiebinger, pp. 20-36.

[35]For the association of women with universities during the Renaissance and Baroque periods see Gabriella Berti Logan, " The Desire to Contribute: An Eighteenth-Century Italian Woman of Science ", *The American Historical Review*, Vol. 99, no. 3, (June 1994), pp.789-91; Siraisi, p. 27.

[36]Berti Logan, p. 789.

[37]For Galileo's trial see Stillman Drake, *Galileo: Pioneer Scientist*, (Toronto: University of Toronto Press, 1990), pp. 192-203; Galileo's *Dialogue concerning the Two Chief World Systems* remained in the *Index librorum prohibitorum* until 1835 see Ugo Baldini, " L' attività scientifica nel primo settecento ", in *Storia d' Italia Annali 3: Scienza e tecnica nella cultura e nella società dal Rinascimento a oggi*, (Turin: Einaudi, 1980), p.529.

[38]Findlen, *Possessing Nature*, pp. 112, 143n, 388-89.

Chapter I

Scientific Trends Affecting Italian Women's Education from the Renaissance to the Nineteenth Century

Although a few women would do some pioneering work as far as Italian science was concerned, women tended to be followers, rather than initiators of scientific trends. Thus this section intends to discuss briefly, for the purpose of clarification, which were the principal scientific trends in astronomy and cosmology, mathematics, natural philosophy, medicine and natural history that affected Italian women active in the sciences from the Renaissance to the nineteenth century.

Astronomy and cosmology. Women who were introduced to cosmology and astronomy prior to Galileo's discoveries studied the Aristotelean-Ptolemaic system of an immobile earth at the centre of the universe. The sublunar region, to which the earth belonged, was composed of four elements: earth, water, air and fire; whereas the celestial region was composed of a fifth, incorruptible element, ether. Some commentary of John Sacrobosco's *Treatise on the Sphere* would provide the necessary information on Aristotelean-Ptolemaic cosmology. A knowledge of the fixed stars could be gathered from an elementary handbook on constellations such as Alessandro Piccolomini's *De le stelle fisse* (1540). Those astronomers desiring to know the size of the universe, would use Al-Farghānī's very popular method of calculating cosmic dimensions. The Arab astronomer (ninth century, Baghdad) had computed the known planets'absolute distances directly from Ptolemy's *Almagest*, and assumed no space between the celestial spheres. The outer and inner surfaces of each planetary sphere was defined by the

maximum and minimum distances (apogee and perigee) of each planet from the centre of the earth. Since there was an accepted order of the planets, one would have to determine the relative apogee and perigee of each planet; these latter steps were made easier by the publication around 1472 of Georg Peurbach's *Theoricae Novae Planetarum*, which was to become a standard astronomy text at universities. Given the measurement of an absolute distance, such as that of the moon, by lunar parallax, for instance, the actual distances to all the celestial sphere, and the size of the universe could then theoretically be calculated.[1]

A widespread belief amongst the intellectual elite, which was to last to the end of the seventeenth century, that celestial bodies influenced all bodies in the sublunar region, and thus, that the knowledge of planetary disposition would permit prognostication on climate, agriculture, health, and events, associated astronomy very closely with astrology. Courses in astrology were taught at universities, and continued to be taught at the University of Bologna into the seventeenth century. During the Middle Ages and Renaissance students in elementary astrology were introduced to the first three books of Euclid's *Elements*, a commentary of Sacrobosco's *Sphere*, and a simplified textbook of planetary theory. To engage in actual computation for astrological purposes, a student had to acquire familiarity with the appropriate astrological tables, astronomical instruments such as the astrolabe, and ephemerides--tabulations of planetary motions--which until the middle of the sixteenth century were the Alphonsine Tables adjusted to the local meridian.[2] During the seventeenth century Johannes Kepler's *Rudolphine Tables* (1627), based on Tycho Brahe observations and his own elliptical planetary theory--founded on the heliocentric system-- became the new standard because of their

greater accuracy with astronomers and astrologers alike. Astrologers also adopted, alongside the classical Pythagorean planetary aspects (the geometrical angles planets formed with one another), the new aspects Kepler had introduced in his belief of their greater accuracy and prognostic importance.[3]

The Catholic Church's condemnation of the Copernican system in 1616, and of Galileo in 1633 ensured that Italian natural philosophers and astronomers officially adopt Tycho Brahe system of an immobile earth at the centre of the world, with the planets circling the sun, while the sun circled the earth, as expounded by the Jesuit Giovanni Battista Riccioli in his *Almagestum Novum* (1651).[4] The learned in Italy could, and did, of course read and adopt unofficially the Copernican system found in the vortices theory expounded in René Descartes' *Principles of Philosophy* (1644), or in the theory of universal gravitation explained in the third book of Isaac Newton's *Philosophiae naturalis principia mathematica* (1687) since, unlike Galileo's *Dialogue*, these works were not placed in the Vatican's *Index librorum prohibitorum*. Descartes' *Principles* escaped censorship because the author emphasized that the work was to be read as a tale. He also camouflaged his support of the Copernican system by disguising the earth's diurnal rotation around its axis, and yearly movement around the sun. According to Descartes, the earth and the planets were at rest, and had no propensity to movement, but as they were surrounded on all sides by a fluid matter that constituted the heavens, they were transported in their courses by this fluid matter which whorled like a vortex around the sun. Alongside the great vortex that had the sun at the centre, there were nine vortices; one such vortex moved the moon around the earth monthly, and the earth in its axis in twenty four hours. Descartes also carefully affirmed the prevailing orthodox view

that the universe was created fully formed; thus, the sun and the earth existed from the beginning, and Adam and Eve were born as fully grown people.[5] Newton's *Principia* might have escaped censorship because although in the "System of the World" of Book III, the Copernican system was certainly implied, and could be deduced from propositions V to XIX, it was, however, never explicitly declared. Furthermore, Book III was highly mathematical and could only be understood, as Newton himself pointed out, "by those only who had first made themselves masters of the principles [in mathematics and mechanics] established in the precedings books ".[6]

The increased complexity of instrumentation, as well as of celestial mechanics, as developed by Giuseppe Luigi Lagrange, and particularly by Pierre Simon de Laplace in his *Traité de mécanique céleste* (1799-1825) and by Carl Friedrich Gauss' *Theoria motus corporum caelestium* (1809), requiring advanced mathematics in order to compute and predict the motion of celestial bodies, ensured that astronomy became even more associated with public institutions of higher learning. Nineteenth century amateur astronomers, with inadequate mathematical background, could still observe shooting stars to derive the height of their appearance and extinction in order to find out and compile catalogues of their radiants, or points from which meteors appear to proceed. These catalogues were then used by theoretical astronomers to discover the connection between meteor swarms and comets.[7]

Mathematics. Through the centuries Italian women were also introduced to mathematics, another topic always closely related to astronomy. During the Renaissance this mathematical knowledge might include the learning of the figurative numbers found

in Pythagorean numerology, a topic which played an important part in astrology. It could also include some knowledge of parts of Aristotelean logic, whereby Aristotle by his reference to mathematical concepts and theorems made his contribution to mathematical development, or/and Plato's *Timeus*, which introduced the reader to Platonic solids (regular polyhedra) and their application in the explanation of scientific phenomena.[8] It was, however, Euclid' s *Elements* which reigned supreme. The work was translated into Latin from the Arabic in the twelfth century. Its first printed version appeared in Venice in 1482. Most importantly, for those men and women who could not read Latin, in 1575 an Italian version came out of Federico Commandino's press.[9] Although in 1269 William of Moerbeke had translated into very literal Latin the chief works of Archimedes, this translation was only occasionally used until the sixteenth century, when Niccolò Tartaglia published it as his own in 1543, and Federico Commandino published his own reconstructed versions of the works in 1558 (Measurement of a Circle, On Conoids and Spheroids, On Spirals, Quadrature of the Parabola,The Sand-Reckoner) and 1565 (On Floating Bodies). Commandino also translated, reconstructed and published Apollonius' *Conics* in 1566, and Pappus of Alexandria's *The Mathematical Collection* in 1588. Thus in the following years, if Euclid's *Elements* remained the canon for rigorous demonstrations to Italian mathematicians like Galileo, Luca Valerio, Bonaventura Cavalieri and others, the works of Apollonius, Pappus and, particularly of Archimedes were sources of methodology and examples for further research.[10]

Algebra also experienced development during the sixteenth century with the solutions of cubic and quartic equations by respectively Niccolò Tartaglia and Ludovico Ferrari, and the work of François Viète, noteworthy for the generality of expression.

Algebra and geometry were to combine to become analytic geometry in Descartes' *La géométrie* (1637), whereby algebraic procedure would free geometry from the use of diagrams, and geometric interpretation would give meaning to the operations of algebra. Analytic geometry was also invented by Pierre de Fermat, whose work on the subject, although it circulated in manuscript form, was only published years after his death. In the first half of the eighteenth century, both Fermat's method of plotting curves from equations, and Descartes' method of constructing them through locus of lines were used by mathematicians.[11]

The most important development in mathematics after the invention of analytic geometry was the discovery of infinitesimal analysis by Isaac Newton in 1665-1666, but whose first account appeared only in 1687 in the *Principia*, and by Gottfried W. Leibniz, whose *New Method for Maxima and Minima, and also for Tangents* (1684) contained his first account of differential calculus. It was, however, Leibniz annotations which were adopted by continental mathematicians, such as the Italians. Whereas analytic geometry spread uniformely through the Italian peninsula during the first half of the eighteenth century, Italy lagged behind Central and Northern Europe in the study of infinitesimal analysis. Within Italy, there were also variations between North and South. Infinitesimal calculus diffused more rapidly in the North through the universities of Bologna, Padua and Pisa during that period, thanks to the efforts of individuals like Gabriele Manfredi, Vittorio Stancari, Jacopo Riccati and sons, Giovanni Poleni and Jacob Hermann. In spite of the efforts of Celestino Galiani in Naples, mathematicians in the South believed infinitesimal calculus to lack rigour and remained attached to synthetic geometry.[12]

Natural Philosophy. Until Galileo's time, women who were introduced to natural philosophy studied commentaries, translations, and/or encyclopedias of Aristotle's natural books, namely *On the Heavens (De caelo), Physics, Meteorology, On Generation and Corruption, On the Soul (De anima)*, and also his *Metaphysics.* The most important of these works were the *Physics* and *Metaphysics* due to their emphasis on general principles and concepts. These concepts ranged from Aristotle's belief in the impossibility of a vacuum to a belief that there were two types of terrestial motion, natural motion and violent, or unnatural motion. Natural motion consisted of the fall of heavy or earthy bodies, if unimpeded, in a straight line towards the centre of the earth. It was also natural for light, airy, fiery or smoky bodies to move away from the centre of the earth and rise, if unimpeded, towards the concave surface of the lunar sphere. In violent motion, such as that of a projectile, the surrounding medium (air), which had been set in motion once the projectile was thrown, was responsible for the continuity of motion. Aristotle and followers also acccepted that if a weight fell from a certain height in a determined time, a weight which was twice as great would fall the same height in half the time.[13]

The publications of Galileo and his school began to chip away at many Aristotelean concepts. In Galileo's *Dialogue Concerning Two New Sciences* (1638) were recorded his discoveries of the times-squared law of distances in fall, which contradicted Aristotle's belief that a heavier body would fall faster, and of the parabolic trajectory of projectiles. In *On Bodies that Stay atop Water* (1612) Galileo pointed out by means of experiments, geometric demonstrations and Archimedes' principle that

density determined whether a body floated or sank when literally placed in water, and not shape as Renaissance Aristotelians believed. Galileo's student, Evangelista Torricelli, inspired by his teacher's research on vacuum, by means of his experiments on a column of mercury was able to show, in contradiction to Aristotle, that there were limitations to nature's ability to prevent a vacuum. The Galilean-Torricellian school of fluid mechanics was to draw the attention of both Newton and P. Varignon in 1687 and were to influence Italian natural philosophers like Domenico Guglielmini and Bernardino Zendrini to name a few.[14]

In the seventeenth century there appeared the works of two natural philosophers, Descartes and Newton, who were to greatly influence the classical sciences of mechanics and optics, as well as Baconian sciences of electricity, magnetisn and heat in the eighteenth century.[15] In Descartes' *Dioptrics* (1637), there appeared for the first time in print Snel's sine law of refraction, recognized in the eighteenth century as Descartes' law, as well as the Cartesian explanation of refraction. *Dioptrics* also contained Descartes' concept of light as pressure, in addition to his explanation why he believed light from the Sun reached the earth in an instant. The concept of light as pressure was also present in his *Principles of Philosophy* (1644). This latter work contained, in addition, Descartes'assertion that the quantity of motion in the universe was conserved, presented in more details than he had done in *Dioptrics.* Mathematics was largely absent from the *Principles*, but it played a role in Descartes' seven rules for determining the speed and direction of bodies after collision. These depended on the mathematical formula for the conservation of quantity of motion, measured as the product of speed and size. In the *Principles*, Descartes defined matter as extension; in doing so he denied,

unlike Torricelli, the existence of vacuum. The denial of a vacuum led Descartes and his followers in the next century to view magnetic attraction as nothing more than mechanical impulse. In spite of objections and persecutions by various Churches, Cartesian mechanistic natural philosophy spread through Europe during the seventeenth and early eighteenth centuries, and Nicholas Malebranche's modifications to it, made it a source of explanation not only for light, magnetism and planetary motion, but also for electricity [16] Thus when Isaac Newton published his main works the *Principia* in 1687, and *Opticks* (1704) and its Latin version *Optice* in 1706, he was faced with a well-established Cartesian philosophy in various parts of continental Europe.

In his *Principia,* Newton was intent on demonstrating by means of a simple mathematical formula that all pairs of material particles in the universe mutually gravitate in accordance to the laws of motion which he had explained.. Newton provided no causual explanation of gravity, but his references in the work to bodies attracting one another across spaces which, unlike the Cartesian space, offered no resistance to accelerative forces which diminished as the square of the distance, to powers exercised in proportion to mass, led those who read the book, whether they accepted Newton's conclusions or not, to believe that Newton viewed gravity as an innate property of matter that acted at distance. This belief was compounded by the fact that in Queries of the 1706 Latin version of his *Opticks*, usually used in Italy, Newton referred reflection, refraction, diffraction and emission of light, and heat production to short-range attractions and repulsions between the particles of bodies and the rays of light. To the aetherless world of short-range interparticulate attractions and repulsions could also be attributed the phenomena of cohesion, capillarity, elasticity and selective chemical combination.

To Cartesians and Leibnizians alike, who did not accept the concept of a vacuum, action at a distance was tantamount to attributing non-mechanical, occult qualities to matter. To Newton's followers short-range interparticulate attractions and repulsions provided explanation for phenomena found in the queries, and mentioned above. It also provided them with a paradigm within which they could experiment.[17]

Christian Huygens's and Leibniz 's criticism that Newton had failed to prove what caused gravity led the latter to hint at an aether mechanism for gravity in the general scholium of the 1713 edition of the *Principia.* In Queries 17 to 24 of the 1717 edition of *Opticks,* Newton mentioned that a subtle, elastic, active medium might help explain refraction, diffraction, and perhaps gravity. The publication in 1744 of a letter from Newton to Boyle, written in 1679, showed that the former had made a parallel between air and aether. This aether was the principle of both cohesion and separation. With Newton himself proven to have been unsure as to whether an aether existed or not, his followers saw fit to introduce weightless substances as carrier of forces associated with heat, light, fire, electricity, and magnetism. For instance, Benjamin Franklin's system of electricity assumed electricity to have been a fluid, whose particles were able to act at microscopic distances, as most Newtonian experimental philosophers would believe, and also at sensible intervals, but then, only by means of a medium defined to be an electric atmosphere. This fluid could run through conductors, and be arrested by insulators. Franklinists believed also that like charges repelled, and unlike charges attracted each other. However, they failed to explain repulsion between negatively charged bodies, which by their definition lacked the mechanism responsible for electric motion. This concept of an electric atmosphere began to be seriously questioned by those who

operated within the Franklinian system with Alessandro Volta's invention in 1775 of the electrophore, a device, which if electrified but once, never lost its electricity, no matter how often one tried to discharge it. This simple machine produced electrostatic charge by induction, or by action at a distance, and could not be explained by the concept of electric atmospheres. For electricity, at least, Newton's original concept of action at a distance without the interaction of a subtle medium began to be applicable.[18]

Newton's *Opticks*, which contained many experiments, and less mathematics than his *Principia*, was more accessible to the reader with a limited mathematical background, and thus turned out to be popular amongst eighteenth century empiricists. The book, besides containing the popular queries, also contained Newton's equally popular experiments on light. In the work, Newton showed that white light consisted of rays that differed in colour, and thus, differed in refrangibility. He also showed that rays of white light, diffracted by a prism could recombine by means of another prism into white light again. Newton considered light to be a physical substance, finer, and and subtler than air, running enormous distances in a very short time, in any direction, in straight lines. The fact that light travelled in straight lines was indicative of its material nature. This corpuscular nature of light served as a basis of explanation for optical phenomena such as refraction, reflection, and inflection to Newton and his followers. For instance in refraction, the corpuscular nature of light meant that its velocity was directly proportional to the medium's refractive index. Thus, like Descartes, Newton believed that light travelled faster in a denser medium than a rarer one. Consequently, light moved faster in denser bodies than in air or vacuum. But the Newtonian explanation for the believed effect was in keeping with Newton's natural philosophy, or that, in a denser medium

stronger attractive forces pulled light into the medium, refracting it closer to the vertical, and by the same token, increasing its speed.[19]

In the eighteenth century, Cartesians, Newtonians, and Leibnizians disagreed on what represented the " true " measure of force, and brought about what is now defined as the *vis viva* (live force) debate. Nowadays, force is always correlated with some kind of acceleration. In Definition II of his *Principia* Newton had defined quantity of motion to be the product of the quantity of matter (mass) and velocity. There is no indication that Newton identified the *vis insita*, or the innate force of matter, which he also called inertia, or force of inactivity in Definition III, with the quantity of motion, but eighteenth century Newtonians did. Thus to Cartesians and Newtonians alike, if not to Newton, force was measured as the product of the mass and the velocity (mv). Descartes had argued that a body could put in motion another body, as long as the total quantity of motion was conserved. Hence the " true " measure of force was the change of quantity of motion it produced at a given time. Newtonians also expounded the conservation of quantity of motion. In 1686, in his *Brevis demonstratio*, Leibniz had objected to the Cartesian law of conservation, and had proposed, instead, to measure the force of bodies in actual motion, which he called *vis viva*. This force was the product of the mass and the square of the velocity (mv^2). To the Leibnizians, it was the *vis viva* which was conserved. In this case, space was the basis for the measure of force. There were also metaphysical differences between Newtonian and Leibnizian systems of philosophy. To the Newtonians and Cartesians all source of motion was God, for matter itself was inert. To Leibniz, matter was alive, and contained the principle of change within it.[20]

It has to be said that not all natural philosophers who were ready to accept Cartesian, Newtonian, or Leibnizian physics, were equally ready to accept their metaphysics, particularly in Italy where adherence to certain metaphysical stances could lead to censorship problems with the Catholic Church. Thus Giovanni Poleni, professor of physics at the University of Padua, whose work *De Castellis* (1718) did much to ignite the *vis viva* debate across Europe in the eighteenth century, took no metaphysical position on the matter. In *De Castellis*, Poleni had " described the fall experiments in which a moving body lost all motion in impact with a soft medium ". A particular experiment, as designed by Poleni, demonstrated, to his view, that force had to be measured according to Leibnizian definitions. Similar experiments carried out by the Newtonian William's Gravesande were enough to convert him to the Leibnizian cause in physics and metaphysics. Although Poleni's experiment, and variations thereof, did much to convert natural philosophers in the Republic of Venice, and the Kingdom of Naples to the Leibnizian definition of force and its conservation, these conversions did not extend, at least in print, to Leibniz's metaphysical stance. Galileo's condemnation by the Catholic Church did much to ensure that Italian natural philosophers separate, at least in their publications, their physics from their metaphysics. [21]

Medicine and Natural History. Nancy Siraisi appropriately points out that the organization of university medical faculties during the thirteenth century ensured that women be excluded from high medical education. That is not to say however that women, particularly from the aristocracy and professional elites, would not be exposed, or introduced to some of the ideas and trends in medicine and related natural fields that

originated or/and were taught at universities. Prior to the late fifteenth century, when major efforts were made by humanists to recover, read and translate directly from the Greek, works by ancient authors in medicine and related fields, the most important texts introduced to students of medicine were a brief Galenic compendium, known as *Ars parva*, Hippocrates's *Aphorisms* and *Prognostics* and sections of Avicenna's encyclopedic *Canon.* Thus, knowledge of Hippocrates, and Galen's works was far from complete. Galen's major anatomical treatise, *On the Usefulness of the Parts of the Body*, although translated into Latin in the fourteenth century, because of its length and difficulties was little known to physicians prior to the sixteenth century.[22]

The Medieval Medical School of Salerno's masters were amongst the first to introduce Aristotle's biological works in their teachings. These works contained some ideas which were in direct conflict with Galenic teachings and that were not to be resolved for several centuries. For instance, Aristotle believed that in reproduction, the male alone contributed the sperm which contained the active principle to conception; the female provided only the inert matter. Galen, to the contrary, expounded that both the female and the male contributed sperms to conception. Aristotle believed also that the heart ruled the entire body. On the other hand, Galen taught that there were three principal organs in the body: heart, brain, and liver. Avicenna in his *Canon* tried to reconcile Aristotelean and Galenic doctrines by stressing the heart's overriding influence over the body while also subscribing to Galen's theory of three principle organs.[23] Members from the Medical School of Salerno were also responsible for the compilation of herbals, works which presented a series of descriptions of plants, and sometimes animal and mineral substances, regarded as medicinal, in conjunction with medical,

pharmaceutical and scientific information regarding their names, uses, habitats and so on. The information contained in these herbals was in part derived from Dioscorides's *Materia medica*, in part from Arab pharmacology, and from local and others sources. One of the most important herbals, the *Circa instans*, attributed to the Salernitan physician, Matthaeus Platearius (d. 1161), became the prototype of Western pharmacopeias. Other similar works were to follow, such as the *Herbal of Rufinus*, heavily influenced by the School of Salerno and written after 1297 by Rufinus, who had studied and taught a Bologna. In fact, until the high Renaissance, medicinal recipes were the commonest form of medical writings.[24]

The humanists' belief that ancient Greek authors were better studied, not via Arab compilations, but in the original language, and/or modern translations from the Greek, led to the printing of the complete edition of Galen's works in Greek in 1525, and of numerous Latin versions of Galenic medicine in the first half of the sixteenth century. In addition, humanists' efforts led to the rediscovery of Theophrastus's botanical writings, and the publication of standard versions of Dioscorides's *Materia medica*, and of Pliny the Elder's *Natural History* in Latin and in the vernacular. The rediscovery by humanists of ancient texts in medicine, pharmacology and natural history, combined with the widening of the geographical environment brought about by voyages to America, Africa and Asia, led to an increased interest in nature, and thus in natural history, on the part of physicians and lay people alike during the sixteenth century. For instance, private gardens were created at various Italian courts, and private and court collections of *naturalia*, objects from nature, and *artificilia*, man-made objects, appeared throughout the Italian peninsula.[25]

The physicians' increased interest in nature translated into an effort on their part to identify as accurately as possible simples, or plants, animals, and/ or minerals with accepted, or potential medicinal values. This effort led to botanizing trips to identify plants, and to collect samples for herbaria on the part of physicians, their students, and also apothecaries. Chairs in simples attached to the faculty of medicine were founded at the universities of Rome (1513), Padua (1533), Bologna (1534), Perugia (1537) and Pisa (1543). Botanical gardens associated with universities appeared at Padua, Pisa, Florence, Pavia, Bologna and Rome to name the most important. In addition, there also appeared the collections (museums) of physicians, such as Ulisse Aldrovandi, professor at the University of Bologna, and apothecaries, like Francesco Calzolari, in which *naturalia* predominated. Thus, by the seventeenth century museums and botanical gardens had been thoroughly integrated into the teaching of simples in Italian universities.[26]

Although the institutional basis for natural history until the second half of the eighteenth century was to remain the faculty of medicine, physicians commitment to the subject went beyond medical purposes. Plants, animals, fossils and minerals could be studied for their own sake. The sixteenth century physician / naturalist usually limited himself to the description and illustration of plants, animals and minerals directly observed from nature using an essentially Aristotelean system of classification; however, there was also the first serious attempt at plant taxonomy by Andrea Cesalpino in his fundamental *On plants* (1583), or the effort by someone like Ulisse Aldrovandi to go beyond the information provided by classical authors on animals, plants and minerals. For instance, the dissection of vipers by Aldrovandi clearly showed them to possess

sexual organs, " and therefore did not conceive by the female's biting off the head of the male ", as previously believed.[27] In fact, by the late sixteenth century physicians had brought two techniques to the investigation of nature: dissection and chemistry. Very few animals and plants brought into the museum escaped dissection. Paracelsus and authors of books of secrets alike, such as the surgeon Leonardo Fioravanti, used chemistry, at the time couched in alchemical language, to challenge medical orthodoxy. More orthodox physicians, such as Aldrovandi, drew from the books of secrets instructions with which to test new remedies. Chemical analysis continued to usually serve medicine through two-thirds of the eighteenth century, for instance at the Academy of Sciences of Bologna, but by then it was couched in the language of affinities, influenced by H. Boerhaave's *Elementa Chymia* (1732) and Newton's queries as found in his *Opticks*. As P. Findlen points out in *Possessing Nature,* by the end of the sixteenth century and beginning of the seventeenth, naturalists, many of them physicians, had introduced to natural history--whether at the service of medicine or not--experience, the concern with method and order, and an ambivalent attitude towards authority, making it a vital enterprise long before the arrival of Buffon and Linnaeus. Furthermore, the books of secrets, which naturalists used then, introduced to anyone who could read the concept of science as a great hunt for the secrets of nature, redefining the function of experiment in science.[28]

Galileo's research in mechanics, quantitative methods, and discoveries were also to have an impact on Italian natural sciences, areas, which as seen above, had shown already considerable activity in the sixteenth century. Galileo himself, in the second day of his *Discorsi e dismostrazioni matematiche,* dealt with a problem in animal mechanics, in the

relation there existed in the animal between volumetric dimension and bone structure. Galileo's disciple Giovanni Borelli (1608-1679) combined mechanics with anatomical physiological data in his *De motu animalium* to successfully analyse mechanically muscle action. As the founder of the Italian iatromechanics's school, Borelli went beyond the simple quantification of natural functions, and used mechanical concepts ontologically, as expressed in his view of the corpuscular structure of matter, and of organic bodies. Borelli's concept of bodies as aggregates of minute machines, which functioned by established physical laws, appeared first in his *Delle cagioni delle febbri maligni* (1649), before a similar mechanistic Cartesian biology began circulating in Italy. Borelli's iatromechanical theories were to influence a student like L. Bellini, Giorgio Baglivi (1668-1706), who applied them to study of the function of glands and the phenomena of digestion and respiration, Marcello Malpighi, who had met Borelli while at Pisa University, and Antonio Vallinieri, one of Malpighi's students at University of Bologna. Borelli's animal mechanics continued to be popular amongst Neapolitan natural philosophers well into the eighteenth century, and serves to explain the welcome Stephen Hales's *Hemaestaticks* (1733)--a work in hemodynamics, in which techniques for measuring blood pressure, heart capacity, and the velocity of circulation were developed--received amongst this Neapolitan circle.[29]

Although the limitations of iatromechanics became more apparent by the mid of the eighteenth century, mechanistic theories in biology continued to flourish in the second half of the eighteenth century amongst naturalists like Charles Bonnet, Albert Haller, and Lazzaro Spallanzani, to name the most important, mostly as a reaction against vitalistic theories of G.L. Leclerc de Buffon, J.T. Needham and C.F. Wolff. Vitalists believed

there existed in nature a non-physical, vegetative force capable of producing living organisms from unorganized matter. Spontaneous generation and epigenesis (defined by Wolff to be the development of an embryo from unformed material by the action of an essential force) were the best proofs of the existence of such vital force. Intent on disproving vitalism, mechanists designed experiments, performed dissections and microscopic analyses in order to prove egg or sperm preformism, and to disprove spontaneous generation. A. Haller rejected aprioristic Cartesian biology, but not biological mechanism per se, as found in his experimentally-based acceptance of preformism, and in his physiological explanation of the irritability, or non-sensitivity of the muscles and of the non-irritability, or sensitivity of the nerves. A shared ontological viewpoint might serve to explain the popularity and influence of Haller's physiological work amongst physicians and naturalists of the University of Bologna, such as Giuseppe Veratti, L. Marcantonio Caldani, Felice Fontana and Tarsizio Riviera, who had been exposed through successive generations to Malpighi's mechanistic theories. A physician like Tarsizio Riviera, professor of obstetrics at the University of Bologna, continued to attribute mechanical causations also in cases of birth deformities as late as 1800.[30]

Marcello Malpighi's ontological concern with the structure of matter, and thus of organic bodies, led him to make use of another Galilean discovery, the microscope, in his pioneering research of the structures of the lung, kidney, tongue, spleen, liver, and skin, on the embriology of the chick, the anatomy of the silkworm, and plant anatomy. The first results derived from Galileo's microscope had been published by the founder of the Academy of the Lincei, Federico Cesi in his *Apiarium* (1630). After that time, whether one belonged conceptually to Borelli's school of iatromechanics like Malpighi, and

Antonio Vallisneri, or kept metaphysical implications away from their work, as Francesco Redi (1626-1698), physician at the Tuscan court, and his followers would do, microscopy would be added to dissections, and often, to experiments in the physician-naturalist's quest not only to understand nature, but also to prove his ontological outlook.[31]

As Malpighi's research program indicates, the physician and/or naturalist could have broad interests and carry out investigations on a variety of subjects from human anatomy and physiology to comparative anatomy and geology. Francesco Redi's interests, however dissociated from ontological concerns of structure in print, still did not prevent him dissecting and examining the reproductive organs of flies and the stingers of scorpions under the microscope. Many vipers were dissected to determine the origin of their venom. Oak-galls were opened to determine whether trees really generated, as believed, the animals found in them. Intent on disproving the long-held Aristotelean maxim of spontaneous generation, or that living forms could spring from dead matter, Redi experimented with putrefied meat, and dung to show that in the protected (covered) meat, or dung, no insects appeared.[70] Malpighi's student, Antonio Vallisneri came to integrate the rationalistic, mechanistic aspects of Borelli's school, as represented by his teacher, with the descriptive experimentation of Francesco Redi. Vallisneri's first known publications " Dialogues on the Curious Origin of Many Insects " (1696 and 1700) are considered an extension of Redi's work to disprove spontaneous generation. His other works discussed worms found in humans, cattle and horses (animal parasitism) such as in *New Observations and Experiments on the Ovaries Discovered and Experiments on the Ovaries Discovered in the Round Worms of Men and Cattle* (1713)

and in *New Observations on the Verminous and Epidemic Constitution which Affected Horses in the Mantovano* (1715). In this latter work, Vallisneri studied the formation and effects of short worms on horses, and claimed that epidemics in cattle were also caused by worms. In his *History on the Generation of Man and of Animals Whether it Arises from Spermatic Worms or from the Egg* (1721), like his teacher Malpighi, Vallisneri favoured egg preformism, over A.Van Leeunwenhoek's sperm preformism, as others would do in the eighteenth century. Minerology received his attention in *Academic Lesson on the Origin of Fountains*(1715) and *On the Marine Bodies Found on Top of Mountains, their Origin, and the State of the World before, during, and after the Universal Deluge* (1721) in which Vallisneri came to reject the history, and truth of the Biblical Universal Deluge in his attempt to explain why marine fossils were found on top of mountains. The complete collection of his works published by his son in 1733, was the most influencial text in the natural sciences in Italy by the middle of the eighteenth century.[33]

The rationalistic and mechanistic aspects of Borelli's school, as represented by Malpighi, purged of many aprioristic implications, would influence physicians such Anton Maria Valsalva (another of Malpighi's students), and his own student at the University of Bologna, Giambattista Morgagni who dedicated most of their efforts towards a better understanding of human anatomy. Valsalva's *De aure humana* (1704), the result of more than one thousand dissections carried by the author and Morgagni over a period of ten years, improved knowledge of the anatomy of the ear extensively. In the text, the ear is subdivided for the first time into three distinct parts: outer, middle, and inner ear. Morgagni's *Adversaria anatomica prima* (1706) and *Adversaria anatomica*

altera et tertia (1718) were valuable guides to anatomical research, in which the author took into consideration old and contemporary bibliography for each single argument discussed. Valsalva's and Morgagni's works had immediate repercussion in Europe, as did Morgagni's principle opus, *De sedibus morborum*, or *On the Sites of Diseases* (1761). This latter work, based on hundreds of dissections by the author and his teacher, Valsalva, was again superior to all others at the time for its thoroughness, and the " successful correlation of clinical symptoms and autopsy findings ". As such, *De sedibus* broke new ground, as far as Italian anatomical research was concerned, because, for all its successes, the results achieved through such a research since Borelli's time, failed to explain clinical symptoms, as conservative critics were quick to point out. In fact, physicians belonging to Borelli's school, and its variations, clung to Hippocratic dogma, when it came to the practice of medicine. Except for the introduction of quinine as a febrifuge, mercury in the treatment of syphilis, iron as a tonic, and then in the eighteenth century, inoculation for smallpox, much of the therapeutics consisted of hygenic-dietetic advices.[34]

Research in animal, and plant physiology continued to be popular amongst naturalists during the second half of the eighteenth century, as exemplified by the works of Lazzaro Spallanzani (1729-1799). These works could range from his discovery that certain animals, such as salamanders for example, could grow back certain parts of their bodies after ablation, as in the *Prodromo di un' opera sopra le riproduzioni animali* (1768) to his experimental demonstration that oxygen was absorbed by various living tissues, as in his *Mémoires sur la respiration* (1803, posthumous).[35] Nevertheless, that period also saw the rise in importance of two branches of natural history--botany and

minerology (earth sciences)--brought about by changes within the sciences themselves, economic reasons, the increased popularity of these sciences elsewhere in Europe and of natural history in general in Italy, and the number of naturalists who entered the field, attracted to it by the publicity the subject in general received in the periodicals that mushroomed in the peninsula at the time.[36]

Undoubtedly, minerology's rise within natural history was aided by the interest various governments abroad, and in Italy, had in the discovery and mining of valuable ores, and in the proper training of mining engineers. A. G. Werner's method, published in 1774, of recognizing minerals through a variety of external characters, facilitated mineral identification in the field. In Italy, the works mentioned above of Vallisneri on the topic, and particularly of an amateur, the Venetian priest Lazzaro Moro in his *On the Crustaceans and Other Marine Bodies Found on Top of Mountains* (1740) were to influence minerologists of later generations such as Giovanni Arduino, Alberto Fortis, Antonio Vallisneri Jr., Lazzaro Spallanzani, John Strange, G. B. Brocchi, and S. Breislak. In his work, Moro had devised a form of illustration for describing strata, which would be later important in the development of stratigraphy. Moreover, he had arrived at a Plutonist interpretation of orogenesis, the process by which mountains were formed. Like Moro, his followers maintained that most transformations of the superficial crust of the earth could be attributed to the diversified action of vulcanic fire, and of the waters; they believed also that rocks like granith, porphyry and basalt had igneous origins. These ideas were in opposition to the Neptunist Wernerian school, whose followers assumed that nearly all formations had developed in water, and thus that granith, porphyry and basalt were sedimentary.[37]

The various Italian governments had also a role to play in the increased importance given to botany during the second half of the eighteenth century , particularly if applied to agriculture. Renaissance naturalists had shown an interest in agriculture, and had written texts on the subject. Furthermore, since the end of the sixteenth century, the Venetian patriciate had invested heavily in land, which they ran as a capitalist undertaking. However, in 1764-1766, a severe dearth hit large areas of Northern Italy, which forced the governments of the area into action. Agricultural academies and societies were founded by governments in most Northern Italian states, where members had the mandate to carry out research on crop improvement, new crops and plant diseases.[38]

Andrea Cesalpino had attempted botanical systematics in the sixteenth century, and botanical works, not associated with research in plant anatomy and physiology, continued to be published in the seventeenth century. The introduction of J. P. Tournefort's system of classification in 1694, led to works in plant taxonomy in Italy which made use of Tournefort's method, such as P.A. Micheli's *Nova plantarum genera iuxta Tournefortii methodum disposita* (1729), a work which described many new species gathered during his trips across Italy. However, it was Carl Linnaeus's artificial, binomial system of classification, based on the number, size, placement, and shape of the reproductive organs of the plants, or the stamen and the pistils, that led to the mushrooming of works on plant classification, and, particularly, on floras of different regions, abroad and in Italy from the 1750s onwards. Some Italian works, based on the Linnean system of classification, were, for example, Antonio Turra's *Flora italice prodromus* (1781), Domenico Vandelli's *Fasciculus plantarum cum novis generis et speciebus* (1771), Antonio

Bertoloni's *Rariorum Liguriae plantarum* (1803), and *Flora Italica* (1833-54), Domenico Nocca's *Ticinensis Horti Academici plantae selectae* (1800), and A. Sebastiani and E. Mauri *Florae romanae prodromus* (1818).[39] These Italian works dealt mostly with angiosperms (flowering plants), since there was a tendency on the part of Italian botanists, unlike their counterparts from across the Alps, to ignore cryptogams (plants having no stamen or pistils, such as ferns, mosses, fungi, algae, lichens), or discuss them in conjunction with other plants in general floras. Such neglect on the part on Italian botanists was corrected by the publication of Elisabetta Fiorini Mazzanti 's *Specimen bryologia romana* (1831) and of G. de Notaris's and B. Crivelli's *Prodromus bryologiae mediolanensis* (1834), works which were entirely dedicated to the classification of mosses. These publications were followed by works on fungal diseases by A. Bassi (1835), on lichen taxonomy and morphology by Fiorini Mazzanti (1857-58) and De Notaris (1850-61), and on the classification and morphology of algae in general by Fiorini Mazzanti (1859-67) and De Notaris (1842-67), and of diatoms in particular by Francesco Castracane (1866-88) towards the second half ot the nineteenth century. De Notaris and Castracane were to carry out seminal work in cryptogamic classification, and in the field of diatoms respectively.[40]

Chemistry had served medicine and natural history since, at least, the sixteenth century; but during the eighteenth century it would increase in importance, much like minerology and botany had done, and develop into a discipline in its own rights. Increased interest in minerology, particularly as it concerned mining, aided chemistry's development. For instance, interest in valuable minerals led to the discovery and isolation of various metals. But the greatest laboratory discoveries, which would

eventually lead to Lavoisier's chemical revolution, would be the isolation and identification of various " airs ", or gases as chemical entities. The seminal publication in the development of the chemistry of gases was a work in plant physiology, Stephen Hales's *Vegetable Staticks* (1727). The work contained a chapter which discussed and demonstrated by means of many experiments that " airs " could be obtained through heating, or fermentation from a large variety of substances (animal, vegetable, and mineral). Hales' approach to air analysis was physical, rather than chemical, since to him the "airs" obtained from the different substances were simply either in a fixed state--when in the substances--or in an elastic state--once released. Nevertheless, without being aware, Hales had obtained, most probably, most of the common gases in his studies. During the course of his research, Hales had also devised two apparati: the pneumatic trough, which he used to collect his " airs " over water, and the pedestal apparatus, which measured the volume of air released, or absorbed in chemical processes within a closed system. These apparati would be perfected and used later in the century by natural philosophers like Henry Cavendish, Joseph Priestley and Antoine Lavoisier in their experiments on gases.[41]

Natural philosophers not only used Hales' apparati, but also his experiments, or variations thereof, in the identification of fixed air (carbon dioxide) by Joseph Black (1756), of inflammable air (hydrogen) by Henry Cavendish (1766), and of nitrous air (nitric oxide) by Joseph Priestley (1772). Between 1772 and 1775, Priestley was also able to discover, in rapid succession, marine acid air (hydrogen chloride), vitriolic acid air (sulphur oxide), a vegetable air (ammonia), modified nitrous air (nitrous oxide) and dephlogisticated air (oxygen), assisted by a modification he had made to Hales'

pneumatic trough, which allowed him to collect water-soluble gases over mercury. On November 1772, Antoine Lavoisier announced to the Paris Academy of Sciences that phosphorus and sulfur, when heated combined with air and produced respectively acid spirit of phosphorus (phosphoric acid), and " vitriolic acid ", both weighing more than the initial phosphorus, and sulfur. To do these experiments he had used Hales' pedestal apparatus, and was led to them by reading Hales' experiments on phosphorus and sulfur. Lavoisier followed these experiments by others which dealt with the calcination of metals (tin, lead, and mercury) in enclosed recepients (a variation of Hales' pedestal apparatus), and the reasons for the increased weight these acquired during the operation..[42]

From the experiments, Lavoisier would conclude that in the calcination of metals, in the combustion of phosphorus and sulfur, and for that matter, in every combustion, combination with dephlogisticated air--or oxygen as he called the gas in 1779--would occur, with the evolution of heat and light, or caloric, and the formation, if one exempted metal calces and nitrous air, of an acid. Thus, in his concept, oxygen was a principle of acidity. Lavoisier's explanation for calcination was the exact opposite of the explanation offered in the standard phlogiston theory as devised by G. E. Stahl (1660-1734), whereby when a metal was heated, it lost phlogiston (inflammable principle) and was converted to calx (oxide). Thus, a metal would be a more complex substance than the calx. The increased weight that occurred during calcination was explained by the absorption of fire particle by H. Boerhaave, and his followers, or by the phologiston's negative weight by others. When in 1781 Cavendish identified the liquid that formed when inflammable air burned in dephlogisticated air as water, as a follower of the phlogiston theory, Priestley explained the formation of water at the end of the process in

terms of the decomposition of dephlogisticated and inflammable airs. This explanation was in keeping with the concept of water as an element, which dated from Greek times. To Lavoisier, water was a compound, which could be obtained in the combustion of oxygen and hydrogen, and thus could be decomposed into its constituent parts. However, he did not go so far as to believe oxygen to have been an element; instead he saw it as a compound of the oxygen principle and caloric.[43]

As it happened with minerology and botany, chemistry's increased importance during the course of the eighteenth century led to attempts by natural philosophers to give order and method, to what they came to perceive as unclear, alchemically-based terms, and Lavoisier was no exception. Thus, in the 1780s, Lavoisier and his supporters, Guyton de Morveau, C. L. Berthollet and A.F. de Fourcroy attempted to reform the existing chemical nomenclature to reflect what they believed to be actual composition. In 1787, there appeared *Méthode de nomenclature chimique, proposé par M.M. de Morveau, Lavoisier, Berthollet, & de Fourcroy*, which contained a method of chemical nomenclature that reflected conceptually what Lavoisier believed to occur in chemical processes. To conclude, it must be said that chemistry's development during the eighteenth century did not separate it from its basis in medicine and natural history. For instance, Priestley's realization that nitrous air (nitric oxide) could absorb and diminish a volume of common air, led him to devise a method, and thus an instrument--the eudiometer-- which used the gas in the determination of the salubrity of the air, or its relative purity. Within a few years, new eudiometer models appeared elsewhere in Europe, such as in Italy, and air salubrity was been measured in many places. The new understanding of the chemistry of gases led to its application in animal and plant

physiology by natural philosophers such as Priestley, Lavoisier, J. Ingenhousz, J. Senebier, Spallanzani and N.T. de Saussure in their attempts to understand the process of respiration in animals and plants.[44]

To conclude, one might add that by the 1850s, most of the sciences discussed above had become highly specialized, making it difficult for men and women dissociated from institutions of higher learning to contribute meaningfully to the various fields.

[1]Edward Grant, *Planets, Stars, and Orbs. The Medieval Cosmos, 1200-1687*, (Cambridge: Cambridge University Press, 1994), pp. 33, 189-92, 637-39; Rufus Sutter, " The Scientific Work of Alessandro Piccolomini ", *Isis*, 60, (1969), pp. 210-23; James M. Lattis, *Between Copernicus and Galileo: Christopher Clavius and the Collapse of Ptolemaic Cosmology*, (Chicago: University of Chicago Press, 1994), pp. 58-59, 77-78; Albert Van Helden, *Measuring the Universe: Cosmic Dimensions from Aristarchus to Halley*, (Chicago: University of Chicago Press, 1985), pp. 6-7, 16-20, 28-31, 41-42.

[2]For the influence of astrology at universities see Siraisi, *Medieval and Early Renaissance Medicine*, pp. 68-69; Nancy Siraisi, *Taddeo Alderotti and His Pupils: Two Generations of Medical Learning*, (Princeton University Press, 1981), pp. 140-45; A. Pannekoek, *A History of Astronomy*, (New York: Dover Publications, 1989), pp. 168-69; Lynn Thorndike, *A History of Magic and Experimental Science*, Vol. VII: *The Seventeenth Century*, (New York: Columbia University Press, 1934), p. 89; Ann Geneva, *Astrology and the Seventeenth Century Mind. William Lilly and the Language of the Stars*, (Manchester: Manchester University Press, 1995), p. 282.

[3]Thorndike, *The History of Magic*, Vol. VII, p. 446, Vol. VIII, pp. 326. 336; Geneva, pp. 152-53, 193-94; Van Helden, pp. 94-105.

[4]Van Helden, pp. 113-16; Grant, pp. 668-69.

[5]John Cottingham, *Cartesio*, (Bologna: Il Mulino, 1991), pp. 126-30; Gary Hatfield, " Reason Nature and God in Descartes " in *Essays on the Philosophy and Science of René Descartes*, Stephen Voss ed., (New York: Oxford University Press, 1992), p. 266; Pannekoek, p. 248; for which of Descartes' books were on the Index see *Index librorum prohibitorum usque ad diem 4 junii Anni MDCCXLIV regnante Benedicto XIV D.O.M.*, (Rome, 1744), p. 455. I would like to thank prof. Marta Cavazza for pointing out to me that the *Principles* were not in the Index.

[6]Isaac Newton, *Mathematical Principles of Natural Philosophy and His System of the World*, Vol. 2: *The System of the World*, Florian Cajori ed., (Berkeley: University of California Press, 1934), pp. 410-28; quotation in Pannekoek, p. 264; Ferrone, pp.34-42.

[7]Pannekoek, pp. 297-307, 321-70, 419-28.

[8]Carl B. Boyer, *A History of Mathematics, Reviewed by Uta C. Merzbach*, (New York: John Wiley & Sons, 1968), pp. 53-55, 84-85, 98; Geneva, pp. 18-19, 37; Paul Lawrence Rose, *The Italian Renaissance of Mathematics. Studies on Humanists and Mathematicians from Petrarca to Galileo*, (Geneva: Droz, 1975), pp. 16, 122.

[9]Boyer, p. 119; Rose, p. 208.

[10]The very able Sicilian mathematician Francesco Maurolico had also translated and reconstructed Apollonius'*Conics*, which, although completed in 1548 was not published until 1654; Boyer, pp. 261, 283, 301; Ugo Baldini, " Archimede nel seicento italiano " in

Archimede, mito, tradizione, scienza, Siracusa-Catania, 9-12 ottobre 1989, Corrado Dollo ed., (Florence: Olschki, 1989), pp. 237-289.

[11]Boyer, pp. 335-4, 346-48; Carl B. Boyer, *History of Analytic Geometry*, (New York: Scripta Mathematica, 1956), pp.177-86.

[12]Boyer, *The History of Mathematics*, pp. 391-414; Ferrone, pp. 524-44; Franco Palladino, " Origine e diffusione del calcolo differenziale in Italia. Con un appendice di lettere inedite ", *Giornale critico della filosofia italiana*, sesta serie, Vol. IV, Anno LXIII, (settembre-dicembre 1984), pp. 384-90; Luigi Pepe, " Il calcolo infinitesimale in Italia agli inizi del secolo XVIII ", *Bollettino di storia delle scienze matematiche*, Vol. I, (dicembre 1981), pp.56-89.

[13]Grant, pp. 19-31, 152-53, 196; René Dugas, *A History of Mechanics*, (New York: Dover Publications, 1988), pp. 19-24.

[14]Dugas, pp. 129-48; Drake, pp. 164-72, 207-20; C. S. Maffioli, " Guglielmini vs. Papin (1691-1697): Science in Bologna at the End of the Seventeenth-Century through a Debate on Hydraulics ", *Janus*, Vo. 71, (1984), pp. 250-87.

[15]This division originates with Thomas S. Kuhn, " Mathematical versus Experimental Traditions in the Development of Physical Science " in Kuhn, *The Essential Tension: Selected Studies in Scientific Tradition and Change*, (Chicago, 1977), pp. 31-65.

[16]David Park, *The Fire within the Eye. An Historical Essay on the Nature and Meaning of Light*, (Princeton: Princeton University Press, 1997), pp. 173-82; Dugas, pp. 154-63; Cottingham, pp. 113-20; Drake, pp.226-28; J. L. Heilbron, *Electricity in the 17th and 18th Centuries. A Study of Early Modern Physics*, (Berkeley: The University of California Press, 1979), pp.30-43.

[17]Heilbron, pp.46-58; Ferrone, pp. 26-36, Casini, p. 97.

[18]Heilbron, pp. 53-55, 330-39, 364-72, 416-17 (for a description of the electrophore), 422-30.

[19]Park, pp. 204-14; Hall, pp. 300, 319-25; Ferrone, pp. 28-34; Casini, pp. 86-87.

[20]For the debate on live forces see Carolyn Iltis, " The Leibnizian-Newtonian Debates in Natural Philosophy and Social Psychology ", *The British Journal for the History of Science*, Vol. 6, no. 24 (1973), pp. 343-77; S. Bergia and P. Fantazzani, " Dalla regolazione delle acque alle leggi dell' urto centrale elastico: una rivalutazione del ruolo di Giovanni Poleni nelle dispute delle forze vive ", *Giornale di fisica*, XXI, (1980), pp. 46-60; Luigi Neri, " Mechanica ", *Anatomie Accademiche*, Vol. II: *L' enciclopedia*, pp. 160-78; C. Iltis, " Madame du Châtelet's Metaphysics and Mechanics ", *Studies in the History of Philosophy and Science*, 8, (1977), no. 1, pp. 28-48; Dugas, pp. 221, 235-38; D. Halliday, R. Resnick, *Physics*, (New York: John Wiley & Sons, 1978), p. 196.

[21]Marta Cavazza, *Settecento inquieto. Alle origini del' Istituto delle Scienze di Bologna*, (Bologna: Il Mulino, 1990), pp. 48-51; Iltis describes Poleni's experiment in Iltis, " The Leibnizian-Newtonian Debates ", pp. 355-59; Ferrone, pp. 245-49; Corrado Dollo, " presenze meridionali nell' Accademia dell' Istituto di Bologna: Francesco Serao, Giuseppe Mosca, Andrea Gallo " in *Scienza e letteratura...*, pp. 233-53.

[22]Siraisi, *Medieval and Early Renaissance Medicine*, pp. 58, 71-72, 190-191.

[23]*Ibid.*, pp. 81, 110.

[24]*Ibid.*, pp. 141-43; *The Herbal of Rufinus* contains many references to the *Circa instans* see Lynn Thorndike ed., *The Herbal of Rufinus*, (Chicago: University of Chicago Press, 1946), pp. xii-xxiv; Harold J. Cook, " Physicians and Natural History " in *Cultures of Natural History*, N. Jardine, J.A. Secord, and E.C. Sparey eds., (Cambridge: Cambridge University Press, 1996), pp. 91-105; Jerry Stannard, " Medieval Herbals and Their Development ", *Clio Medica*, Vol. 9, no. 1, (1974), pp. 23-33.

[25]Siraisi, *Medieval and Early Renaissance Medicine*, pp. 190-91; Findlen, *Possessing Nature*, pp. 48-150, 249-50; Charles G. Nauert Jr., " Humanists, Scientists, and Pliny: Changing Approaches to a Classical Author ", *American Historical Review*, Vol. 84, no. 1, (February 1979), p. 76; Giuseppe Olmi, *L' Inventario del mondo: catalogazione della natura e luoghi del sapere nella prima età moderna*, (Bologna: Il Mulino, 1992), pp. 255-313; Andrew Cunningham, " The Culture of Gardens " and Paula Findlen, " Courting Nature " in *Cultures of Natural History*, pp. 38-56, 57-74.

[26]Findlen, *Possessing Nature*, pp. 48-150, 243, 250-60; Cunningham, pp. 38-56; Olmi, pp. 255-313; Sandra Tugnoli Pattaro, *Metodo e sistema delle scienze nel pensiero di Ulisse Aldrovandi*, (Bologna: Clueb, 1981), pp. 58-59, 152.

[27]Quotation found in Findlen, *Possessing Nature*, pp. 211, 58-61, 194-240; Tugnoli Pattaro, p. 79; Lisbet Koerner, " Carl Linnaeus in His Time " in *Cultures of Natural History*, p. 146; Cook, p. 100.

[28]Cook, pp. 100-03; Findlen, *Possessing Nature*, pp. 212, 224-25; Eamon, pp. 11, 168-93; Silvana Taglianini, " Chymica " in *Anatomie Accademiche*, Vol. II: *L'enclicopedia*, pp. 87-121; Henry M. Leicester, *The Historical Background of Chemistry*, (New York: Dover Publications, 1971), pp. 123-28.

[29]Ugo Baldini, " La scuola galileiana " in *Storia d' Italia*, Annali 3: *Scienza e tecnica*, pp. 426-29; Bernardino Fantini, " Iatrofisica e iatrochimica: la fisica , la chimica ed i modelli dell' organizzazione del vivente ", *Medicina nei secoli, arte e scienza*, Vol. 9, no. 1, (1997), pp. 59-95; Erwin H. Ackernecht, *A Short History of Medicine*, (Baltimore: The Johns Hopkins University Press, 1982), pp. 115, 118, 120-21, 135; Brigaglia e Nastasi, p. 230; Henry Guerlac, " Hales, Stephen ", *D.S.B.*, Vol. VI, pp. 37-38.

[30]Baldini, " La scuola galileiana ", p. 430; Giuseppe Montalenti, " Spallanzani nella polemica fra vitalisti e meccanicisti " in *Lazzaro Spallanzani e la biologia del settecento*,

G. Montalenti e Paolo Rossi eds., (Florence: Leo Olschki, 1982), pp. 3-17; Marta Cavazza, " Illuminismo e devozione: il caso Haller, " *Intersezioni*, a. XIII, no. 2, (agosto 1993), pp. 389-94; Berti Logan, p. 804; Walter Bernardi, *I fluidi della vita. Alle origini della controversia sull' elettricità animale*, (Florence: Olschki, 1992), pp. 69-75; Tarsizio Riviera, *Storia di un monocolo. Con alcune riflessioni*, (Bologna: S. Tommaso d' Aquino, 1793), pp. 24, 48, 69-73, 82, 85, 88-73; for the mostly French school of mechanical causation of deformities see Evelleen Richards, " A Political Anatomy of Monsters, Hopeful and Otherwise: Teratogeny, Transcendentalism, and Evolutionary Theory ", *Isis*, Vol. 85, no. 3, (September 1994), pp. 377-411.

[31]Baldini, " La scuola galileiana ", pp. 428-29; Findlen, *Possessing Nature*, pp. 214-20; for the Galilean microscope see Drake, pp. 184-85; Rupert Hall, pp. 169-71.

[32]Findlen, *Possessing Nature*, pp. 217-20; Baldini, " La scuola galileiana, pp. 428-29; Rupert Hall, pp. 185-86.

[33]For a summary of Vallisneri's works see Girolamo Tiraboschi, *Biblioteca modenese*, T. V, (Modena, 1734), pp. 324-25, 330-36; Ferrone, pp. 277-89; Dario Generali, " Introduzione " of Antonio Vallisneri, *Epistolario*, Dario Generali ed, Vol. I: *(1697-1710)*, (Milan: F. Angeli, 1990), pp. 114-27; Rhoda Rappaport, " Italy and Europe: The Case of Antonio Vallisneri (1661-1730)", *History of Science*, XXIX, (1991), pp. 75-78; Baldini, " L' attività scientifica nel primo settecento ", pp. 506-07; Antonio Vallisneri, *Istoria della generazione dell' uomo, e degli animali se sia da' vermicelli spermatici o dalla uova*, (Venice: Gabriel Hertz, 1721), pp. 62-77, 213,-15, 225-226; Hall, pp. 191-92.

[34]Morgagni's defence of Malpighi's methods led him into a serious dispute with conservative members of the University of Bologna's Medical Faculty which forced him out of Bologna, see Cavazza, *Settecento inquieto*, pp. 179-201, 272-76; Raffaele A. Bernabeo, " La Libreria scientifica di Anna Morandi Manzolini ", in *Le cere anatomiche bolognesi del settecento*, Università degli Studi di Bologna, Accademia delle Scienze, settembre-novembre 1981, (Bologna: Clueb, 1981), pp. 36-39; quotation in Ackerknecht, p. 134, see also p. 123, 142-43; Baldini, " La scuola galileiana ", pp. 429-430, 430n; Maria Dalle Donne, *Theses ex universa medicina depromptae quas defendendas proponit Maria Dalle Donne*, (Bologna : S. Tomaso Aquino, 1800), pp. 24-25.

[35]Berti Logan, pp. 804-05; François Duchesneau, " Spallanzani et la physiologie de la respiration: révision théorique " in *Lazzaro Spallanzani e la biologia*, pp. 45-66; Ackerknecht, pp. 136-37.

[36]P. L. Farber, " Research Traditions in Eighteenth-Century Natural History " in *Lazzaro Spallanzani e la biologia*, pp. 397-403; Baldini, " L' attività scientifica nel settecento italiano ", pp. 509-12; Luca Ciancio, *Autopsie della terra. Illuminismo e geologia in Alberto Fortis (1741-1803)*, (Florence: Olschski, 1995), pp. 120-30, 23-34, 312, 318-19; Martin Guntau, " The Natural History of the Earth " in *Cultures of Natural History*, pp. 227-28.

[37]Guntau, pp. 211-29; Baldini, " L' attività scientifica nel primo settecento ", p. 509; Ciancio, pp. 16, 32-37, 119-49, 162, 283, 288, 293-97; Rachel Laudan, *From Minerology to Geology. The Foundation of a Science 1650-1830,* (Chicago: University of Chicago Press, 1987), pp. 49, 58, 68, 131, 180-200; Nicoletta Morello, " Lazzaro Spallanzani geopaleontologo dall' origine delle sorgenti alla vulcanologia " in *Lazzaro Spallanzani e la biologia*, pp. 271-81.

[38]Mauro Ambrosoli, *The Wild and the Sown. Botany and Agriculture in Western Europe, 1350-1850*, (Cambridge: Cambridge University Press,1997), pp. 41-162; Fernand Braudel, *Civilization and Capitalism 15th-18th Century*, Vol. II: *The Wheels of Commerce*, (Frome Fontana Press, 1982), pp. 284-87; Renato Pasta, " L' Accademia dei Georgofili e la riforma dell' agricoltura ", *Rivista storica italiana*, anno CV, fasc, II, (1993), pp. 448-50; F. Venturi, *Settecento riformatore*, V: *L' Italia dei Lumi*, Tomo secondo: *La Repubblica di Venezia (1741-1803)*, (Turin: Einaudi, 1990), pp. 64-70; Ciancio, p. 179.

[39]Baldini, " L' attività scientifica nel primo settecento ", pp. 510-11; Lisbet Koerner, " Carl Linnaeus in his time and place " in *Cultures of Natural History*, pp 145-62; for Turra's works see *G.E.* (febbraio 1781), p. 113; *N.G.E.I.*, (marzo 1794), pp. 121-25; for Vandelli's see *E.L.*, (aprile 1772), p. 35; Domenico Nocca, *Ticcinensis Horti Academici plantae selectae quas descriptionibus illustravit, observationibus auxit Domenicus Nocca*, (Ticino: Galeati, 1800); for Bertoloni's works see V. Giacomini, " Bertoloni, Antonio ", *D.B.I.*, Vol. 9, pp. 610-11; for Sebastiani and Mauri see Castracane, p. 312.

[40]The range of dates represents the period within which the authors published their articles and monographs see for De Notaris, F. Garbari, " De Notaris, Giuseppe ", *D.B.I.*, Vol. 38, pp. 773-78; for Castracane, G.C.Giacobbe, " Castracane degli Antelminelli, Francesco Saverio Giuseppe Baldassare ", *D.B.I.*, Vol. 22, pp.191-94; for Fiorini Mazzanti's works see Castracane, pp. 307-26; for Bassi, Pietro Redondi, " Cultura e scienza dall' illuminismo al positivismo " in *Storia d' Italia*, Annali 3: *Scienza e tecnica*, pp.700-01.

[41]Leicester, pp. 131-33; Guerlac, pp. 38-41; Henri Guerlac, " The Continental Reputation of Stephen Hales ", *Archives Internationales d' Histoire des Sciences*, Vol. 4, no. 15, (1951), pp. 394-404; Leonard K. Nash, " Plants and the Atmosphere " in *Harvard Case Histories in Experimental Science*, James Bryant Conant, L.K. Nash eds., Vol. 2, (Cambridge : Harvard University Press, 1957), pp. 338-40, 357.

[42]Leicester, pp. 134-37; Joseph Priestley, " Observations on Different Kinds of Air ", *Philosophical Transactions*, Vol. LXII, (1772), pp. 210-24; Joseph Priestley, " An Account of Further Discoveries in Air by the Rev. Joseph Priestley, L.L.D., F.R.S. in Letters to Sir John Pringle, Bart. F.R.S. and the Rev. Price, F.R.S. ", *Philosophical Transactions*, Vol. LXV, (1775), Part I, pp. 384-94; Fernando Abbri, *Le terre, l' acqua, le arie. La rivoluzione chimica del settecento*, (Bologna: Il Mulino, 1984), pp. 114-15; Guerlac, " The Continental Reputation...", pp. 393-94, 403-04; Leicester, pp. 140-41.

[43]Abbri, pp. 200-02 269--338; Leicester, pp. 122-25, 142-44.

[44]Leicester, pp. 144-45, 231-32; Marco Beretta, *The Enlightenment of Matter. The Definition of Chemistry from Agricola to Lavoisier*, (U.S.A.: Science History Publications, 1993), pp. 147-57, 200-14; Simon Schaffer, " Measuring Virtue: Eudiometry, Enlightenment and Pneumatic Medicine ", *The Medical Enlightenment of the Eighteenth Century*, Andrew Cunningham, Roger French eds., (Cambridge: Cambridge University Press, 1990), p. 287-302; Duchesneau, pp. 45-66.

Chapter II

The Debate over Women's Education and Female Scientific Education

Male Italian humanists and authors of the Baroque and Enlightenment periods wrote extensively on women's education. Influenced by Christian doctrine , Aristotle's *Politics, Ethics, Economics* and/or *The Generation of Animals,* Galen's *On the Usefulness of Parts,* and later in the eighteenth century, by Rousseau's *Emile*, these Italian pedagogical authors usually emphasized, a woman's biological and intellectual inferiority in relation to men, her chastity and subordinate role as wife and mother, as historians of gender and science such as C. Merchant, and D. F. Noble appropriately point out. By the same token, they discouraged the study of natural philosophy and mathematics as unnecessary subjects for women. And yet, the ideas expressed by many of these authors were more ambivalent, nuanced and complex than might appear at first glance. It is true that there were writers who did not see the need for women to study geometry and/or natural philosophy. Still there were others, who encouraged learned women to study such subjects. Other authors, while not finding the sciences useful to women, still wrote several natural philosophy works in the vernacular addressed to those women who could not handle the Latin language. In fact, many conservative authors accepted that family and regional customs, and/or, most importantly, the exceptional nature of some women, which raised them above their sex, would determine whether they were to receive higher education. This image of the exceptional woman, which existed amongst male humanists of the Renaissance, would persist amongst men well into the nineteenth century. However, what men believed an exceptional woman could achieve,

particularly in the sciences, changed over time to reflect the increased democratization of knowledge amongst women brought about by the advent of printing, the ever larger number of scientific and philosophical works published in the vernacular, and the spread of philosophical and literary academies, to which women were associated, throughout Italy. What the exceptional woman could achieve in the sciences was also affected by changes in the sciences themselves from the sixteenth century onward, by their increased importance in the eighteenth century, and by the transformation many literary and philosophical academies would experience because of this increased importance of the sciences in the eyes of the academies' members and government s alike.

I. *Male Humanists and the Education of the Exceptional Woman*

Prior to the advent of printing, Italian humanists usually provided pedagogical advice through letters which they addressed to the person they were advising, such as, for instance, the Bishop of Trieste, Enea Silvio Piccolomini's letter to Prince Ladislao, King of Hungary and Bohemia, writtten in 1450, when the King was ten years old. Some of these letters were also addressed in Latin to women, whom the humanist themselves recognized as exceptional because of the humanist learning they had already achieved. These women, belonging to the ruling families, urban aristocracy, or the professional elite, had received a thorough grounding of Latin, and often of Greek, had studied history and philosophy, and were familiar with works of Greek and Roman classical literature. The most important advices concerning the sciences given by male humanists to these already learned women date from the fifteenth century, and are those of Leonardo Bruni to Battista Malatesta da Montefeltro (1384-1447), Lady of Pesaro, and of Lauro Quirini

to Isotta Nogarola of Verona. In his *De Studiis et litteris liber* (1424), Bruni advised Lady Battista to put in first place, as befitted a woman, religious and moral studies in the form of sacred scriptures and moral philosophy. But also, as expected of a humanist, she was to study grammar, and to read the best and most approved classical Latin authors such as Cicero, Virgil, Livius, Sallust, Tacitus, and specially Caesar. Also a woman was not to be totally ignorant of disciplines like geometry, arithmetics, astrology, and perhaps, rhetoric; yet, she was not to distinguish herself in them, or dedicate too much time to each of these latter subjects subtleties and obscurities, since women in general were unlikely to make use of them in a public capacity.[1]

The Venetian humanist Quirini (1420-1480/81), in his letter to Isotta Nogarola first praised her for having overcome her own nature, then after dropping all references to her gender, addressed her as he would a male humanist on a course of studies. Thus, Quirini advised her to consume large amounts of Aristotle's works. She was to begin with Boethius works on dialectic, and his commentaries on Aristotle's *Categories*, then she was to proceed with Aristotle's *On Interpretation* and his moral books. After having digested these, she was to begin the study of mathematics (in spite of its difficulties) and pursue determinatelly the study of natural philosophy. Quirini advised her also to follow diligently the Arabs, who very nearly approached the Greeks. Among these, he recommended Averroes, Avicenna's natural philosophy and the *Summa* of Alghesali.[2]

In spite of male rhetoric in favour of extensive scientific knowledge (Quirini), or against such extensive knowledge (Bruni), one suspects that women, such as Battista Malatesta and Isotta Nogarola, who had achieved a high level of Latin literacy and learning, and belonged to the aristocracy, ultimately determined by themselves what

subjects they chose to study with greater zeal. Nevertheless, these letters serve to illustrate that already by the fifteenth century, male pedagogical writers came to expect some form of scientific literacy from the " exceptional " woman. Men would come to expect greater scientific literacy of the exceptional woman as the sciences increased in importance in the following centuries The letters also show, along with others written to various learned women from the same period, that Italian male humanists did much to advance, if not to create, the myth of the exceptional woman, who was above her gender, and to whom the regular rules of an education geared for marriage did not apply. The myth would persist in later centuries, as would the reaction of some learned women, such as Laura Cereta, had to such a myth. To the Brescian humanist, Laura Cereta (1469-1499), men such as Bibolo Sempronio, who singled her out as exceptional, demeaned other women since nature had endowed both men and women with plenty of gifts. According to Cereta, custom, and not sexual differences, accounted for the difference in learning between men and women in general. Women were simply not encouraged to study.[3]

II. *Sixteenth Century Pedagogical Treatises and the Education of Women*

Men continued to provide pedagogical advices to men and women in the sixteenth century; however, the advent of printing changed the format of these advices. They would no longer take the form of Latin letters directed to specific people, as characterized advices in former centuries, but instead, they would become treatises on education ultimately directed to anyone who could read the vernacular. These treatises could be either influenced by classical authors, such as Alessandro Piccolomini's *De la*

institutione di tutta la vita de l'huomo nato nobile, e in città libera, libri X in lingua toscana (1542), or be influenced by the Christian dogma proposed by conservative members of the Counter-Reformation movement, such as Silvio Antoniano's *Three Books on the Christian Education of Children* (1584), or be affected by neither, such as Stefano Guazzo's *Civile Conversation* (1574). Aimed to the reading public at large, these tracts tended to emphasize that a woman's education had to be directed towards fulfilling her subordinate role within the family, as befitted her nature. Nevertheless, the authors also recognized that, due to their nature and different customs, some women would not fit the prescribed mold. In fact, while still re-enforcing gender-differences, some authors attempted, just the same, to improve the education of women in the sciences, beyond what they themselves prescribed.[4]

One of these authors, the Sienese Alessandro Piccolomini (1508-1579) belonged to the Academy of the Intronati of Siena and of the Infiammati of Padua, whose members were intent on making classical authors accessible to readers (men and women) who had no knowledge of Greek and Latin. Piccolomini's pedagogical treatise, *De la institutione di tutta la vita de l' huomo nato nobile*, was written for the instruction of children of the aristocracy in general, and for the benefit, specifically, of the child Alessandro Colombini, son of Piccolomini's friend Madonna Laudomia Forteguerri of Siena. However, as the treatise was written in the vernacular, it could serve as a guide to any parent who could read it. The work drew in part from Plato, but mostly from Aristotle's *Ethics, Economica and Politics*, treatises which were considered the most necessary to man. In the *Institutione.* the author dealt with happiness, friendship, love, marriage, family, and the care and education of the child from conception until fully grown. The

treatise discussed both men and women, but, as expected, the latter's role was confined to the family and subordinate to that of the husband within it. Piccolomini did not believe women to be so much inferior to men as physiologically different, and thus perfectly suited for her function within the family. In the best Aristotelean tradition, he believed that in generation men provided the active virtue and women the matter, but both were equally important and were to be of the highest quality.[5]

To Piccolomini, women were more gullible, religious, and compassionate than men. Their bodies were weaker and less valid than men's bodies; nevertheless, it happened quite often that in their souls women were as gifted as men. In marriage the husband was above the wife, and yet, he was not to take advantage of his position for she was a companion, not a servant. His job was to acquire the goods needed for the household; equally important, hers was to look after the children and preserve what the man had acquired. The man was not to impinge in the wife's dominion.[6] Thus it was the wife's duty to educate the children until they were five years old in the Italian language and religion, and the father's, or a preceptor's duty to educate them after that age. It was the wife's province to nurse those who were ill in the family. She was to ensure that the right medication and physician would be provided to the sick. It was the duty of both parents to ensure the intellectual and moral qualities of preceptors. However, if it happened in the marriage that the husband was imprudent and the wife was wise, then it made sense to go against the natural order and have the wise woman rule the man.[7]

As far as education was concerned, women had to learn Italian literature, since it was their responsibility to teach their young children the Italian language. The authors of choice in Italian were to be Petrarca, Bembo, Molza, and one woman, Vittoria Colonna.

Women, along with men, had a special duty to learn moral philosophy, which had to be taught only when the child was eleven years old. One might assume therefore, that before that age, by default, girls were to learn to write and reason in Latin, to be introduced to Greek authors, have knowledge of poetry, history, and some mathematics. However, natural philosophy was less useful to women than men, not because they lacked the ability to understand it, but because it was not needed for their main role in life. Nevertheless, in spite of what Piccolomini said about women and natural philosophy, it turned out that as a great popularizer of the subject, he did much to make natural philosophy accessible to women who could only read the vernacular, and had practically no mathematical knowledge.[8] Moreover, if Piccolomini believed that a woman's duty was to be confined to the perfect running of the household, and her position in the family was subordinate to that of her husband, he was equally prepared to reverse the roles, if the wife turned out to be much wiser than the husband. As befitted a humanist of the late Renaissance who was addressing the aristocracy, Piccolomini expected women to be educated to a considerable degree. No such expectations affected Silvio Antoniano's work which was directed to a wider audience than Piccolomini's, and had no humanist basis to it.

As a by-product of the Tridentine Council, Silvio Antoniano's *Three Books on the Christian Education of Children* presented a very narrow view of women's education. As far as Antoniano was concerned, girls belonging to a humble status needed not to learn how to read; those of the middling classes suffered no harm if they learned to read; as far as girls from the nobility were concerned, they could learn how to read, write and enumerate. Antoniano did not approve of aristocratic girls learning, like the boys,

languages, rhetoric and poetry. Their reading had to be limited to the lives of saints, and other spiritual books. By the same token, music had to be limited to the singing of psalms, and other religious songs. They were not to engage in conversations with learned men for it would encourage loose behaviour. Regardless of background, a woman's main role in life was to be confined to her home and attend to spinning, weaving and other feminine duties. Since women were naturally vain, if they were too learned, they would then desire to teach, which was against St. Paul's precepts. In spite of such conservative outlook, Antoniano accepted that there were exceptions to all rules, and that some women could and would go beyond the education prescribed by him.[9]

Antoniano had to acknowledge that, in spite of his wishes, there were fathers who wanted their daughters to learn more than what he prescribed, and that there were areas where women were allotted more freedom. As Stefano Guazzo pointed out in his *Civile Conversation*, the manner of bringing up daughters could be different for different regions, and from a city to the next. In his town of Casale Monferrato and region of Piemonte, daughters were given more freedom, as were the wives of the Sienese, who were expected to entertain by their husbands, and to be skilful in the enterprise. On the other hand, Roman matrons were meant to lead a more cloistered life. The education of daughters also varied, according to Guazzo. Some men had them learn only to spin, sew, and govern the house, while others would teach them to read, write, poetry, music and painting. The author himself believed that daughters were to be educated according to their future roles in life, roles that were mostly confined to the family. Thus if a girl was destined to court life, she was to have a broad education, suited to a courtier. If she were to marry a merchant or artisan, she was to learn to read, write, and most

importantly, keep accounts. Although chastity was a must to all daughters, those destined to a nunnery were to be brought up without worldly vanities. Guazzo dedicated a lot of time and effort educating his own daughter Olimpia, who eventually married a lawyer, like himself.[10]

Ultimately sixteenth century pedagogical authors as Antoniano and Guazzo realized that, regardless to what they advised, when it came to the education of daughters, families did as they saw fit. However, during the sixteenth century there occurred several changes that would favour the increased democratization of knowledge, scientific and otherwise, amongst women who could read, making them less dependent on their families for the acquisition of knowledge. One such important change was the advent of printing, which did much to increase the circulation of knowledge. Moreover, as discussed in Chapter I, the humanists' admiration of ancient learning led to the rediscovery, translation into Latin from the original Greek, and printing of ancient works in natural philosophy, mathematics, medicine, and natural history. Most importantly, several of these work were translated into Italian, such as Euclid's *Elements* (1575), Pliny's *Natural History* (1548, 1561, 1580), and Dioscorides's *Materials of Medicine* (1544), for instance. Natural philosophers, too numerous to mention, also wrote their own adaptations of ancient texts, or their objections to these texts, increasingly in the vernacular, making them accessible to anyone who could read.[11] A few of these texts would be written for the express purpose of educating women in the sciences. Three of these texts will be discussed below. The others will be covered in chapter three, as they were written by women for other women. Lastly, there also began to appear around the peninsula several philosophical and literary academies, with more, or less, formal

organizations, of which some were founded by women, or to which women were associated.

III. *Sixteenth Century Scientific Publications Aimed at Women*

Of the scientific works written in the vernacular and published in the sixteenth century, a few are known to have been written for women. Two of these works, *De la sfera del mondo* and *De le stelle fisse* (1540) originated from the pen of the humanist Alessandro Piccolomini, who stated in his *De la instutitione di tutta la vita de l' huomo nato nobile* that women did not need to be instructed in natural philosophy as they were unlikely to make use of it. In truth, Piccolomini was a great popularizer of natural philosophy with works such as *De la sfera del mondo* and *De le stelle fisse*, *L' istrumento della filosofia* and *La filosofia naturale* (1551), *La prima parte a le teoriche overo le speculationi dei pianeti* (1558) and *Trattato della grandezza della terra e dell' acqua* (1558). All these books went through several editions, and some were also translated into French. The other work to be discussed will be Giovanni Marinelli, *Le medicine pertinenti alle infermità delle donne* (1574). These works clearly illustrate the ambiguous attitudes the authors held in relation to women : on one hand, they taught women current scientific knowledge, and how to utilize it; on the other hand, they made certain assumptions about their female audience, which demonstrated to the reader that women instructed by such works were not at par with men. Due in part to the subject matter discussed, these assumptions are present to a greater extent and degree in Marinelli's work, a book which dealt with women's diseases, than in Piccolomini's texts, which taught cosmology and astronomy.[12]

The first two books, Piccolomini's *De la sfera del mondo (On the Sphere of the Universe)* and *De le stelle fisse (On Fixed Stars)* were both dedicated and for the benefit of Laudomia Forteguerri in particular, and to other women in general, making the author the creator of a genre of literature that would then be continued by Fontanelle and Francesco Algarotti in the following centuries.[14] But, unlike those authors who were to follow him, Piccolomini did not use the dialogue form to put across, what turns out to be, an elementary exposition of Aristotelean and Ptolemaic cosmography in the case of *On the Sphere of the Universe*, and an elementary handbook for star-gazers in the case of *On Fixed Stars*. The references to the likely female audience, and to Laudomia Foteguerri were concentrated, with a few exceptions, to the introductions of both books.

Nevertheless, the author made certain assumptions about his potentially female audience, and, particularly about Forteguerri. Firstly, he assumed that Forteguerri and women like her, because of their sex had had no opportunity to dedicate themselves to the study of science in general, and of astronomy in particular. Secondly, Piccolomini assumed that most women, even those belonging to the provincial aristocracy, like Forteguerri, would not have learned Latin well enough to enable them to read the original works in astronomy. Thirdly, the author left out from the tables found *On Fixed Stars* the three extra hours of star-gazing available during the winter months, because he did not believe that Forteguerri would be such an eager amateur astronomer so as to make observations in the early hours of the morning in such months. Most importantly, both works were geared for people (women and men) with limited mathematical knowledge.[15]

To compensate for the limited mathematical knowledge among his readers, Piccolomini began his *Sphere of the Universe* with some of the mathematical definitions found in Euclid's *Elements*, such as what was a point, line, surface, sphere, and different types of angles, to cite a few. These definitions were all illustrated with appropriate drawings.[16] There was no mention in the book of the complicated theory of epicycles and eccentrics, and whether such representations really existed in the heavens, or were mathematical constructs to save the appearances of planetary motions; these explanations were left for his more theoretical work on planetary theory.[17] Instead the reader was presented with a series of definitions, all suitably illustrated, useful to beginners in astronomy, such as what were the circles of the zodiac, equinox, meridian, horizon, the Tropics of Cancer and Capricorn, the Artic and Antartic circles, the colures of the equinox, and of solstice, and the eclipses of the sun and the moon.[18]

In spite of the sun being singled out for its importance, excellence, and as a guide and director of other planets, there was no compromise in the book with the Copernican theory, or the theory of the Pythagoreans, as referred by Piccolomini.[19] Instead Ptolemaic-Aristotelean cosmography was emphasized throughout. For instance, it was present in Piccolomini's division of the universe in ten heavenly spheres and four elementary ones.[20] The author also accepted many Aristotelean maxims regarding the universe, such as its finite size, its circular motion, and the fact that it contained no void; [21] that the earth was fixed and immovable at the centre of the universe;[22] and that the heavens were not exposed to hot and cold since they were formed of a fifth element different from the four elements of the inferior world.[23]

The book ended with practical instructions on how to make an instrument that would allow Forteguerri to find the position of any star in the heavens, and which was meant to be used in conjunction with his second book *On fixed stars.*[24] This second book, expressly made for Forteguerri, was a guide to the starry images which gave such a beauty to the eighth sphere.[25] It contained forty eight star charts, one for each constellation. all appropriately named, and representing only stars up to the fourth magnitude. Each magnitude had its own symbol and, quite often, a star of the first magnitude had a name associated with it. Legends were given for each constellation, but most importantly, there were ephemeris like tables, along with instructions on how to use the tables in conjunction with the instrument described in his *Sphere of the Universe.*[26]

The author again assumed that those who would use his book did not have an extensive knowledge of mathematics. For instance, Piccolomini provided a careful and detailed explanation of the tables so as to familiarize the reader with their use. The tables were also arranged so as to avoid any calculations on the part of the user. For each of the three main stars of any constellation, for the calends (first day) of every month of the year, at any hour of the night, two numbers were provided. The first number denoted how many degrees the star sought was far from the zenith in the vertical circle. The second number gave the degrees of the horizon, followed by two letters that designated in which quarter of the horizon was the star to be found.[27] If Forteguerri, and others were willing to adventure further in their mathematical efforts, Piccolomini provided them with explanations on how to find readings for other days of the month. He also explained how he achieved the numbers found in the tables.[28]

In spite of the elementary nature of both books, the author was far less patronizing to his female audience than Francesco Algarotti would be to his two hundred years later, as shall be seen. In the later editions, both books changed very little in character, except that after Laudomia Forteguerri died in the siege of Siena, they were no longer dedicated to a lady. The female audience for whom the books had been written and found in the informal gatherings of the members of the Academy of the Intronati of Siena had disappeared with the siege.[29]

The author of *Le medicine pertinenti alle infermità delle donne (The Medicines Pertaining to the Diseases of Women)*, Giovanni Marinelli, was a physician from Modena, who at the time of publication lived in Venice.[30] His purpose in writing such a tract in Italian was to make the knowledge of medicine accessible to all, and particularly to women. The three books, which composed the work, covered the life of a young woman from marriage until she gave birth. Consequently, the first book showed how to remove any obstacles to successful copulation; the second pertained to those infirmities of women which might have caused sterility, and how to cure them. The third book dealt with pregnancy and birth, matters dear to a woman's heart, according to Marinelli. It was directed mostly to midwives, so that they might correct any faults they had and ensure successful deliveries.[31]

The Medicines was influenced in its arrangement and contents by such Hippocratic works as *On the Nature of the Woman, On Generation, On the Nature of the Child, On Diseases of Women,* and *Aphorisms*, works familiar to Marinelli, who also had written several commentaries in Latin on the Hippocratic body.[32] The author was also influenced by works such as Galen's *On the Usefulness of the Parts of the Body,* and *On the Affected*

Parts, and Avicenna's *Canon*; but most importantly, as expected of one educated in natural philosophy and medicine at the University of Padua, an institution of higher learning where Aristotelean natural philosophy reigned supreme, he was influenced by Aristotle, in particular, his *On the Generation of Animals.*[33]

The work provided advices on what food to eat , or not to eat, which herbals, mixtures and ointments were best to combat sterility and the various infirmities affecting the womb, and once pregnant, to facilitate delivery. It also instructed midwives on what procedure to follow in case of difficult deliveries.[34]

In spite of its intended usefulness, the work re-enforced, far more than Piccolomini's works ever did, certain stereotypical views about women, such as the view that a woman's most important role in life was to procreate so as to ensure the survival of the family. Other views on women, inherited from Greek sources, emphasized their inherent physical inferiority. Thus, because of their coldness and humidity, women were far less perfect than men. Since women did not have men's perfect complexion, they needed to get rid of their excess humidity (the menses) to stay healthy.[35] Marinelli described, in the best Hippocratic tradition, certain telltale signs which would indicate whether a woman was expecting a male or female child. The woman carrying a male child would have good colour, no spots in her body; her right breast would swell up as well as the right side of her abdomen. If she carried a female, she would have bad colouring, spots, move lazily, have a tendency to eat bad food, and both her left breast and left side of her abdomen would swell up. Naturally, he also advised how to generate a much desired male child.[36]

Marinelli referred to the female semen, but unlike Galen, he doubted it played a role in generation. Like Galen, he did not doubt that the female semen entrapped in the

wombs of women who did not engage in intercourse, such as widows, nuns or old maids, was the cause of the uterus-related suffocation and strangulation experienced by them.[37]

Like Aristotle, Marinelli believed that it was the role of the male sperm to provide the spirit, which had the formative virtue to generate the child. The female's role was to provide the matter from the menstrual fluid for generation. To the author, the menstrual fluid was equivalent to the female semen. Again in the best Aristotelean tradition, Marinelli believed the heart to be the first part of the embryo to be formed, followed by the liver,and then the brain. There again a distinction existed between male and female embryos; the former gained strength faster than the latter.[38]

The excerpt above clearly demonstrate that Marinelli believed in the biological inferiority of women from the moment of conception. One suspects, he also believed in their intellectual inferiority; although Marinelli never declared explicitly this belief in his work. Nevertheless, Marinelli's position in relation to women was ambiguous, especially as it related to his daughter, Lucrezia Marinelli: on one hand, he described women as deficient men in his work, and re-enforced this image of women to the women who would read his book; but on the other, he would teach his daughter Latin, a language which allowed her access to her father extensive library. Fluent in Latin , and with a library at her disposal, Lucrezia Marinelli would grow up well aware of the biological theories of Hippocrates, Galen and Aristotle, used by her father and others, which made of women imperfect men. In her *La nobiltà et eccellenza delle donne, et i diffetti e mancamenti degli huomini* (*On the Nobility and Excellence of Women, and the Defects and Faults of Men*, Venice, 1600), Lucrezia Marinelli would reject Greek biological theories on women. Women found themselves in an inferior position in society due to

historical conditions, and not because of any natural, or physical causes inherent in them. In fact, if boys and girls of equal age and disposition were given the same educational opportunities, girls would prove to learn faster than boys. A Venetian contemporary of L. Marinelli, Moderata Fonte (Modesta Pozzo de' Zorzi) in her *Il merito delle donne* (*Women's Worth*, also published in 1600), believed that men's superiority, and thus women's inferiority, derived from the former subjugation of the latter, brought about at first by men's greater physical strength, and then later by men's ability to convince women that such subjugation was a natural and acceptable condition. In 1651, Sister Arcangela Tarabotti, also from Venice, in her *Che le donne siano delle spezie degli uomini* (*Women Are of the Same Species as Men*), objected like Lucrezia Marinelli, to Aristotle's theories on generation, and the use some men made of them to make women less rational than men. [39]

As the publications of Lucrezia Marinelli, Moderata Fonte, and Arcangela Tarabotti indicate, Venetian women, at least, were to find their voice in print in defence of their own biological and intellectual equality, if not superiority, to men by attacking Greek, particularly Aristotelean, theories on generation, and the use men made of them to prove women's inferiority. In 1405, in her *Book of the City of Ladies*, the learned Christine de Pizan could not accept that the biological theories, found in the *Secreta mulierum*--a treatise spuriously attributed to Albert Magnus--which advanced that women were imperfect men, could have Aristotle as their source, a philosopher she admired.[40] Her feminist sisters from the late 1500s and early 1600s were in no doubts that the theories on the imperfection of women originated with Greek physicians and philosophers, and particularly with Aristotle. Women were able to display a broader scientific knowledge

in the sixteenth and seventeenth centuries than women of earlier centuries ever could, because they certainly had a greater amount of scientific material at their disposal, but also because of their increased participation in a number of academies founded in Italy at the time. Contact with the men within these academies could only help them extend their learning.

IV. *The Involvement of Women in the Rise of Philosophical and Literary Academies*

What becomes clear to readers of both Guazzo's *Civile Conversation*, and Girolamo Bargagli's *Dialogue of Games* (Siena, 1572) is that a new form of gathering was becoming popular, at least in towns like Casale of Monferrato and Siena, which consisted of "conversazioni' between gentlemen and ladies. These gatherings appeared to have risen simultaneously with the rising of new academies such as the Intronati of Siena and the Illustrati of Casale, and can be explained by the informality of such academies. As Amodeo Quondam suggests many academies began as conversation "clubs" which lacked rigid organization.[41] Academy members, along with their wives, and other ladies and gentlemen, friends of academicians, met at the house of a male academician, or sometimes, at one of the ladies to discuss mostly literature, but also philosophy, and play a variety of word games. Men may have dominated these discussions, even when ladies were present, by choosing the subject matter that interested them most. This certainly is Kelly Gadol's and Riccardo Bruscagli's thesis. Nevertheless, Bargagli has demonstrated in his work that such dominance did not always occur.[42] In a positive note, the gatherings and the adaptation of classical works into Italian by the academicians served to introduce women, who were not fluent in Latin, to a cultural life wider than the one

preached by men like Antoniano in his *Three Books on the Christian Education of Children.*

Women might have taken part in academic discussions; they might have formed salons around male academicians, but it is harder for us to guess whether they were full-fledged members from the very beginning of these early academies. Michele Maylender informs us, maybe wrongly, that only in 1614 were women admitted to the membership of the Academy of the Intronati. There is no denying that Veronica Gambara was a member of the academy she founded in the early 1500s, the Academy Correggiana, where she received gentlemen proficient in the sciences, ancient languages, and literature.[43] Women needed not to be physically present at academic meetings for their work to be discussed. For example, Alessandro Piccolomini read and discussed one of Laudomia Forteguerri's poems at a meeting of the Academy of the Infiammati of Padua. Other examples might be found. [44]

The gatherings described by either Bargagli or Guazzo were not reunions which took place in some court setting. The ladies in them were not the courtiers described by Baldassare Castiglione in *Il Libro del Cortigiano* (1528), of whom a certain level of culture was expected.[45] The men and women associated with the Academy of the Intronati of Siena belonged mostly to a minor provincial aristocracy. Those associated with the Academy of the Illustrati of Casale belonged to the professional classes.[46] Conservatives like Antoniano might have objected, but the fact remains that "conversazioni" between men and women had spread from the courts to the houses of academicians and their associates, then to the academies themselves, and from town to town.

By the late 1500s there were women associated with the Academy of the Incogniti of Venice.[47] Even in supposedly conservative Rome such associations had occurred by the turn of the century. Margherita Sarrocchi had formed her own academy at home as early as 1588. Most importantly, she promoted and contributed to the foundation of the Roman academies of the Umoristi (1603), and of the Ordinati (1608), of which she was a member. Sarrocchi was never made a member of the more science-oriented Academy of the Lincei, which by the wishes of its founder, Federico Cesi, had a male membership approaching the status of a brotherhood. In spite of Cesi's ideals, members of his academy also attended Sarrocchi's salon. Luca Valerio, one of the Lincei, was her companion. Galileo Galilei during his stay in Rome in 1611, also attended Sarrocchi's circle. Lest one may think that there were no women associated with science-oriented academies during that period, there was at least one woman, the astronomer and astrologer, Laura Cereta, who had attended with her physician brother Daniele Cereta a predominantely science-oriented academy, Brescia's Academy Mondella, in the late 1490s, many years before the Academy of the Lincei was founded.[48]

As academies spread throughout Italy in the seventeenth century, conservative clerics were even more vociferous than Silvio Antoniano had been in the late sixteenth century, against academic meetings between men and women, which, according to them, encouraged general lascivious behaviour, and women to break the Pauline Edict of maintaining silence in public places. However, as it occurred in the sixteenth century, exceptions were made to women whose virile nature allowed them to absorbe a great deal of knowledge, and use it to serious purposes. Thus both the Jesuit Giovanni Domenico Ottonelli in his 1646 publication, and Cardinal Giambattista de Luca in his *Knight and*

the Lady (1700) saw danger in conversations carried out between men and even modest learned women. Extending by his own admission rules applicable to the church to the outside world, Ottonelli felt that a learned woman who engaged in conversations was really teaching in public, and that was forbidden by the scriptures, unless she was to receive special dispensation from the Pope. Then she was entitled to teach at home. To De Luca, a knowledge of the sciences, liberal arts, literature, and music made women more attractive to men than necessary, and worse still, made them independent. Both had to admit that some women because of their virile temper could handle both extensive knowledge, and academic conversations; as they had to accept that in certain areas women's academic activities were viewed with approbation.[49]

Bologna's Academy of the Gelati, founded in 1588, was essentially a literary academy, which by 1670, under the supervision of Valerio Zani, had expanded its horizons to include scientific topics in its discussions. These topics were presented by members, whose major interests lay in natural philosophy and mathematics. Although the academy's first female membership dated from 1700, women had attended some of the academy's gatherings from as early as 1664, to the consternation of Canon Antonio Ghiselli, a member of the academy and recorder of its memoirs.[50] Always critical of such gatherings, nevertheless, he felt that by 1712 such modern conversations between men and women were out of control. Too much time was spent in what he considered to have been frivolous conversations to the detriment of other activities, such as religious and household concerns. Lest one might think that Ghiselli only expected women to take care of the household and read spiritual books, he was also full of praise for Vittoria Delfini Dosi achievements. She had successfully defended her theses in law in 1722 at

the Real Collegio Maggiore of Bologna, and thus gave, according to him, a resolute and public example of her knowledge at a time when women dedicated themselves to entertainment and pleasure.[51]

Like Ghiselli, the philosopher and mathematician Paolo Maria Doria let us know of the presence of ladies like Aurelia d' Este in Neapolitan academies by the early 1700s. Unlike the other authors previously discussed, Doria approved of meetings and conversations between men and women who had been provided with a virtuous education; such conversations would not offend society, but improve it. He approved and believed that, on the whole, women were able to understand the sciences.[52] Thus when Doria founded the Academy of the Oziosi in 1734, in opposition to the Neapolitan Academy of Sciences founded by Celestino Galiani, women members were accepted.[53] Doria also published most of his works in philosophy and in mathematics in the vernacular, and since his mathematical works were based on Euclidean synthetic geometry, there were undoubtedly more accessible to women who could not understand Latin and had no knowledge of the new mathematical syntheses.[54] Nevertheless, Doria, like many Italian men, had ambiguous attitude towards women and scientific education. Thus, if Doria advocated scientific studies for women, he could not accept the Cartesian view that all women, and for that matter, all men, had equal ability to understand them. In addition, if women had the liveliness of mind to acquire scientific knowledge, they simply lacked the strength of spirit to create it. Again there were exceptions to such a rule, for in rare occasions the weakness of the body was not followed by weakness of mind.[55]

V. *Pedagogical Authors and the Advocation of a Broader Education for Women*

By the early 1700s, there was nothing new in either Doria's misogynous statements on women's abilities, or in Ghiselli's view that conversations between men and women were frivolous and dangerous exercises. Nevertheless, both authors displayed a more positive attitude towards a broader and more extensive education for women in general than authors in the past ever did, unless they were addressing exceptional women. Doria's and Ghiselli's attitude on education illustrate changing trends amongst conservative educators forced upon them, to a great extent, by the rise of the academies, and women's association with them. Whether conservative educators liked it or not, the association of women with academies, which had begun as a new phenomenon in towns like Brescia, Siena, Casale di Montefletro and Correggio in the late 1400s and early 1500s had spread by the 1700s to include many towns in most areas of the Italian peninsula. By then, women were out, participating in greater numbers in conversations at salons, or academies, and it was becoming clear even to conservative men that some sort of education had to be offered them that went beyond spiritual books and poetry. An increasing number of these men came to realize that to encourage women to study a variety of topics might not only improve their conversation, but also have the beneficial effect of keeping them away from more frivolous pursuits. At a time when the sciences were at the peak of their popularity, it made sense to have women study scientific topics, at least,at the elementary level.

In answering a mother who had asked him advice on how to raise his daughter, Gasparo Gozzi felt that women needed to acquire at least a veneer of culture, but that pedantry had to be avoided at all costs. If women were confined to their homes, they

needed not to be educated beyond the needs of the household, but in his time many of them found themselves participating in conversations with gentlemen and other ladies, and thus had to be educated adequately.[56] In 1777, Pietro Verri certainly followed Rousseau's advices as found in *Emile* when it came to the early education of his daughter Teresa. Like Sophie, Teresa's ultimate goal was to be a good wife and mother. Nevertheless, Verri was prepared to go a bit further than Rousseau went with Sophie when it came to his own daughter's education in later years. Books were to be her dearest companions. Besides learning drawing and music, she was to read history, all the comedies, tragedies and novels which expressed decent sentiments. Teresa was not to be really knowledgeable and learned in the sciences; however, if she were that way inclined, he would ensure that she would have all the tools and encouragement required to succeed. Her knowledge was to be used carefully. When engaged in conversations, she was not to discuss topics that were above most people's understanding, in other words, Teresa was to avoid pedantry. By the end of the eighteenth century, Neapolitan fathers from the aristocracy, who had daughters being educated in convents, were prepared to have these daughters instructed in the sciences by male teachers who, by special dispensation, gave their lessons within the convents' walls.[57]

Of course the idea that if women were encouraged to study, they would then keep away from frivolous pursuits was not new; as early as 1488, the learned Laura Cereta made this point to Bibolo Sempronio. In 1729, Aretafila Savini de' Rossi from Siena, again stressed in her *Apology in Favour of a Course of Studies for Women,* presented to Padua's Academy of the Ricovrati, the fact that a serious course of study in the sciences, and other subjects, made women less idle, better partners, managers of homes and

educators of children, a sentiment also shared by the Neapolitan Maria Vigilante in 1789 in her introduction to her translation of Isaac Watts' *The Knowledge of the Heavens and the Earth Made Easy: Or the First Principles of Geography and Astronomy Explained by the Use of Globes and Maps.* Other women, such as Eleonora Barbapiccola in her introduction to her translation of Descartes' *Principles of Philosophy* (1722), or the mathematician Maria Gaetana Agnesi in her letter to Archbishop Pozzobonelli, were prepared to limit respectively the study of the sciences, or the reading of books in the Vatican's *Index librorum prohibitorum* to those exceptional women who had male virtues. [58] With some of the women themselves ready to accept that only women with male virtues were able to handle subjects which in principle were open to all men, it is not surprising to find men like Count Benvenuto Robbio di San Raffaele ready to state, still in the 1790s, that a veneer of the sciences was all that women were capable to achieve. Women could, and did study the sciences, but unless they were exceptional, their weak nature ensured that their scientific productions would be second rate.[59]

As all the examples in this chapter indicate, since the Renaissance many of even the most conservative male pedagogical writers accepted that the exceptional woman might be encouraged, even entitled to study some natural philosophy and/or mathematics. The image of the exceptional woman is a common factor in all the works written by men mentioned above, whether they were written in the 1490s, or in 1773. In fact, this image can be found as late as 1879 in Francesco Castracane's eulogy of his friend, and sometimes advisor, the botanist Elisabetta Fiorini Mazzanti.[60] If the idea of the exceptional woman remained constant amongst men in Italian society throughout the

centuries under discussion, what such a woman might achieve with her exceptionality did not.

The changes experienced by the so-called exceptional woman can be linked to a better and more widespread education for women of the bourgeoisie and aristocracy, as they can to a revolution in the sciences.[61] As the sciences gained in popularity throughout the eighteenth-century, men came to accept, even expect that some sort of scientific knowledge might be part of a woman's education. It seems natural progression that they might also accept , or even expect, that an exceptional woman might go beyond the study of science to its actual production and teaching. As methods of experimentation and observation became more dominant in the sciences, it is again not surprising that men came to accept that some of the exceptional woman's scientific production might be based on her own experimentations and observations. As exceptional women were made members of literary academies in the past, it again seems natural that when publicly-funded scientific academies arose in the eighteenth-century, often out of pre-existing literary and philosophical academies, they might also have some exceptional women as members, as it occurred in the Bologna Academy of Sciences and the Pontificial Academy of the Lincei.[62]

However, one should not conclude that all men were ready to accept the exceptional woman at par with them. In fact, as shall be discussed in later chapters, women who attempted to forge a position for themselves in the scientific community had many obstacles to face, even when they had powerful patrons. Nevertheless, one might still say that men had created a two-tier system of educated women in the Italian states. At the top there was the exceptional woman, who had raised herself above her sex, and

therefore could perhaps be allowed into the inner sanctum of scientific endeavour and immerse herself into the sciences. At the bottom there was the ordinary educated woman, who might be allowed to stop at the threshold, take furtive glances into the room of scientific endeavour, but never enter.

If one accepts this thesis, it becomes easier to understand why the physician Tarsizio Riviera, professor of surgery and anatomy at the University of Bologna, could instruct and ensure that two women receive degrees in medicine, and at the same time publish a work such as *On the Moral and Physical Nature of Women* in 1796.[63] In the work Riviera, a supporter of Haller's theory of irritability and sensibility, provided a physical explanation based on such a theory as to why women could never engage in deep study and achieve great things. The mobility of the fibres (nerves) caused by women's delicate nature did not allow them the vigorous application required, firstly to concentrate on important information, while they eliminated all unimportant ones. Secondly, the same mobility did not permit impressions to be stamped deeply into their sensory centres. Consequently, a woman's imagination was vivid, but empty, full of images, but poor in thought, unless, of course, she was an exception.[64]

It also becomes clear to whom Francesco Algarotti was addressing his *Il Newtonianismo per le dame* published for the first time in 1737. It certainly was not designed to instruct exceptional women who were proficient enough in mathematics and Latin to go straight to the original source, which they did , as shall be discussed later.[65] The work was meant to be used by any woman, or man, for that matter, who needed a veneer of the newest scientific theories to be used in salon conversations.

Il newtonianismo was in the form of dialogue, and Algarotti's model was Fontanelle's *Entretiens sur la plurarité des mondes* (1686), instead of Alessandro Piccolomini's *Sphere of the Universe* and *On Fixed Stars* (1540).[66] A comparison between Algarotti's and Piccolomini's texts, written about two hundred years apart, both directed towards a female audience with little knowledge of mathematics, tells us that this audience had changed. Piccolomini destined his works to exceptional women like Forteguerri, who because of a deficient education, had not been taught enough mathematics or Latin. Although, as seen, the mathematics found in Piccolomini's works was at the bare minimum, the works still prepared the lady for some hands-on science. The first book taught her the cosmography of the heavens she would be observing, and provided her with practical instructions on how to make an instrument with which she could observe them. The second book was a practical guide on how to observe the stars which comprised the eighth sphere of the heavens.

Since Algarotti's work was never meant to have any practical purpose other than its use in salon conversations, it was not so inclusive of its female audience as Piccolomini's had been. In fact, Algarotti's intent was to explain to a fictitious lady optics, without making use of experimental tools, and physics, without making use of geometry.[67]

His book was divided into six dialogues. Dialogue one exposed Descartes' hypothesis on the nature of light and colour, so that it could be rejected in dialogue two along with Malebranche's wave-like theory of light. Dialogue two also explained general principles in optics, the structure of the eye, and vision. Dialogues three and four dealt with the actual exposition of Newtonian optics; dialogue five presented an exposition of the principle of universal attraction, and its application to optics. Dialogue

six rejected new hypotheses on the nature of light and reconfirmed the Newtonian system, which being based on mathematics, observation, and experimentation, was bound not to be replaced like those of his predecessors, Gassendi and Descartes.[68]

Using basically the same outline that Newton used in his *Opticks*, Algarotti explained reflection and refraction, how white light consisted of rays of different refrangibility, the nature of rainbows, and Newton's rings. He then expounded how Newton with two prisms, first decomposed white light, and then recomposed it, and how light bent when it passed close to a body due the universal attraction of matter.

Drawing mostly from Book III of Newton's *Principia*, Algarotti also explained that if a body in motion was drawn towards a centre, it swept out around that centre, areas proportional to the the times. He then elucidated how the force of attraction of each planet was proportional to the quantity of matter it contained, and how the same force of attraction decreased as the square of the distance increased. The author also provided a Newtonian explanation of tides, and described how Maupertuis was able to confirm Newton's mathematical demonstration of the shape of the earth.[69] Algarotti achieved all this without drawing a single diagram, and by eliminating all mathematical demonstrations. The lack of mathematical knowledge on the part of the marchioness (or the reader) and her inability to experiment would not allow her to be exposed to the theory of universal attraction in full, therefore, she was only to receive an impression of what it meant.[70]

In the author's defence one might say that he provided in simple terms the latest physical explanations to such natural phenomena as rainbows, tides and the appearance of comets; thus he enlightened the ordinary reader considerably. Furthermore, if she or

he so desired, the reader could also attempt to repeat several of Newton's experiments in optics described by Algarotti.

Most importanly, before one might dismiss *Il Newtonianismo* as " frivolous " and a " boudoir " piece as Mme. Châtelet had done[71], the book contained two concepts which were considered dangerous by the Church to the Italian reading public at large: firstly, Algarotti declared the Copernican system to be the true system, and not an hypothesis; and secondly, by clearly accepting the Copernican system, he also accepted without any disguise that the earth moved. Consequently, two years after its publication, on April 13, 1739, Algarotti's frivolous *Il Newtonianismo per dame* was placed in the Index of restricted books by the Vatican, where it stayed in its subsequent editions of 1739, 1746, 1750 and 1752, in spite of corrections and changes on the part of the author. As seen in chapter one, none of Newton's works were ever placed in the Index by the Vatican.[72] Ironically, a book which was meant to be read by unexceptional female readers for its simplicity, after 1739, became less accessible to them in the Italian states than Newton's difficult works.

To conclude one might add that both the concept of the exceptional woman, as well as women's long-standing association with the various literary and philosophical academies in the Italian peninsula proved useful to a few women in the long run. The fact that even conservative writers were prepared to believe that some women would not fit the mold prescribed to women in general, emboldened a few women to take steps not normally taken by other women. It also encouraged some men, either because of their belief in women's abilities, or because it served their own purposes, to assist these women in their enterprises. The fact that this image of the exceptional woman evolved

over time serves to explain why some of the steps taken by women, and encouraged by men, were the earning of degrees, the teaching of the sciences at institutions, and the carrying out of research. Moreover, the fact that, as shown above, some women were associated with literary and philosophical academies from their inception, and that several of these academies developed into publicly-funded scientific academies, might explain why men were willing to make some exceptional women members of these scientific academies. For instance, the Academy of Sciences of Bologna evolved from the Academy of the Inquieti, founded in 1690 by Eustachio Manfredi, and operating from his home. Two women, Manfredi's sisters, were associated with the original academy. Padua's Academy of Sciences developed from the Academy of Ricovrati; again at least two women had been members of first academy, Elena Cornaro Piscopia, and Cristina Roccati. Other examples can be found.[73]

Early feminists such as Laura Cereta, Lucrezia Marinelli, Moderata Fonte, and Aretafila Savini de' Rossi appeared aware that what separated the so-called exceptional woman from other women was not a virile nature, but the greater learning the former had been able to acquire through her family's, and/ or her own efforts. If women in general were encouraged to study as men were, the intellectual differences that appeared to exist between exceptional women and other women, and for that matter between men and women, would disappear. Nevertheless, the fact that men were willing to acccept that some women would strive to achieve great learning, either because of their nature, or custom, made the character of the learned woman not appear ridiculous in the country at large, as Lady Mary Wortley Montagu appropriately pointed out to Lady Bute in 1753, and encouraged other women to follow suit, as the following chapters will demonstrate.[74]

[1]Merchant, *The Death of Nature*, pp. 288-89; Noble, pp. 146-47, 157-59, 163-71; Leonardo Bruni, "De studiis et litteris liber" in *Il pensiero pedagogico dell' umanesimo*, Eugenio Garin ed. , (Florence: Giuntine e Sansoni, 1968), pp. 147-171. An English translation is found in G. Griffiths, J. Honkius, D. Thompson, *The Humanism of Leonardo Bruni. Selected Works*, (Binghamton, N.Y.: Medieval & Renaissance Texts & Studies, 1987), pp. 240-251; Margaret L. King, *Women of the Renaissance*, (Chicago: University of Chicago Press, 1991), pp. 157-239.

[2]Lauro Quirini's letter to Isotta Nogarola is found translated in Selection no. 19 of King and Rabil Jr., *Her Immaculate Hand*, pp. 111-116.

[3]See the selection of letters from men to women found in Part III of *Ibid.*, pp. 91-129; for Cereta's letter to Bibolo Sempronio see Diana Robin ed. *Laura Cereta. Collected Letters of a Renaissance Feminist*, (Chicago: The University of Chicago Press, 1997), pp. 4-7, 72-80.

[4]For the format advices took prior to printing see Garin ed., *Il pensiero pedagogico...*, pp. 147-719; Alessandro Piccolomini, *Della institutione morale di M. Alessandro Piccolomini Libri XII. Ne' quali egli levando le cose soverchie et aggiungnendo molte importanti, et à miglior forma et ordine ridotto tutto quello che già scrisse in sua gioveneza delle Institutione del' homo nobile*, (Venice: G. Zilotti, 1560); Silvio Antoniano, *Tre libri della educatione christiana dei figliuoli*, (Verona: S. dalle Donne e G. Stringari, 1584); Stefano Guazzo, *The Civile Conversation of M. Steeven Guazzo. The First of Three Books Translated by George Pettie, Anno 1581 and the Fourth by Barth Young, Anno 1586, with an Introduction by Sir Edward Sullivan*, (New York: AMS Press Inc, 1967).

[5]For a biography of Alessandro Piccolomini see Florindo Cerreta, *Alessandro Picolomini letterato e filosofo senese del cinquecento*, (Siena: Accademia Senese degli Intronati, 1960), pp. 35-41; Alessandro del Fonte, "Amore, famiglia e matrimonio nell' *Institutione* di Alessandro Piccolomini", *Nuova Rivista Storica*, anno LXVIII, (settembre-dicembre 1984), fasc. V-VI, pp. 518-519; Piccolomini, pp. 78-81; Aristotle, *Opere*, 5: *Riproduzione degli animali*, (Bari: Laterza, 1990), II (B), 1, 732a.

[6]Piccolomini, (1560), pp. 332, 404, 498-499.

[7]*Ibid.*, pp. 87-88, 59, 488-489.

[8]*Ibid.*, pp. 87-88, 117, 81-82, 119, 126; for the diffferent editions of Piccolomini's works in natural philosophy see Cerreta, pp. 175-96; Rufus Suter, " The Scientific Work of Alessandro Piccolomini ", *Isis*, 60 (1969), pp. 210-23.

[9]Antoniano, pp. 153r-154r, 158r; Ginevra Conti Odorisio, *Donna e società nel seicento*, (Rome: Bulzoni, 1979), p. 75.

[10]Guazzo, Vol. II, pp. 19, 74-76; for a summary of Guazzo's life see John Lievsay, " Stefano Guazzo e il rinascimento inglese, 1575-1675 " in *Stefano Guazzo e la Civil conversazione*, (Rome: Bulzoni, 1990), Giorgio Paluzi ed., pp. 63-120.

[11]Rose, p. 208; Nauert Jr., p. 76; for lists of natural philosophers writing in Italian during the sixteenth century see the bibliographies of Findlen, *Possessing Nature*, pp. 249-5, 413-20; Eamon, pp. 431-45.

[12]Alessandro Piccolomini, *De la sfera del mondo di M. Alisandro Piccolomini, divisa in Libri quatro, i quali non per via di tradutione, ne e quel si voglia particolare scrittore obligati, ma parte di nuovo producendo, contengono in se tutto quel ch' intorno à tal materia, si possa desiderare. Ridotta a tanta Agevolezza et à cosi facil modo di dimostrare, che quel sia voglia poco esercitato ne gli studi di mathematica potrà agevolissimamente , et con prestezza incenderne il tutto, di nuovo ricorretta et ampliata,* (Venice, 1553); Alessandro Piccolomini, *De le stelle fisse, Libro uno con le sue figure et con le sue tavole, dove con meravigliosa agevolezza potrà ciascuno conoscere qualunque stella delle quarantotto imagini del cielo stellato, & le favole loro integramente & sapere in ogni tempo dell' anno à qualsivoglia hora di notte in che parte del cielo si havino non solo le dette imagini, ma qualunque stella di quelle,* (Venice, 1553); Cerreta, pp. 175-96, Suter, pp. 210-33; Giovanni Marinelli, *Le medicine pertinenti alle infermità delle donne*, (Venice: G. Valgisio, 1574).

[13]Cerreta, p. 39.

[14]For an analysis of Algarotti's and Fontanelle's works see Findlen, " Translating the New Science ", pp. 167-70; Schibinger, pp. 38-41; for Piccolomini's see Suter, pp. 214, 219.

[15]Piccolomini, *La sfera del mondo*, pp. 1r-3v; Piccolomini, *De le stelle fisse*, pp. 3r, 7v-8v.

[16]Piccolomini, *De la sfera del mondo*, pp. 3v-7r. See the definitions in Euclid, *The Thirteen Books of Euclid's Elements*, translated by Sir Thomas L. Heath in Great *Books of the Western World*, Vol. II, (Chicago: Encyclopedia Brittanica, 1952), pp.1-369; M. Pedrazzi, " Alessandro Piccolomini e la sua assiomatica per la *Sfera del mondo* ", *Cultura e scuola*, anno XV, no. 63-64, (luglio-dicembre 1977), pp. 423-432.

[17]Suter, pp.212-217.

[18]Piccolomini, *Sfera del mondo*, pp. 18r-28v, 44r-46v.

[19]*Ibid.*, pp.15v-16r, 54r. Piccolomini might have been aware of Copernicus and his work, *De revolutionibus* (1543) in the later editions of his work, since both authors had been connected with Padua University. Nevertheless, the author attributed the motion of the earth to the Pythagoreans, as did Giordano Bruno, Galileo, and Copernicus himself. See Suter, pp.217-218.

[20]Piccolomini, *Sfera del mondo*, pp. 9r-10v. For the number of spheres in the universe see Grant, pp. 271-323, particularly, pp. 310-311.

[21]Piccolomini, *Sfera del mondo*, pp.11v-11r; Aristotele, *Opere*, 3, *Fisica*, libro III, 208a, libro IV, 214a-215b, libro VIII, 261b.

[22]Piccolomini, *Sfera del mondo*, pp. 14r-16r; Aristotele, *Opere*, 3, *Del cielo*, libro II, 296a.

[23]Piccolomini, *Sfera del mondo*, p. 28r; Aristotele, *Opere*, 3, *Del cielo*, libro I, 268b-269b.

[24]Piccolomini, *Sfera del mondo*, pp. 49r.-53r.

[25]Piccolomini, *De le stelle fisse*, p. 3r.

[26]*Ibid.*, pp. 10r, 29v; Suter, p. 221.

[27]Piccolomini, *Delle stelle fisse*, pp. 4v-6r, 54r-122v.

[28]*Ibid.*, pp. 8v-10v.

[29]Suter, pp. 215-217, 221. For Laudomia Forteguerri see Cerreta, p.31n; for the informal gatherings of the Academy of the Intronati and the effect of the siege see Riccardo Bruscagli, " Nel salotto degli Intronati " in Girolamo Bargagli, *Dialogo de' giouchi che nelle vegghie senesi si usano di fare*, (Siena: Accademia Senese degli Intronati, 1987, reprint of 1572), pp.9-38.

[30]For biographies of Giovanni Marinelli, his son Curzio, also a doctor, and Lucrezia Marinelli see Girolamo Tiraboschi, *Biblioteca modenese*, Tomo III, (Modena: Società tipografica, 1783), pp. 157-163; Conti Odorisio, pp. 50-52.

[31]See the introduction of G. Marinelli.

[32]For the Hippocratic works mentioned above see E. Littrè, *Oeuvres complètes d' Hippocrate*, (1851), T. 7, T. 8 , (Amsterdam : A. M. Hakkert, 1962). Marinelli's commentaries on Hippocrates were: *Commentaria in Hippocratis coi medicorum omnium facile principis Opera*, (Venice, 1575); *Hippocratis aphorismi; de febribus ex Hippocrate liber.* The list was provided by Tiraboschi, pp. 158-159. For Marinelli's knowledge of the Hippocratic works mentioned above see his *Commentaria in Hippocrati Coi medicorum.*

[33]For the relationship between natural philosophy and medicine in Italy in the sixteenth-century see Charles B. Schmitt, " Aristotle among the Physicians " in *The Medical*

Renaissance of the Sixteenth Century, A. Wear, R.K. French and I.M. Lonie eds., (Cambridge: Cambridge University Press, 1985) , pp. 1-15.

[34]Marinelli, *Le Medicine;* for which diets to follow during pregnancy see pp. 250v-255r; for examples of remedies to combat sterility and help delivery see pp. 3v-4r, 189r-191v, 247r-248r, 266r-267v; for instructions to midwives see 273v-289r.

[35]Marinelli, *Le medicine,* pp. 94v.-95v.. For women's physical inferiority see Aristotele, *Opere,* 5, *Riproduzione degli animali,* (Rome: Laterza, 1990), Book I (A), 19, 727a-b, 20, 728a, Book II (B), 3-4, 737a; Galen, *On the Usefulness of the Parts of the Body,* translated by Margaret Tallmadge May II. (Ithaca. N.Y.: Cornell University Press. 1968), p. 628; Hippocrates, *Oeuvres complètes,* T. 7: *De la nature de l' enfant,* ed. Littrè, pp. 505-507, 511.

[36]Marinelli, *Le medicine,* pp. 243v-245v; Hippocrates, *Aphorismes,* Section v, no.42, no.48; Hippocrates, *De la nature de l' enfant,* Littrè ed. p. 503.

[37]Marinelli, *Le medicine,* pp. 175v-177v; Galen, *On the Affected Parts,* Book VI: " Diseases of Viscera and Urogenital Tract", translated by R. E. Sigel, (Basel: S. Karger, 1976), pp. 182-187.

[38]Marinelli, *Le medicine,* pp. 60v, 96v, 235r-238v; Aristotele, *Opere,* 5, *Riproduzione degli animali,* I (A), 20, 728a, II, (B), 4, 740b, IV (D), 6, 275a.

[39]Conti Odorisio, pp. 50-51, 55, 59, 88-90; Tiraboschi, T. III, pp. 159-163; L. Marinelli, pp. 32r-33v, 41v, 45v-46r; Moderata Fonte, *Il merito delle donne,* Adriana Chemello ed (Venice: Eidos, 1988), pp. 20-22; Arcangela Tarabotti, *Che le donne siano delle spezie degli uomini,* Letizia Panizza ed., (London: Institute of Romance Studies, 1994), pp. 18, 43, 65, 68, 91-92 .

[40]Pizan, pp. 22-23.

[41]Amodeo Quondam, " La scienza e l' accademia " in *Università, Accademie e Società scientifiche in Italia e in Germania dal cinquecento al settecento,* L. Boehm, E. Raimondi, eds., (Bologna: Il Mulino, 1981), pp. 23-24.

[42] Kelly Gadol, pp. 175-201; Bruscagli, "Nel salotto degli Intronati ", in Bargagli, pp. 34-35. For what took place in these meetings, and for some women's interests see Bargagli, pp. 43-230; Guazzo, *Civile Conversation,* Book 4.

[43]Michele Maylender, " Accademia degli Intronati " in *Storia delle Accademie d' Italia,* Vol. V, (Bologna: A. Forni, 1926-1930), p. 361; Quondam, p. 29.

[44]For Forteguerri's poem and Piccolomini's discussion of it see Alessandro Piccolomini, *Lettura del S. Alessandro Piccolomini infiammato fatta nell' Accademia degli Infiammati*

MDXXXXI, (Bologna: Bonardo, 1541); Paul F. Grendler, *Schooling in Renaissance Italy, 1300-1600,* (Baltimore: The Johns Hopkins University Press, 1989), pp. 93-95.

[45]Baldassare Castiglione, *Il libro del cortigiano con una scelte delle opere minori,* Bruno Maier ed. (Turin: Unione tipografica-editrice torinese, 1964), book III, pp. 339-349.

[46]Bruscagli, pp. 30-31; Emilio Speciale, " Il discorso del gentiluomo " in Paluzi ed. *Stefano Guazzo,* p. 34.

[47]G. Spini, *Ricerca dei libertini: la teoria dell' imposture delle religioni nel seicento italiano,* (Rome: Universale di Roma, 1950), pp. 206-212; Beatrice Collina, " Moderata Fonte e *Il merito delle donne* ", *Annali d' Italianistica,* 7 (1989), pp. 148-149; Francesca Medioli, " Chiavi di lettura " in Arcangela Tarabotti, *L' inferno monacale* (Turin: Rosemberg & Sellier, 1990) p. 145.

[48]For Sarrocchi's academy, the Lincei's members' attendance of it, and Sarrocchi's role in founding other academies see Ugo Baldini, Pier Daniele Napolitani, " Per una biografia di Luca Valerio ", *Bollettino di storia delle scienze matematiche,* Anno XI, no. 1, (giugno 1991), pp. 51-59. For the academies mentioned see Maylender, *Storia delle accademie,* Vol. IV, pp. 140-141, Vol. V, pp. 370-381. For the male-oriented aspect of the Academy of the Lincei see Mario Biagioli, " Knowledge, Freedom and Brotherly Love: Homosociality and the Accademia dei Lincei ", *Configurations,* (1995), 2, pp. 139-166; for Cereta see Otavio Rossi, *Elogi Historici di Bresciani Illustri,* (Brescia, 1620), p. 200; Helio Caprieli, *Chronica de rebus Brixionorum,* (Brescia, 1505), p. V; Vincenzo Peroni, *Biblioteca Bresciana,* (Brescia, 1818-23), Vol. I, pp. 250-51; Vol. II, pp. 282-84.

[49]P. Gio: Domenico Ottonelli, *Della pericolosa conversatione con le donne , ò poco modeste , ò ritirate , ò cantatrici, ò academiche. Opera del P. Gio: Domenico Ottonelli di Fanano, sacerdote della Compagnia di Giesu,* (Florence : L. Franceschini e A. Logi, 1646), pp. 389-414; Cardinale Giambattista de Luca, *Il cavaliere e la dama,* (Bologna: De Longhi, 1700), pp.550-590.

[50]For the Academy of Gelati see Maylender, " Accademia dei Gelati ", Vol. III, PP. 81-88. For its changing nature see Cavazza, *Settecento inquieto,* pp. 36-37; *Prose de' Signori Accademici Gelati di Bologna,* (Bologna: Manolessi, 1671), pp. 142-170, 299-312, 369-370; *Memorie, imprese, e ritratti de' Signori Accademici Gelati di Bologna. Raccolta nel Principato del Signor Conte Valerio Zani,* (Bologna: Manolessi, 1702). For the first female member see *Leggi dell' Accademia de' SS" Gelati di Bologna col catalogo degli accademici viventi MDCC,* (Bologna: Benacci, 1700), p. 35. For women's earlier attendence see B. U. B. Ms. 770, vol. XXXIV, 1663-1666, *Memorie antiche manoscritte di Bologna et accresciute sino ai tempi presenti del Canonico Antonio Francesco Ghiselli, Noble Bolognese,* p. 385.

[51]B.U.B., Ms. 770, *Memorie,* Vol. XXXIX, (1679), pp. 319-320, 622-623, Vol. LXII, (1700), pp. 3-4, 411-413, 653, Vol. LXIII, (1701), pp. 12, 17, 59, 97-98, 108-110, Vol.

LXXX, (1712), pp. 445r-475r, Vol. LXXXIX-X, (1719-1724), see 1722, pp. 136r-141v.

[52]Paolo Mattia Doria, *Ragionamenti di Paolo Mattia Doria indirizzate alla Signora D. Aurelia d' Este, Duchessa di Limatola ne' quali si dimostra la donna in quasi che tutte le virtù più grandi non essere dell' uomo inferiore,* (Francfort, 1716), pp. 369-370, 424, 453-454. For the presence of other ladies in Neapolitan academies see Findlen, "Translating the New Science ", pp. 174-176.

[53]Paolo Mattia Doria, a Genoese nobleman, began his career as a Cartesian philosopher, but according to Vincenzo Ferrone, his dialogue with modern science led him to a scientific counter revolution that rejected all modern theories and methods from infinitesimal calculus to Newtonian universal gravitation. His opposition to the investigation and mathematization of nature was founded on metaphysics and elementary geometry see Ferrone, pp. 120-129, 524-542. For the women members of the Academy of the Oziosi see Maylender, Vol. IV, pp. 190-192.

[54]For a list of Doria's publications see Federico Amodeo, *Vita matematica napoletana,* (Naples: F. Giannini e Figli, 1905), prima parte, pp. 50-52. Doria's works came under severe attack for his rejection of modern mathematical methods, see Ferrone, pp. 524-544, 584-604.

[55]Doria, Introduction and pp. 342-363.

[56]Gaspare Gozzi, *La Gazzetta Veneta,* Antonio Zardo ed., (Florence: Sansoni, 1967), see *Gazzetta Veneta,* no. LXXXV, mercoledì, addi 26 novembre 1760, pp. 359-363.

[57]Pietro Verri, " *Manoscritto " per Teresa,* Gennaro Barbarisi ed., (Milan: Serer e Riva, 1983), for the earliest stages of Teresa's upbringing see pp. 96-107; for her education see pp. 153-199. For Rousseau's education of Sophie and small children see Jean-Jacques Rousseau, *Emile or on Education,* Introduction, Translation and Notes by Allan Bloom, (New York: Basic Books Inc., 1979), pp. 37-74, 357-480; Antonio Illibato, *La donna a Napoli nel settecento. Aspetti della condizione e del' istruzione femminile,* (Naples: M. D' Auria, 1985), pp. 24-25.

[58]For Cerata's letter to Sempronio see Robin ed., pp. 72-80; Aretafila Savini de' Rossi, " Apologia in favore degli studi delle donne contro il precedente discorso del Sig. Antonio Volpi scritta dalla Sig. Aretafila Savini de' Rossi, dama senese ad un cavaliere " in *Discorsi accademici...,* pp. 50-65; Maria Vigilante, " La traduttrice a chi legge " in Isacco Watts, *Elementi di Geografia, ed Astronomia del Signore Isacco Watts tradotti dalla settima ed ultima edizione inglese nell' idioma italiano da Maria Vigilante con alcune piccole osservazioni, e aggiunzioni della medesima, tanto in rapporto alle differenti posizioni di Napoli e Londra, che per comutazione de' dominj di varie parti della Terra,* (Naples: Raimondi, 1789), pp. VII-X; Giuseppa Eleonora Barbapiccola, " La traduttrice ai lettori " in Renato Descartes, *I principi della filosofia di Renato Descartes. Tradotti dal francese al confronto del latino in cui l' autore gli scrisse di Giuseppa Eleonora*

Barbapiccola tra gli Arcadi Mirista, (Turin: Mainesse, 1722); Maria Gaetana Agnesi's letters is found in Anzoletti, pp. 360-63.

[59]Benvenuto Robbio di San Raffaele, *Disgrazia di Donna Urania, ovvero degli studi femminili*, (Florence: Stamperia Granducale, 1798), pp.27-34, 61-64, 101-08, 114-15, 169-175; Findlen, " Translating the New Science ", pp. 169-75.

[60] Castracane, pp. 307-308.

[61]For the idea of a scientific revolution, with the changes in methodology that such revolution implied is found in Zilsel, pp. 544-562; Koyré, pp. 3-24; Rupert Hall, pp. 36-77, 329-43. For a better education for women see Traversi, pp. 20-23

[62]For a list of female members at the Bologna Academy of Sciences see Richard Leonard Rosen, " The Academy of Sciences of the Institute of Bologna, 1690-1804", Ph.D Dissertation , Case Western Reserve University , 1971, pp. 177-193. For Fiorini Mazzanti membership at the Pontificial Academy of the Lincei see Castracane, pp. 307-308.

[63]Gaetano Gandolfi, *Elogio di Tarsizio Riviera già Professore di Chirurgia nella Università di Bologna*, (Bologna: U. Ramponi, 1807), p. XIII.

[64]Tarsizio Riviera, *Sopra l' indole morale e fisica delle donne*, (Bologna: Tommaso d' Aquino, 1796), pp. 23-25. For Riviera's Hallerian tendencies see Bernardi, pp. 68-76; Walter Tega, " Introduzione " in *Anatomie Accademiche*, Vol. II: *L' enciclopedia*, pp. 23-25.

[65]Since not many Italians were proficient on English at the time, it was the Latin version of Newton's *Opticks*, which was often used, see Ferroni, pp. 26-32. For Laura Bassi's teaching of Newtonian physis see Berti Logan, pp. 797-798; for Cristina Roccati's see Paola Savaris, " Cristina Roccati: una rodigina del '700 tra scienza e poesia " *tese di Laurea*, Università degli Studi di Ferrara, Facoltà di Magistero, anno accademico 1990-1991, pp. 27-34.

[66]For the similarities between Fontanelle's and Algarotti's works as it pertains to women see Mary Terrall, " Gendered Spaces, Gendered Audiences: Inside and Outside the Paris Academy of Sciences ", *Configurations*, 2 (1995), pp. 225-226. For a positive review of Algarotti's work see Walter D. Wetzels, " Newton for the Ladies: Algarotti's Popularization of Newton's *Opticks* ", *Transactions of the Eight International Congress on the Enlightenment*, (Oxford: The Voltaire Foundation, 1992). pp. 1152-1155.

[67]Francesco Algarotti, " Dialoghi sopra l' ottica Newtoniana " in *Illuministi italiani*, Tomo II: *Opere di Francesco Algarotti e di Saverio Bettinelli*, Ettore Bonora ed. (Milano: R. Riccardi, 1969), p. 21.

[68]*Ibid.*, p. 165.

[69]*Ibid.*, pp. 40-45, 63-78, 84, 88-91, 95-101, 107-108, 114, 120-121, 159-163.

[70]*Ibid.*, pp. 107-108, 110-111, 104.

[71]Quotation from Terrall, p. 226.

[72]For Algarotti's support of the Copernican system see dialogues 5 and 6 of Algarotti, " Dialoghi..."; for Algarotti's problems with censorship see Casini, pp. 97-99; Ferrone, pp. 34-42.

[73]For the Academy of the Inquieti see Cavazza, *Il settecento inquieto*, pp. 57-78; Rosen, pp. 26-34; for the Academy of the Ricovrati see F. Venturi, *Settecento riformatore*, V: *L' Italia dei Lumi*, Tomo secondo: *La Repubblica di Venezia (1761-1797)*, (Turin: Einaudi, 1990), p. 225; Massimiliano Desa, *Vita di Helena Lucretia Cornara Piscopia*, (Venice: Casamara, 1687), pp. 36-39; see letter no. 106 of Kal. Sept. MDCCLII of Giovanni Alberto Colombo to Cristina Roccati in A.C.R.: *Ms. Silvestriana* no. 203: Lettere 177 autografe a Cristina Roccati.

[74]See Lady Mary Wortley Montagu's letter to Lady Bute October 10 [1753] in Lady Mary Wortley Montagu, *The Complete Letters of Lady Mary Wortley Montagu*, Vol. III: *(1752-1762)*, Robert Hallsband ed., (Oxford: Clarendon Press, 1965), p. 39.

Chapter III

Women and Science prior to Galileo's Trial and Condemnation in 1633

As seen in the previous chapter, until the eighteenth century very few pedagogical writers were ready to prescribe scientific studies to women, unless, of course, they had risen above their nature, and were therefore exceptional; then the normal rules of education did not apply. In spite of the advices of educators on what women were, or were not to study, the latter would be exposed to varying degrees to the sciences, if they were learned in Latin, and from the sixteenth century onwards--when scientific translations into the vernacular became increasingly popular--even if they were not. In fact women from the period under discussion were interested, and were often enough active in a variety of scientific fields such as mathematics, astronomy, natural philosophy, alchemy, natural history, botany and medicine. They appeared sometimes as patrons, translators, collectors, practioners, and even as harbingers of a new approach to do science. To what extent they were learned in these subjects becomes much harder to measure, for unlike the men, they seldom wrote tracts of an exclusively scientific nature. Men wrote commentaries on ancient and Islamic authors, translations from Greek, Latin and Arabic texts, and also produced original works such as Luca Pacioli's *Summa de arithmetica* (1494), Bombelli's *Algebra* (1572), or Galileo's *Sidereus Nuncius* (1610) to cite a few examples. Many of these works were produced under the auspices of humanist patrons, or in the capacity of the writers as teachers at universities, or related institutions, or in a private capacity.[1]

Now women were far less likely to have patrons than men; they had less mobility, and therefore were less likely to get access to the libraries where manuscripts for translation were to be found. Even when women had patrons, ability, and accessibility to manuscripts, they seemed to have preferred to translate works of a literary rather than scientific nature. Now women's relationship with universities was tenuous indeed, and can be traced, mostly to the Medical School of Salerno, to a period which predated its formal organization as an university medical faculty in the second half of the thirteenth century, as Nancy Siraisi points out in *Medieval & Early Renaissance Medicine.* The other references to women 's association with universities are few, far in between, and difficult to prove with any degree of certainty. For instance, in her *Book of the City of Ladies,* Christine de Pizan referred to Novella Calderini teaching law in lieu of her father at the University of Bologna in the fourteenth century. Cherubino Ghirardacci mentioned Bittizia Gozzadini's law degree, and teaching at the same university during the thirteenth century in his *Della Historia di Bologna* (1596). Two women were supposedly also associated with the University of Bologna's medical school, one such woman was Dorotea Bocchi, the daughter of the physician Giovanni Bocchi. She was supposed to have taught her father's students, and in 1350 received one hundred lire for her efforts. Unfortunately the sources which inform us of those facts date from 1714. The other, Alessandra Giliani, who was supposed to have assisted Mondino di Liuzzi in the early 1300s in his anatomical preparations, according to A. Macchiavelli in his *Effemeridi Sacro-civili, perpetue bolognesi* (1739), is put down as a legend by Nancy Siraisi since the techniques she was supposed to have used dated from the seventeenth century. Costanza Calenda, the daughter of a professor of medicine in Naples appeared as a doctor

in medicine in 1422, according to S. De Renzi in his *Storia documentata della Scuola di Salerno* (1857); but as P. O. Kristeller points out in " Learned Women of Early Modern Italy ", the documents which would confirm her doctorate were destroyed during the last war. On a positive note, there is real evidence that the humanist Cassandra Fedele gave at least one oration at the University of Padua in 1487, a place were she was not allowed to study.[2] The association of the women mentioned above, and others, with universities needs to be confirmed by modern methods of scholarship; and undoubtedly, their tenuous association with these institutions affected the number of scientific works they were likely to produce. However, what would become relevant to the women who were to receive degrees and positions at the universities in the eighteenth and nineteenth centuries was the belief that men in these latter centuries had--as the dates of some of the sources mentioned above indicate--that there were women associated with Italian universities in the past whose names were still remembered, and who set important precedents for those women who were to follow.

Whether women were associated with universities, or not, the fact remains that for the period under discussion, there is proof of women's knowledge and activities not only in the field of medicine, and its related subjects, botany and alchemy, but also in the field of astronomy, and its related topics of mathematics, astrology and natural philosophy or physics, and finally in the field of natural history, a subject which, as chapter one illustrates would increase in importance in Italy from the sixteenth century onwards. The first topic to be considered will be women's knowledge and activities in the field of medicine, followed by those in astronomy and natural history.

I. *Women and Medicine*

As Nancy Siraisi points out in *Medieval and Early Renaissance Medicine*, women, particularly those associated with the Medical School of Salerno, played a role in medical practice during the Middle Ages. However, their activities were insignificant as compared to those of men; and matters were made worse once university faculties of medicine were organized in the thirteenth century, as it happened with the Medical School of Salerno in the second half of that century. Then women were excluded from higher medical learning, and the most prestigious medical practice.[3] The scholarly work of John F. Benton and Giulia Orofino in recent years has confirmed the existence of women associated with the Medical School of Salerno, prior to its formal organization in the second half of the thirteenth century, as well as the role of one of these women physicians, Trota or Trotula, as a medical author. The organization of university medical faculties might have excluded women from the formal study of medicine, but not necessarily from all the knowledge imparted to students of medicine. As already indicated in chapter two, a number of women had some knowledge the medical theories of Hippocrates, Galen , and Aristotle, and in particular of the medicinal properties of plants. There is plenty of evidence that women continued to practice medicine even after the organization of medical faculties, undoubtedly at a lower level of prestige than university-trained physicians. In fact, most women probably acted as nurses in their own household, a role prescribed to them by educators since the Renaissance.

A. *Medieval Female Practioners of Medicine*

As mentioned above, John F. Benton and Giulia Orofino have been able to confirm the presence of women physicians at the Medical School of Salerno in the Middle Ages. Benton has been able to confirm the presence of at least one woman physician at the School of Salerno, Trota, with his discovery at Madrid's Biblioteca de la Universidad Complutense of a manuscript of Northern French or English origin, dating from about 1200. The manuscript is a physician handbook containing a collection of Salernitan medical texts from various authors. The last work in the collection, identified by the scribe as *Practica secundum Trotam* (*Practice according to Trota*), is a treatise in four folios of remedies and medical advice on gynecology, the care of children, beauty, and on a series of ailments affecting both men and women, such as vomiting, scrofula, insanity, piles, and snake-bite. Twice. the scribe of the Madrid *Practica* referred to its author as a woman, whose name is spelled in full as Trota. [4]

Half of the material found in the *Practica secundum Trota* is also found in another Salernitan manuscript dating from the same period, *De aegritudinum curatione* (*Concerning the Healing of Diseases*)--a compendium of extracts from works of well-known Salernitan masters, such as Copho, and Platearius, for instance--in paragraphs labelled " Trot " or " sine nom.[ine] " (no name). Since there is material found in the Madrid *Practica* which is not found in the *De aegritudinum* labelled under " Trot ", and vice-versa, Benton concludes that both the Madrid *Practica* and the " Trot " and "sine nom." sections of *De aegritudinum* formed part of a larger *Practica*, composed by Trota, but now lost, and similar in its form to the *Practicae* of masters Platearius and Bartholomeus of the same school. The fact that the Madrid *Practica* dates from about 1200, and its contents were influenced by the works of Constantine and Copho, indicates

that Trota practiced in the twelfth century. The fact also that the title master never appears before Trota's name in the *De aegritudinum*, as it appear before the names of male authors, indicates to Benton that she was never accorded that title.[5]

A comparison between the earliest manuscripts of the three works traditionally attributed to Trota, *Cum auctor* (*Trotula major*), *Ut de curis*, and *De ornatu* (*Trotula minor*) and the *Practica* leads Benton to conclude that the three former treatises were stylistically different from the latter treatise. Moreover, the remedies in the *Practica* differed from those found in the texts traditionally attributed to Trota, or Trotula. The fact that the earliest manuscripts of *De ornatu* (a text on cosmetics written for women) referred to its author as a male, and that the other two texts attributed to Trota, *Cum auctor* and *Ut de curis*, were gynecological treatises written for physicians, and represented, besides, a more " learned " level of academic medicine than the *Practica*, leads Benton to conclude that these treatises were really written by men. He is also led to this conclusion by the fact that *Cum auctor* expounded the Galenic theory of women as imperfect men, and along with *Ut de curis*, prescribed bleeding for cases of excessive menstruation, something that the *Practica* never did in such cases. To Benton, Trota's *Practica* was not a treatise concerned with expounding medical theories, but instead, was representative of the tradition of empirics and midwives, as such it was based on experience, and not on theory.[6]

Benton's findings establish Trota's existence, as well as her role as an author; however, they also lower her status from that of an academically learned physician to that of an empiric. They seem to indicate that the women physicians of Salerno were never able to rise as high as male physicians, even before the Medical School of Salerno was

formally organized as a medical faculty in the late 1200s. Of course Trota may have written the theory-oriented works originally attributed to her, and the differences in style and content found between the *Practica* and these works might be explained by the fact that they were aimed at different audiences, such as empirics (*Practica*), and learned physicians (*Cum auctor*, and *Ut de curis*); however, this needs to be proven.

Since, as mentioned above, half of the material which is found in the Madrid *Practica* is also found in the *De aegritudinum curatione* in paragraphs labelled " Trot " or " sine nom[ine]", a look at these sections in the *De aegritudinum curatione*, as published in Salvatore de Renzi's *Collectio salernitana*, indicates that Trota's *Practica* covered more than women's problems. As Monica Green suggests only about a quarter of the material dealt with gynecological and obstetrical matters.[7] Thus along with topics like " the Purgation of Women after Childbirth", " So That Women Might Conceive ", " On the Displacement of the Womb " or On the Tumor of the Womb", there were topics which dealt with redness of the eyes, headaches, gums, toothache, intestinal pains, how to induce vomit, how to whiten the face, how to cure constipation, kidney stones, burns or scalding, and so on.[8]

Trota did not go into details on the causes of a disease, as Benton appropriately points out; instead often she would provide alternative remedies as befitted variations in the disease concerned. These remedies were usually based on plants, but they could also contain minerals. They could take the form of drops, plasters, ointments, powders, washes, drinks, or syrups. Diets could also be prescribed for some ailments. Thus for toothache, one of the remedies consisted of mixing rue with pepper, and placing the mixture on the tooth overnight. For canker of the gum, lips or tooth, first one was to

rinse the mouth with vinegar, and then rub the area with finely powdered alum. Most of the herbals used by Trota, often in combinations, could also be found in herbals which were heavily influenced by the Salerno School, such as *The Herbal of Rufinus*, dating from the late thirteenth century.[9]

Benton stresses also that several of the works associated with the Medical School of Salerno, such as *De ornatu*, refer to the women physicians of Salerno. The fact that medical licences were granted by royal officials, instead of church officials, or masters, facilitated the licencing of women physicians. The presence of women physicians associated with the Medical School of Salerno is also confirmed by the Pseudo Apuleo Herbarium Manuscripts of Florence and Vienna. These manuscripts are illuminated herbals which have their origins at the School of Salerno in the thirteenth-century. According to Orofino, who has studied the images represented in these manuscripts, the women illustrated in them appeared as doctors, and shared with their male colleagues gestures and attributes. They were shown not only treating women, but also treated men in cases of hemorrhage, poisoning, burns, diseases of the mouth, insomnia, intestinal and urinary tract diseases and other such ailments. These women physicians were sometimes assisted by a man in a subordinate position. Like Trota, some also wrote tracts pertaining to medicine, but as Monica Green suggests, " these attributes need to be reconfirmed in accordance with modern scholarly standards."[10]

The organization of university medical faculties during the course of the thirteenth century did not stop women from treating men and women suffering from a variety of ailments. For instance, there are records of women female practioners belonging to the guilds, and in tax rolls in towns like Siena, Venice and Florence in the Middle Ages.

Women continued to be licenced for medical practice in the Kingdom of Naples well into the fourteenth century. Raffaele Calvanico found evidence of twenty four women surgeons in the kingdom from 1273 to 1410. However, there are no indications that any of the women mentioned above were associated with universities, or that they wrote any works pertaining to their field of expertise.[11]

One assumes that all the women mentioned above practiced medicine for a profit. There were women, however, who were led to the practice of medicine because of their faith, and a belief that they needed to help the destitute. Such was the case of Francesca Bussa dei Panziani, or St. Francesca Romana (1384-1440). The record of the proceedings for her sainthood indicate that she was a skilled medical practioner. Francesca may have used prayers to assist the ill, but she also used remedies, in the form of ointments, or plasters, made of plants and minerals, which were specific to the diseases being treated. The people questioned during the proceedings, were more interested in emphasizing the fact that her cures were the result of her saintly intervention, rather than any medical skills she might have had. Still Francesca had many successes to her name, such as the treatment of the ill in Roman hospitals, the ability to close wounds that had failed to heal, in spite of previous attempts by physicians. Throughout, the saint stressed that it was not her office to treat patients, and that physicians had to be consulted; nevertheless, Francesca was ready to go beyond the standard herbal and mineral cures, and use sutures to ensure the healing of wounds.[12]

Women had greater difficulties obtaining licences as medical practioner with the rise of medical tribunals (*protomedicato*) responsible for the licencing of the healings arts in many Italian towns during the sixteenth century. These tribunals, run by members of

colleges of medicine, tended to limit the licencing of females to midwifery, and/or the making and application of external remedies used on women, as a study by Gianna Pomata of the *protomedicato* for the town of Bologna indicates. Some women, like Lavinia Olimpi from Bologna in 1638, might be licenced to apply external remedies to male and female patients for various illnesses. But usually official records indicate that women involved in the healing arts, practiced by then some kind of unlicenced low-level medicine in the towns and country areas, and would only come to the attention of the *protomedicato* when complaints were lodged against them. One could not usually expect publications from a group on the margins of legality, whose level of education must have been, one suspects, rather low. [13] In fact, most of the publications which referred to medical theory,or/and medical practice originated with women from the learned elite. Since medicine could not be considered a profession to these women, their knowledge of medical theory and practice was displayed, with one notable exception, in letters, and in tracts in moral philosophy, or in defence of women.

B. *Medical Knowledge and Practice amongst Women of the Learned Elite after 1500*

As discussed on chapter two, the advent of printing, the rise of the academies, and the translation of ancient works and the publication of new ones in the vernacular did much to increase women's knowledge in the sciences, including medicine. On the whole, it might be said that after 1500, women of the learned elite displayed some learning of basic medical theory, and a greater learning, usually based on practice, of the medicinal properties of a variety of plants. Isabella Sforza (1503-1561), in a work filled with evangelical maxims, and furnished with theological doctrine, *Of the Real Tranquility of*

the Soul (1544), displayed for instance, some knowledge of medical theory. As owing to a publication in moral philosophy, Sforza emphasized that the health of the soul was more important than the health of the body. Nevertheless, in the best Hippocratic tradition, she also stressed the importance of diet and location on health. Thus, people who lived in the countryside, and were given to more exercise, better air, and a moderate diet, were likely to be healthier than those who lived in cities. It was with Galen in mind, that she defined as the noblest parts of the body, the heart, head , and liver.[14]

As seen in chapter two, knowledge of medical theories, particularly of Greek theories on generation, were displayed on works by women defending women's biological and intellectual excellence. Lucrezia Marinelli, learned in Latin, and the daughter and sister of physicians Giovanni and Curzio Marinelli, was well aware of medical theories, and particularly objected to Aristotle's theories on generation, which made women the providers of only matter in generation,and weaker and colder, and therefore, less perfect than men.[15] L. Marinelli in her work, *On the Nobility and Excellence of Women*, used Plutarch, Hippocrates, Marsilio Ficino, and Aristotle himself to discredit Aristotle's theories on women, and emphasize their perfection. If women were weaker than men, as Plutarch pointed out, vigorous exercise would make them strong, and as capable of efforts as men, country women could serve as examples. As Hippocrates had shown, climate affected people, therefore women from southern climates, like Spain, would be warmer than men in northern climes, like Germany; and thus, by Aristotelean logic, Spanish women would be nobler than German men. Failings in Aristotle's logic could also be found in the fact that, if men were nobler than women because they were hotter, a young boy, being the hottest, would therefore be nobler than a mature man, which was an

absurdity, according to Marinelli. Ideally, one should have a woman's temperate body, for as Marsilio Ficino pointed out, not all heat was useful to the proper functioning of the soul.[16]

Sister Arcangela Tarabotti also objected to Aristotle's theories on generation in her publication, *Che le donne siano delle spezie degli uomini*, and the use some men made of them to make women less rational than men, and even into a different species. The sister used Galen to discredit Aristotle, and took from the physician's works only what could be used in defence of women, while she ignored misogynist aspects found in them. Thus, as Galen had shown, both women and men participated equally in the generation of a child. Actually, women played a greater part in it, for she nourished, and also raised the creature. Tarabotti, like Marinelli, used Aristotelean reasoning against himself: if females were formed in eighty days, and males in forty, the former should by logic be more perfect than the latter, for whatever took longer to create necessarily required more study and diligence. The sister would only be ready to accept Aristotle's ridiculous statement that women only served as instruments in generation, the moment that men would be able to procreate the world all by themselves. As far as Tarabotti was concerned, women were equal to men in creation, generation, species, and soul.[17]

Unlike Sforza, Marinelli, and Tarabotti, most learned women's medical knowledge pertained to remedies and their application, and had to do with women's prescribed role as nurses, and sometimes apothecaries to members of the households, or convents in which they lived. As seen in chapter two, women were expected by men like Alessandro Piccolomini, and even conservatives like Silvio Antoniano, to look after the ill of the household, to ensure that the sick would have the right medicine, and that the appropriate

physicians would be procured.[18] The humanist Battista da Montefeltre (1384-1448) played such a role during her father-in-law's illness, Malatesta dei Malatesta, Lord of Pesaro, and then during the illness of her own husband, Galeazzo.[19] This practical need of women to know what medicines to use for the various ailments that might afflict household members made them readers of herbals.

When Moderata Fonte, or Modesta Pozzo de' Zorzi (1555-1592), wrote the dialogue *Il merito delle donne*, she was aware, as Stephen D. Kolky points out, that if she were to show that women were praiseworthy, they were to have command in a number of scientific areas. This scientific knowledge Fonte placed in the hands of only one woman in her dialogue, the celibate, self-taught, and book-learned Corinna, the author's alter ego.[20] It befell to Corinna the task to inform the readers of the medicinal properties of various plants and minerals, the diseases they were supposed to cure, and of the medical theory which underlay both disease and cure.

A perusal of this section indicates that the greatest number of herbs, with only one or two exceptions, and most of the minerals mentioned as medicinals in the book can also be found in the Salernitan-influenced herbal, *Herbal of Rufinus.* In fact there is real coincidence as to the diseases the remedies were supposed to cure between Fonte's work and the *Circa instans* section of the *Herbal.* Therefore, Fonte must have used either the Venetian herbal of Benedetto Rinio (fifteenth-century), or a version thereof, which used extensively the Rufinus herbal, and was found in Venetian pharmacies, or perhaps , even the printed version of the *Circa instans*, which was published in 1497. Unlike Rufinus, or the *Circa intans*, Fonte did not provide any descriptions of the plants, only their medicinal value was mentioned. Furthermore, to Fonte, as to the Greeks and

Romans,and physicians of later periods, disease was caused by either the excess, or defect of one or more of the four humours of the body (blood, phlegm, bile, black bile), and the purpose of the remedies was to restore the balance.[21]

It might be assumed, that many women from the aristocracy to the peasantry would be familiar with the use of herbal, and sometimes mineral, medicines, far more than surviving historical records might indicate. This knowledge was not only confined to women belonging to households, but also to those belonging to convents which ran their own drugstores, as a few of the examples below serve to indicate. For instance, the Lateran Canoness Semidea Poggi of the Monastery of San Lorenzo of Bologna, felt quite confident about her herbal skills, to prescribe a remedy to Cardinal Scipione Borghese Cafarelli in 1621, which was guaranteed to dissolve bladder stones. It consisted of an infusion of wine, or broth, which contained a tablespoon of "lame violet" seeds.[22]

Galileo' eldest daughter, Sister Maria Celeste (1600-1634), who was responsible for the drugstore in the Florentine Convent of San Matteo di Arcetri together with her friend, Sister Luisa, manufactured many of the remedies mentioned by Moderata Fonte in her work. Amongst Maria Celeste's productions, which were sent to her father Galileo, there were rosemary flowers, confectioned with sugar, which, according to Fonte, benefitted a weak stomach. Citron, a fruit, whose rind was hot, its white pith, temperate, and whose seeds had a cooling effect, was a perfect remedy for worms, and burning fever. From the citron Maria Celeste made *morseletti*, sour of citron, and from its rind, syrup. Cooked pear, of which she had a new recipe, opened the chest. Cinnamon water, as the cooler weather approached, would be useful to frigid complexions, for it mitigated coldness.

Maria Celeste would also make remedies, which were a bit more elaborate. For instance, *oximele*, which was referred to by Dioscorides, was made with honey, old vinegar, sea salt, and rainwater. The mixture was boiled, ten times, cleared and aged, and was good for angina, ears, and sores in the mouth and throat. When Galileo had no appetite, his daughter sent him *oxilacchara*, recommended by his physician. It contained sugar, pomigranate wine, and vinegar, and had to be taken in the morning. Papaline pills were made with aloe, dipped in rose water seven times, and rhubarb; the aloe conforted the nerves, rose water had a refreshing effect, and rhubarb was useful after a burning fever. During the 1630 plague epidemic, Maria Celeste sent Galileo a preservative against the plague, which was a compost containing dry figs, nuts, rue, and salt, all mixed with honey, and to be taken with wine.[23]

Many of the remedies made by Maria Celeste had often the double effect of being tasty, and of having curative properties, as Fonte indicated in her work. Often they appeared to have been recommended by Giovanni Ronconi, Maria Celeste's and Galileo's physician. And although Maria Celeste appeared quite capable of deciding what treatments might have been needed for specific ailments, she tended to act in consultation with Ronconi, and followed his advice.[24] It is important to say that Maria Celeste's and Sister Luisa's remedies, not only served the nuns, and Galileo's household, but provided additional income to a financially strapped convent.[25]

In 1561, the Venetian Isabella Cortese wrote *I secreti delle signore di Isabella Cortese nei quali si contengono cose minerali et medicinali artificiose et alchimiche, et molte dell' arte profumatoria appartenenti a ogni gran signora* (*The Secrets of the Ladies by Isabella Cortese which Contained Mineral, Medicinal, Artificial, Alchemical,*

and Cosmetic Matters Belonging to Any Great Lady), one of the few works entirely dedicated to scientific matters, written by an Italian woman prior to the eighteenth century which survives. In it, Cortese displayed a knowledge of the medicinal properties of plants similar to the one found in women in convents and households. But Cortese's learning extended beyond botany. In 1585, the Augustinian monk and social commentator, Tommaso Garzoni identified Isabella Cortese, along with Girolamo Ruscelli, Leonardo Fioravanti, Gabriele Falloppio, Giambattista della Porta, Pietro Bario and others as " professors of secrets ", men and one woman who wrote works professing to reveal the " secrets of nature "--usually artisanal and medicinal recipes couched in alchemical language--to anyone who could read. Several of the so-called professors of secrets were medical men, usually empirics, intent on challenging medical orthodoxy by means of the medical recipes which predominated in their books. As W. Eamon points out, the authors also presented in their works an image of science as " venatio", or as a hunt for the secrets of nature, and as such, were instrumental in shaping the scientific culture in the early modern era. Cortese's work has all of the characteristics mentioned above, typical of books of secrets.[26]

Cortese might have been an empiric, as many other professors of secrets, but nothing is really known of her background, except what she herself mentioned in the work. Apparently she had travelled extensively in search of alchemical secrets, had resided for a period in Olomouc, in Moravia, and had learned alchemical techniques from alchemists in Italy and Eastern Europe. The book itself was dedicated to her brother-in-law, Mario Chaboga, Archdeacon of Ragusa, who shared her interest in alchemy. Eamon believes her to belong to the Venetian aristocracy, in part because of her travels,

in part because her book refers to great ladies, and in part because alchemical operators in Italy catered to the aristocracy.[27]

Cortese's introduction clearly put across the idea of science as " venatio", or a hunt for the secrets of nature, present in other books of secrets. According to her, man's intellect (one would assume woman's also) needed stimulation, and therefore he felt compelled to dig up the secrets of nature. Furthermore, man also made himself the ape of nature, and often superseded nature, by making what nature could not make. As appropriate of professors of secrets who challenged orthodoxy, Cortese did not display the admiration, authors of her century demonstrated, towards recently-recovered ancient learning. As far as she was concerned, her age surpassed in all things the ancient.[28]

In spite of this outburst of modernism, Cortese was not ready to dismiss in practice all ancient learning, for she used theriac, a compound discussed by Galen in his treatises, in several of the remedies found in book one of her work. Thus scorpion oil, useful for fighting the plague, contained, besides one hundred scorpions, and rhubarb, also the finest theriac; while the pills against the French disease (syphilis) contained theriac, alongside terebenthine, dittany, rhubarb, agaric and diagridium. The remedies found in book one, such as ointments, oils, and occasionally diets, were based on herbs, and sometimes minerals, and were used to treat wounds, scrofula, warts, ringworm, scabies, kidney stones, spleen problems, and the effects of venereal disease in the mouth, hands, and pubic areas of both females and males.[29]

Book two used the language of alchemy, designed to conceal, rather than reveal the processes carried out; it was also permeated by the belief that one metal could be transmuted into another, and that each metal had its corresponding planet. Thus for

instance, *sol* stood for gold, and the recipes showed how to remove *sol* from Saturn, *luna* from Jupiter,or mercury from Saturn, how to make lazurium of *luna* in ten days,and water that dissolved *sol* and *luna.* Similar instructions for producing similar compounds can also be found in the *Primun manuale* (1582), attributed to Paracelsus, but whose authorship is questioned by A. E. White, because the work is believed to belong to the most suspicious section of alchemical literature. rather than to serious experimental records. Nevertheless, after having studied alchemical theory for thirty years, Cortese was openly contemptuous of such theories, and ultimately what she provided in her book were methods--based on the trial and error approach--of producing objects for practical use. Thus in book two she also provided instructions on how to make standard chemical compounds, such as borax, sal ammoniac, or oil of arsenic or sulfur.[30]

Most of the instructions found in book three dealt with the crafts, and explained how to make mirrors, or treat and dye leather. In addition, the section also contained many remedies for the treatment of colic and/or worms in horses. Book four, the largest section of the work, concentrated almost exclusively on cosmetics directed mostly, but not always, towards women. There were instructions on how to make perfumes, toothpastes, soaps, lipsticks, hair dyes, and waters, which would remove acne, wrinkles, or freckles. The cosmetics' ingredients were often based on herbs; although for soaps and peelers a mineral basis was preferred.[31] From her own instructions on how to be an effective practical alchemist, it appears that Cortese might have tried many of the recipes herself. However, since nothing is known of the author, it is impossible to know with any degree of certainty whether she actually experimented, or whether she simply

gathered information from various sources to produce a work, which intended, on the whole, to be useful to women, and also men, in their household duties.[32]

As botany developed into a discipline increasingly independent of medicine during the eighteenth century, it became no longer fashionable for women of the aristocracy and professional elites to express a knowledge of the medicinal properties of plants, unless they were professionally qualified physicians, or pharmacists. In fact the ethnologist Carolina Coronedi Berti informs us in her *Notes on Popular Medicine* (1877) that by then, knowledge of the medicinal properties of plants, once widespread amongst city women, had been relegated to the peasant women in the countryside.[33] As shall be seen later, learned women of the eighteenth and nineteenth century would continue to interested in botany, but they would express their botanical knowledge in a way which reflected changes in the discipline, and thus, not like their sisters in the past.

Learned women of the Renaissance and Early Baroque periods were also introduced to astronomy, and its related fields of mathematics, astrology, and natural philosophy, or physics; to what extent was often dependent on their teachers, and ultimately, on the women's own abilities and interests. A substantial number of women, whose works have been published, displayed some knowledge of cosmology and astrology. A much smaller number would be conversant with astronomy, mathematics, or physics. Since these women expressed their knowledge in these fields through works of an essentially literary nature, whether in the form of orations, dialogues, poems, letters, and in tracts in defence of women, one is more likely to underestimate such knowledge, rather than overestimate it. Such modes of expression were not conducive to put across scientific thought. Nevertheless, amongst this group there appeared the first female translators of ancient

science, the first patrons, but not the first teachers. This privilege belonged to the women physicians of Salerno, who, as G. Orofino has shown, had male students.

II. *Elite Women and the Study of Astronomy, Astrology, Mathematics, and Physics*

Whereas, as seen, women from different social groups had some kind of practical medical knowledge, the learning of what were essentially the disciplines of the *quadrivium* was restricted to women of the aristocracy, or the professional elite. As a highly literate group, dissociated from universities, the language these women used to express their thought had much to do with the audiences they were trying to reach, and the place and century in which they lived. Thus female humanists, who usually communicated their learning via letters to other humanists, or in form of orations to a learned audience, used Latin as the language of communication. The advent of printing and the increased popularity of works in the Italian vernacular during the sixteenth century, led learned women to publish their literary works in Italian; as such they could reach a wider audience. One of these women, Christine de Pizan, was born in Venice in 1364, but having moved to Paris when she was four years old, wrote in the French vernacular, at a time when works by women in the Italian vernacular were rare. Her need to earn a living from her literary works, and thus to reach as wide an audience as possible, may have determined her use of the vernacular.[34]

A. *Christine de Pizan and the Translation of Ancient Science*

Christine de Pizan's father, Tommaso de Pizzano, was a native of Bologna, graduated in medicine and other sciences from its university, and taught astrology there from 1345

to 1356. After 1368, he became physician and astrologer to King Charles V of France, a position he held until the king's death in 1380.[35] Astrology, which included a basic course in arithmetics, geometry and astronomy, as well as astrology proper, was, as seen in chapter one, an essential part of medical training at the University of Bologna in the fourteenth and fifteenth centuries, as well as at other universities.[36] This aspect of Christine's father's learning was to have an influence on her education, and consequently, it was to affect certain aspects of her literary productions in the vernacular, making her one of the first women to translate science.

As far as Christine's education was concerned, she informed us in *La vision* and in the *Chemin de Long Estude* respectively, that she had learned Latin, but knew no Greek.[37] Custom prevented that Christine, as a girl, would inherit her father's great body of knowledge, in spite of her desire to know. What she had learned when small were bits of knowledge here and there, which Christine might have never used, if the deaths of her father and husband, and financial difficulties had not forced her to become a man, as she stated in *La Mutacion de Fortune*, and begin to write. The need to have patrons such as Philippe de Bourgogne determined how and what she would write.[38] Pinet describes her as a popularizer of history and the sciences, and by no means the first in French literature to do so. Although Christine regretted her husband's death, she came to appreciate the fact that his death gave her an opportunity to study the sciences she loved and advance in her study, which made her able to handle subtler matter. This fact is confirmed in her works, because from *Epistre d' Othea a Hector* (1401) to *La vision* (1406), the scientific matter she presented, on the whole, increased in complexity.[39]

To write the *Epistre d' Othea,* Christine tapped various sources such as *Ovide moralisé* for mythology, and *Flores Bibliorum* for biblical abstracts to cite a few. But in the section where she described the influences planets had on metals, her main sources were Geber or Jabir ibn Haiyan and Nicholas of Lynne. The latter composed a calendar in 1386, which contained supplementary astrological information on the influence of heavenly bodies on sublunar ones. Geber's *Summa*, a popular work in the fourteenth century, contained a considerable amount of new alchemical theory.[40]

Christine following the standard wisdom of the times, associated the sun with gold and the heart, the moon with silver, Mars with iron, Mercury with quick silver and Saturn with lead and the head. But then she diverged from standard knowledge and attributed tin to Venus, copper to Jupiter, and the mouth along with the heart to the sun. The standard texts referred tin to Jupiter, copper to Venus and the mouth to Mercury.[41] This leads one to conclude that errors might have been made in the copying of her manuscripts, or that Christine did not use direct quotations, but that she had proceeded from memory, for she no longer had the original sources at her disposal.

In *La Mutacion de Fortune* (1402-1403), Alexander the Great's trip through the air, gave Christine an opportunity to show some knowledge of elementary cosmology as found in the *Sphere* of Sacrobosco, the text used in the astrology course at the University of Bologna. Thus as Alexander rose higher, he saw the earth as a round ball with the sea which encircled it, and felt hotter as he reached the sphere of fire.[42]

At a room in the castle of Fortune, where all the sciences given by God were arranged, Christine's main sources of information were Brunetto Latini's *Livres dou tresor* and Isidore de Seville's *Etymologiae*, written in Latin. Thus physics was defined

as Latini had defined it. Mathematics was divided into arithmetics, music, geometry, and astronomy (*quadrivium*). Her definition of music was based on Isidore's, and that of geometry on both Latini's and Isidore's.[43] However, Christine was not a slave to those writers when it came to defending her father and his learning. There was a difference to Isidore between astronomy and astrology. The former encompassed the study of the motions of the whole heavenly sphere. The latter followed the course of the sun and the stars (planets) in certain stations. To Christine, astrology and astronomy were one and the same thing, and encompassed in one definition both of Isidore's definitions. Isidore was negative towards, what he defined as, superstitious astrology. Christine saw nothing wrong with the fact that astrologers (mathematiques) were able to predict events, or cast individual horoscopes, by the study of the courses of the planets in the zodiac.[44] Nevertheless, she was not an astrological determinist as Cecco d' Ascoli had been at the University of Bologna. To her God was above all things, and had the final word.[45]

In *Du Chemin de Long Estude* (1402-1403) we are presented with a minor treatise in cosmography when the Sybill takes Christine on a voyage among the heavenly spheres. As Pinet suggests, other writers like Froissart and Dante had already taken such a trip and might have inspired Christine. From whom she borrowed her cosmology is more difficult to ascertain, since it had characteristics of its own. Again Christine might have worked from memory, from facts she had learned from her father.[46]

The standard text, Sacrobosco's *Sphere,* following Aristotle's *Meteorology*, had the sublunar region divided into four spheres, which began with the earth at the centre, followed by water, air and fire; ether was the material of the etherial region, which enclosed the sublunar one. Christine had the ether placed between the spheres of air and

fire, therefore in the sublunar region. These spheres were followed by the fourth heaven, or Olympus. The firmament began in the fifth sphere.[47]

Once in the firmament, Christine made reference to the seven planets and their spheres, which were referred to as places, and to two simultaneous motions of the sun: a daily motion, and an annual motion along the ecliptic. She also mentioned the movements of the heavens, an oblique one around the two poles, a daily motion from east to west, and another west to east.[48] When it came to the celestial circles, Christine named five of them: equinoctial, horizon, meridian, zodiac, and the milky way (galactic equator).[49]

Sacrobosco referred to six major circles: the equinoctial, meridian, zodiac, and the colures of solstice and of equinox. William of Conches in the twelfth century had added the milky way to the six major circles mentioned by Sacrobosco. By making the milky way one of the celestial circles, Christine had placed it in the celestial region, in sharp contrast with Aristotle, who had it in the sublunar region. In this she was in agreement with Albert Magnus, Henry of Langenstein, and Nicole Oresme, who were the exceptions to the rule at the time.[50] Christine departed again from Aristotle when she accepted the music of the spheres as advocated by the Pythagorean school. Aristotle had rejected such harmonies; but like the philosopher she placed the comets in the sublunar region. As Towner points out, Christine admired Aristotle, and therefore might not have been aware she was deviating from the master, not being familiar with some of his works. [51]

Christine was certainly familiar with, at least, the first book of Aristotle's *Metaphysics* for she freely quoted it in *La vision.* In this latter work, in the section which deals with the " opinions of the philosophers on the principles of the world ", Christine reviewed

earlier philosophical ideas on first causes up to Aristotle, and included his objections to his predecessor' thoughts in imitation to what the philosopher had done in the first book of his *Metaphysics.*[52] Thus she related how the ancient philosophers had stated that matter was the element and the first principle of the nature of things. Nevertheless, these philosophers had not agreed on whether there had been one, or several material causes as first principles. To Thales such a first principle had been water, to Diogenes and Anaximenes it had been air, and to Hipparchus and Heraclitus, fire. To Anaxagoras, the first principles had been infinite in number and composed of similar parts; to the Pythagoreans such principles had consisted of numbers, to Empedocles of four elements, air, fire, earth and water, and to Plato of the great and the small.[53] In the second part of the work, Christine listed the objections Aristotle had had to the philosophers' explanations of first principles, such as the fact that they had failed to come to terms with the cause of movement, or to deal properly with form.[54]

Unlike Aristotle, Christine skimmed over Plato's thoughts on first principles.[55] However, like him, but not in the same way, she discussed the Pythagorean school in some detail. Aristotle had stated that the Pythagoreans had ten bodies moving through the heavens, nine which were visible and one invisible, the "counter-earth" or anticthon. Only in *De caelo* did Aristotle make reference to the earth, the counter-earth, and the other planets moving around a central fire.[56] Christine made no reference to the earth rotating around a central fire, and appeared to place the counter-earth in the tenth sphere with a movement contrary to that of the other spheres.[57]

Aristotle had been particularly critical of the Pythagoreans who used non-sensible things (numbers) to investigate nature.[58] On the contrary, Christine expanded on

Aristotle's work and explained some of the number series of the Pythagorean school. Thus, she pointed out the fact that successive square numbers were formed by the sequence of odd numbers 1+3+5+7...+ (2n-1), as well as making reference to triangular numbers, to cite a few examples.[59] It is hard to say whether Christine's foray into Pythagorean numerology was borrowed from the translator or commentator of the *Metaphysics* which she had used, or whether she had learned it from her father. One is inclined to think the latter, for Pythagorean numerology played an important part in astrology.[60]

Towner refers to the fact that what Christine presented in *La vision* was the first French vernacular exposé of Greek philosophical thought as found in the first book of Aristotle's *Metaphysics,* and she is probably correct. Without taking away from Christine's achievement, some of the ideas she presented were also found in Nicole Oresme's *Le Livre du ciel et du monde,* a very liberal translation of Aristotle 's *De caelo,* which was compiled in 1377, under the patronage of Charles V. Nevertheless, with her translation of the first book of Aristotle's *Metaphysics*, Christine may have become the first proven female translator of a scientific work. Unlike the female translators of the eighteenth and nineteeth centuries, what Christine translated was ancient, rather than new science.[61]

As seen, in her later work Christine had drawn from the Aristotle's *Metaphysics,* and perhaps his *Physics* and *On the Soul,* as well as Roger Bacon's *De celestibus*, texts she referred to several times in the section of *La vision* dealing with the philosophers' opinions.[62] Nevertheless, the bulk of scientific material she used in the works discussed above appears to have been derived from her father's teachings, or inherited from him.

One is led to this conclusion by some peculiar aspects of her cosmology, her defence of Pythagorean teachings, and by her knowledge of Pythagorean numerology. When it came to the sciences, an intellectual dependence on one's teacher, as Christine could show towards her father, was not uncommon amongst learned women; it could be found among female humanists and among the others who were to follow them.

Until printing facilitated the circulation of knowledge by making books available to those men and women who could buy and read them, a learned woman's education in the *quadrivium* sciences very much depended on whether her teachers and/or male members of her family had extensive interest in these sciences. Whether she would continue these studies later in life depended, to a much greater extent, on her own interests. Christine de Pizan might not have been so familiar with Aristotelean-Ptolemaic cosmology and astronomy, and Pythagorean numbers had not her father, and also teacher, been a professional astrologer. Similarly, to what extent female humanists, who as the title implies were well versed in classical languages and literature, were exposed to the sciences of the *quadrivium* depended on their teachers, who might have been, or not members of the humanists' family.

B. *Female Humanists and the Sciences of the Quadrivium*

One of the greatest experts on the Italian Renaissance, P. O. Kristeller advises that humanists' interests did not immediately include such fields as theology, logic, natural philosophy, metaphysics, medicine, mathematics and astronomy. Historians of science, such as P.Rose, P. Findlen and others would dispute this argument, since many ancient scientific works were recovered, and translated by humanists with interest and knowledge

in the sciences. A female humanist, who had as a teacher, and/or as a member of her family, a humanist with scientific interests, was more likely than not to be educated at some level in a few of the sciences of the *quadrivium.* A perusal of the surviving works of these humanists as found, for instance, in works such as *Her Immaculate Hand*, which contains selected works of women humanists of Quattrocento Italy, show, as expected of humanists in general, and women in particular, that the philosophy they studied the most was moral philosophy. However, those women who had teachers learned in the sciences, showed in their surviving works that they had been exposed to some form of scientific learning, as it occurred with Cassandra Fedele, Olimpia Morati, and Laura Cereta. To what extent they were learned in the disciplines of the *quadrivium* is more difficult to measure since their works consist of letters, dialogues, and orations, usually written in Latin, and addressed to other humanists. [63]

The first of these humanists, Cassandra Fedele, was born in Venice in 1465, to a family whose male members, such as her father and grandfather, had a reputation for learning, and for service to the Venetian Republic. The education of a daughter served to further enhance the family's reputation for learning, and advance the career of the Fedele males in government. Being learned in the languages, Cassandra Fedele's father would also ensure that his daughter learn both Latin and Greek. According to her biographer, Giacomo Filippo Tomasino, Cassandra Fedele was also learned in philosophy, dialectic, theology and music. Her teacher in the letters was Gasparino Borro, master in theology, and learned in astronomy. Fedele's reputation for learning came quickly to the attention of the Venetian government, and Tomasino let us know that the Venetian senators were so impressed by her learning, that they attempted for years to

get her to teach at the Venetian Republic's University of Padua. Such permission was denied her because of her sex. Finally in 1487, Fedele was allowed into the university to deliver an oration in honour of Bertuccio Lamberto, Canon of Concordia, who was receiving the honours of Liberal Arts. She was also to speak publicly before the people of Venice and the Venetian Doge. As her fame as a learned lady spread, Cassandra was to receive an invitation from Queen Isabella of Aragon to join her court, which she turned down at the request of the Venetian government.[64]

Fedele's surviving literary works consist of letters, and four orations, the last of which she delivered when ninety one years old at the request of the Venetian rulers to welcome the Queen of Poland. Fedele was also supposed to have written a work entitled *Scientiarum ordine*, which she delivered to the printer when she was 80 years old, according to Tomasino. However, the printer failed to print the work, and then managed to lose it. Lucrezia Marinelli in her tract in defence of women, published thirty-six years prior to Cassandra's letters, also mentioned such a work. Cesira Cavazzani (1906) believes she was writing the work, as indicated by the letters, but believes she never completed it.[65] As this work is not available, one can only assess her knowledge in science by making use of her letters and orations.

One might surmise that Fedele was made to study more systematically and to a greater extent than Pizan. In fact, we know from several of her letters of her struggle to learn the philosophy of the Peripatetics, and of Aristotle in particular.[66] Since her principal teacher after the age of twelve was a theologian, who had an interest in astronomy, one might expect that Fedele would make some cosmological references in her works, as Pizan had done; there are no such references in her surviving letters and orations.

Cavazzana goes so far as to suggest that as Fedele often exposed difficulties in studying Aristotelean philosophy, she might have never progressed a great deal in it. To be fair to Fedele, one should not make such an assessment from just some letters and a few orations.[67]

King and Rabil, who have looked at the sources in her orations, point out that Fedele was familiar with Virgil's *Eclogues*, Cicero's *Tusculan Disputations*, Horace's *Odes*, Ovid's *Metamorphoses*, and Plato's *Republic*, works which were all part of the humanist diet.[68] One can also detect a certain familiarity with Aristotelean logic as found in his *On Interpretation*, when she wrote to Filomoso that "one should not simultaneously affirm and deny".[69] Fedele made no reference in her works to the more mathematically oriented aspects of Aristotelean logic as found in his *Prior Analytics*, and *Posterior Analytics*.

In her short letter to Bartolomeo Scala one can also detect some knowledge of Aristotle's *On the Soul*, when Fedele referred to man's soul excelling all others for reason of its rationality.[70] And again in the same letter Fedele demonstrated some familiarity with Plato's *Timeus* by stating that man's soul differed from others by its immortality,[71]and with Aristotle's *Parts of Animals*, when she referred that it was in speech that man excelled beasts.[72] Fedele's references to Aristotle's works in logic and natural philosophy, and Plato's *Timeus* were few and far in between, leading one to conclude that perhaps her teacher, being first and foremost a theologian rather than a natural philosopher, might have taught her little natural philosophy. It is also possible that she had difficulties with Aristotle's works in logic, and natural philosophy, as she often stated; or most likely, she had little interest in them. In the end it turns out to be

irrelevant to know how learned Fedele was in Aristotelean logic, and natural philosophy. What mattered for the men and women, who later defended women's rights to an education in the sciences, and participation in academic life, was the fact that she had publicly spoken at the University of Padua, and that they believed she was learned in the philosophies.

Cassandra Fedele's career came to a halt when she was made to marry by her family. Her widowhood at fifty six and financial difficulties failed to reinstate her as a public figure. Only in 1547, when she was eighty years old, was she offered a position as prioress of an orphanage by the Venetian Senate, after Pope Paul III, to whom she had written for assistance, had interceded on her behalf. The same senate had no qualms dragging her out of retirement, when she was ninety one years old, to deliver an oration in honour of another woman, the Queen of Poland. The fact that Fedele was able to deliver an oration in Latin, after sixty years, is indicative that she had continued to study in private.[73]

In spite of belonging to a century where writing in the vernacular had become increasingly popular, another woman, Olimpia Fulvia Morati (1526-1555), has to be considered an humanist because of her education and literary productions.[74] Morati has to be understood in the context of the court of Ferrara and its university, not only as it regards her Protestant faith, which has been documented extensively, but also as it pertains to her humanistic education.[75] Her teachers, beginning with her father Fulvio Pellegrino Morati, then Celio Calcagnini, and the brothers, Chilea and Johannes Sinapius, and some of her correspondents, such as Gregorio Giraldi, were associated with the teaching of Latin humanism at court and/or at the university. Whether they were a

physician like Johannes Sinapius, or not, their main areas of interest were the Latin and Greek languages, rhetoric, and ancient authors.[76]

It is obvious from one of Celio Calcagnini's letters that Olimpia was being groomed for service at court as a companion to Anna, the daughter of the Duke of Ferrara, and the future Duchess of Guise; and Calcagnini, who had acted on many diplomatic missions for the ruling family, was instrumental in getting her the position.[77] Again, her father's letter to her on how to deliver an oration in public in Latin, is indicative of what was expected of Olimpia. There was no question of her keeping silent in public places, as those who invocated the Pauline edicts would have wished. But, as Stefano Guazzo pointed out, a woman destined for service at court was expected to have a different education from her contemporaries.[78] In the best of humanist traditions, Morati was to have Greek added to a curriculum of letters, Latin and rhetoric, and in this language her principal teacher was Chilea Sinapius, who also taught at court.[79] Morati's literary output reflected her humanist education. Without counting her letters, these works consisted of three *proemia* on a commentary to Cicero's *Paradoxa*, an eulogy to Muzio Scevola, a translation of two of Boccaccio's stories, two dialogues, three Latin and five Greek *Carmina*, and a reduction into Greek verse of eight of King David's Psalms.[80]

As M. King points out, the young Morati had shown little interest in sacred studies, in spite of the fact that her father, his friends, and several of her teachers were adherents of the Reform. The establishment of the Roman Inquisition in 1542, and the appearence of one of its branches in Ferrara, forced her to come to terms with her Protestant faith. Soon after her father's death in 1548, Morati was dismissed from court. In 1550, Morati married the German physician Andreas Grunthler, moving with her husband to Germany

in 1551, where she would eventually become a victim of the religious wars, which raged in the German states at the time. Morati's surviving works reflect the changes which occurred in her life. To the period of Morati's residence at Ferrara, and its court, belong most of the works which made reference to natural philosophy, mathematics and humanist studies. After her move to Germany, her letters became religious in tone, because the study of divine matters was what concerned her most by then. Even to the few pupils she had in Germany, Morati introduced the sacred scriptures, and not the classical authors of her youth. In her letter to her former companion, Anna of Guise, Morati testified to this change in herself; what delighted her not when young was all the delighted her later in life.[81]

In spite of being married to a physician, Morati owed her education in the sciences not to her husband, but to her teachers in Italy, and in particular one teacher, the humanist Celio Calcagnini, whose program of humanist studies, and scientific interests are reflected in the works she wrote while living in Ferrara. Calcagnini believed that all " parts of *humanitas* are connected among themselves "; there was no " physics without logic, nor logic without mathematics, nor anything without rhetoric." Calcagnini was also interested in cosmology, as expounded in the second book of Pliny's *Natural History*. His own book, *Quod Coelum stet et Terra moveatur Commentatio* (1544), had the earth rotate diurnally, but at the centre of the cosmos.[82]

As part of the *paidea* Morati might have been introduced painlessly to mathematics by learning Pythagorean number games. As we have seen, Christine de Pizan was aware of them. By Morati's reference to Pythagorean silence in her letter to Johannes Sinapius, she appeared aware of the Pythagorean doctrine of prudence in divulging knowledge, as

found in the apocryphal letter of Lysis to Hipparchus.[83] A reference to Aristotelean logic was made by Morati in the relationship she saw between the whole and its parts.[84] As far as astronomy is concerned, Morati appeared to have had some knowledge of the constellations, at least of those which belonged to the zodiac. The reference to Castor and Pollux, sons of Zeus, in the Greek *carminum* in praise of studies, also depicted these stars as they appeared in the constellation Gemini: "Colts Castor tames, Pollux the boxing gloves ".[85] Finally, in the "Dialogue between Lavinia della Rovere and Olimpia" (1550), Morati stated that God gave her cognition so she could recognize his handy work and have some understanding of the elements that formed the world, the reappearence of the solstitial constellations that brought back the shortest days, the positions of the stars, the power of the winds, the family of plants and the power of the roots, the perfection of man, and so on. From such statements, one might assume that Morati could have been familiar with Sacrobosco's *Sphere,* Aristotle's *On Meteorology* and *On the Soul* and Theophrastus'*On the History of Plants.* But it is more likely that Morati gathered all this information from Pliny's *Natural History*, a work which also interested her own teacher, Celio Calcagnini.[86]

From an analysis of those two important women humanists' works one might be inclined to agree with Kristeller and conclude that the sciences were very secondary studies in their education, for references to works in natural philosophy, logic and/or mathematics were few. Nevertheless, as seen above, Morati had far more references in natural philosophy and mathematics in her works than Fedele had in hers; one suspects because Morati had a more effective introduction to these topics, owing to Calcagnini, than Fedele ever had. A father's, or/and teacher's interest and practice in some specific

science did much to improve a woman's chances of learning this science, as it occurred with Laura Cereta.

The humanist Laura Cereta (1469-1499), as Rabil states, followed the humanists' interests in biography, history and moral philosophy. Like most humanists, she expressed no interest in speculative philosophy, dialectic, theology or law.[87] Like Fedele and Morati, Cerata had learned Greek and Latin, and produced a similar body of surviving works, consisting of letters and an oration, which all contained plenty of classical references. But unlike them, she was to learn her Latin in a convent setting, taught by a woman (a nun) esteemed for her counsel, learning, discipline and sanctity. As shall be discussed later, other women were to get a good classical education within convent walls, which seems to indicate that the cultural level of some of the nuns could be, and in fact was, quite high.[88]

An important difference between Cerata and the female humanists discussed so far arose from the fact that until August 1486, Cereta was a practicing astrologer; a position which men held at court, but that in her case was carried out in a private capacity. Where did Cereta acquire the mathematical and practical knowledge to be both an astronomer and astrologer it is difficult to ascertain. It appears, however, she did not acquire it at the convent, for Cereta attended mathematical lectures after her departure from that place. Unfortunately, she did not name her teacher. Rabil believes her sole teacher in the humanities and sciences to have been her father, but, as far as Latin was concerned, Cereta's letter to Nazaria Olympica indicates otherwise. In the other hand, Robin does not believe her father, a lawyer and magistrate, was ever her teacher.[89]

If Cereta's father did not teach her mathematics, he provided her, nevertheless, with the books, instruments, and, perhaps even the practical instructions to be an astrologer. As Cereta herself informs us, her father had been responsible for the fortification of, at least, one town during the Brescian war, and may have also practiced astrology, two occupations which required practical mathematical skills. However, one should also consider the possibility that she was almost entirely self-taught in these subjects.[90]

How much astronomy did Cereta learn is more difficult to ascertain. M. Palma in his biography of the humanist describes her scientific knowledge as superficial, and typically medieval.[91] To a certain extent, Palma was right; Cereta was no innovator, her cosmology and astronomy appears to have been Aristotelean and Ptolemaic in nature; there are no indications in her surviving letters to believe otherwise.

Like Christine de Pizan and her father, and many others in the Renaissance, she also accepted, at least until her husband's death, that heavenly bodies influenced the sublunar region and its inhabitants. For instance, Cereta began her letter to grammarian Giovanni Oliverio with a description of the positions of the planets in the houses of the zodiac. According to her, such positions favoured the study of arts and letters, and thus it would have been favourable for Oliverio to welcome her younger brothers to his school.[92] The same belief is also found in her letters to Alberto de Albertis and to Regimundo Fortunato respectively entitled " On the Correlation of Heavenly Bodies with the Birth of Man " and " The Influences of Planets on Living Things ". In the former letter Cereta presented as a gift to De Albertis his horoscope for his forty eight year, complete with the position of the planets for that particular date. In the letter to the natural philosopher, Fortunato, she pointed out that not only the sun, the moon, along with the erratics (planets), and the

fixed stars played a role in regulating nature, but that each plant had its planetary ruler, and that there were plants, whose virtues were imposed by the signs of the zodiac. Thus Saturn ruled asphondili, and heliothrope was best when plucked out under Libra.[93]

Cereta did her own astronomical observations, in the country, using the astrolabe. When accused by the natural philosopher Michele Baeto of having borrowed her astrological knowledge from some book, Cereta proved him wrong by providing him a description of the heavens for the four days which preceded the letter.[94] From these facts, one might surmise that Cereta's knowledge was, at least, equal to those medical students who, as seen in chapter one pursued astrological studies beyond the elementary level.[95]

Since Cereta made use of the astrolabe, she would have studied, most likely, some treatise on its use. Such treatises would show, among many other propositions, how to find the zenith of the sun and of the stars, at whatever hour desired.[96] In addition, Cereta would have learned how to use the Alphosine Tables, tabulations of planetary motions, to aid in calculations, probably adjusted to the Brescia meridian.[97] These studies, if not very complex mathematically, still required considerable specialization and arithmetical computation. Cereta was aware of her skills, and saw herself as an astrologer, who performed her craft, not to parade it before the world, as men with similar skills often did by becoming astrologers to princes and kings, but to be a model of virtue. As a woman, all Cereta would have been able to achieve was to be a model of virtue, since the position of astrologer to a princely house, appears to have been an exclusively male dominion.[98]

From her letters of 1485 and 1486, one can gather that Cereta continued to study and expand her knowledge in astronomy, and consequently, in arithmetics and geometry.

There was a concern on her part to measure the dimensions of the universe, that is, to know the distances from the centre of the earth to the planets and then to the stars, to know the magnitude of the celestial orb, and of the spaces in between. From her letter of August 1, 1486 to Giovanni Oliverio, she appeared to be approaching her aim, although some errors were committed.[99] As Cereta was attempting to measure the dimensions of the universe, it is likely she used Al-Farghānī's method of determining cosmic dimensions, as described in chapter one. It was the West's most popular method of measuring cosmic dimensions. It would be still used in the following century, for instance by A. Piccolomini, when he provided Laudomia Forteguerri with the dimensions of the universe in his *Sphere of the Universe*, by Maurolico in his *Cosmographia*, and by Clavius in his *Sphera*. If Cereta was attempting to measure the dimensions of the universe by this methodology, she needed to be learned in the geometry and trigonometry of the times. Therefore, one has to question Palma's ready dismissal of Cereta's knowledge as superficial.[100]

Astrology aside, one could readily say, that until her husband's death, Cereta was a practicing astronomer, who continued to expand her knowledge in the field. She even went so far as to question Al-Farghāni's and, thus Ptolemy's assumption that the distance from all the fixed stars to the centre of the Earth was the same, with no differences between them.[101] The death of her husband in August 1486, put an end, as far as the letters are concerned, to Cereta's astrological work. In a letter to Nazaria Olympia, she stated that once she had delighted in the studies of heavenly dispositions, but that at the moment she preferred to ignore the destinies in store for her. Knowledge of the future

was the act of a temerary soul, and not of a faithful one. To God should be left all knowledge of future events.[102]

Cereta's surviving letters came to an end by March 1488, six months prior to her father's death, when she sent them to Cardinal Maria Ascanio Sforza. Cereta described these letters as a first draft from her rustic pen. However, no other letters survived, perhaps because they were not published. Nevertheless, it leads Rabil to conclude that her humanist activities came to an end because as a woman, she found it difficult to continue them without the support of her father. He also dismisses as unproven Ottavio Rossi's statement (1620) that Cereta had taught philosophy publicly at Brescia, after she was twenty years old.[103]

Rabil, himself, provides evidence in a footnote that Cereta might have continued her interest in natural philosophy until her death in 1499; she might not have taught, but found a way to express her love of philosophy by means of discussions, or readings at the Academy Mondella. Luigi Mondella (d. 1530), a professor of medicine with an interest in botany, ran an academy out of his home, which was attended both by Laura Cereta and her brother Daniele; the latter was described by Mondella himself, as most proficient in medicine and poetry. The fact that Daniele, who was younger than Cereta, and who in 1486 was attending the school of a grammarian, was described as proficient in medicine by Mondella, indicates that his sister Cereta must have attended the Mondella Academy after 1489, as Rossi was probably indicating, and as Elio Caprioli, himself described in his *Chronica de Rebus Brixianorum* (1505). [104] Therefore, Cereta appears to have left her letter writing activities behind her to occupy herself with an activity which would

become increasingly popular in the sixteenth-century, that of discussions in an academic setting. There Cereta's interests in astronomy and cosmology could continue to flourish.

Cereta was not the only person interested in astrology, cosmology and astronomy at the time, a study of library inventories by Tiziana P. Marangon indicate texts in astrology were found in libraries of physicians, lawyers, merchants and artisans. It is natural that this interest would filter down to women.[105]

One woman whose level of knowledge in mathematics and astronomy might have been as high, if not higher, than Laura Cereta's, was Teodora Danti (late 1400s-1573), who was supposed to have written a commentary on Euclid, which unfortunately was lost.[106] Although essentially a contemporary of established humanists like Cereta, Fedele and Morati, she does not appear amongst their rank in works on women by Renaissance historians. Unlike established women humanists, Danti did not leave behind her letters, orations, or dialogues written in Latin. Male members of her family were not humanists, but applied mathematicians. Danti's education reflected the family's interest in applied mathematics. Danti was educated by her father, a man, who like Cereta's father, had an interest in applied mathematics. Pier Vincenzo Rinaldi (he had changed the family name to Danti) was an architect, who had been responsible for the restoration of several works at Perugia, and the construction of mathematical instruments, which included a famous astrolabe. In fact, many members of the family were described as architects, who were involved either in the fortification of walls, the building of palaces, dikes, mathematical instruments, war machines, and other works, which required knowledge in applied mathematics.[107]

Pier Vincenzo Danti translated Sacrobosco's *Sphere* into Italian in 1498 for the benefit of his children, in particular Teodora, who profited greatly from the exercise. As her father pointed out in the introduction, Teodora not only learned Sacrobosco's *Sphere*, but also understood how to use the astrolabe and the almanac, and she was only a child at the time.[108] One would expect that as Danti grew older and more advanced in mathematics, she would be introduced to the planetary construction of Ptolemy's *Almagest* as summarized in Campanus' *Theorica Planetarum* and the materialization of Ptolemaic planetary mechanisms through Peurbach's *Theoricae Novae Planetarum*, works which were referred to by her father in his *La Sfera di Sacrobosco.*[109]

Pier Vincenzo Danti's annotations in *La Sfera* provided explanations in areas where he felt Sacrobosco had not been clear enough, among these there were added geometrical definitions. He also dealt with changes in knowledge that had occurred since Sacrobosco had written the original *Sphere* in the early 1200s. Thus Danti referred to the need to add another sphere to the nine mentioned by Sacrobosco, because Peurbach, and the moderns had discovered a variation in the motion of the eighth sphere (decreasing and increasing) defined as trepidation. In this new scheme the primum mobile became the tenth sphere, which still provided diurnal motion to the lower spheres, while the ninth sphere provided precessional motion.[110] Pier Danti also referred to the new discoveries by Christopher Columbus which showed that Sacrobosco and Ptolemy had been wrong when they had stated that the zone between the tropics was uninhabitable.[111] In the section dealing with planetary movements, where Sacrobosco provided a very simple explanation of equant, deferent, and epicycle, as expounded by Ptolemy, Danti in his

annotation saw these circles as mathematical constructs needed to save the appearances of motions of the planets, much like Piccolomini.[112]

Teodora Danti, who never married, and lived first with her father, and then with her brother and his family, was responsible together with her brother for teaching astronomy and mathematics to her nephew Ignazio.[113] Ignazio, a Domenican friar, was to become cosmographer to the Duke of Tuscany, taught mathematics and Sacrobosco's *Sphere* at the University of Bologna, and then became first mathematician at the papal court. He published several books pertaining to mathematics and astronomy, including one on Euclidean perspective (1573), where it is possible he used manuscript material on Euclid he had inherited from his aunt, who besides being an astronomer and mathematician, was also a painter.[114] If the male members of her family were able to make a career out of mathematics and astronomy, Teodora Danti's activities were confined to the home, as a teacher and academician. An academy, where literary and scientific discussions took place, was run out of her father's and/or her brother's home.[115]

As the examples above illustrate, prior to the spread of scientific printed material in the sixteenth century, a woman's introduction to the sciences of the *quadrivium* was very much dependent on whether, the male members of her family, and/or teachers had any interest in these sciences. Thus a woman like Teodora Danti who came from a family of applied mathematicians, was more likely to be introduced to the mathematical sciences than Fedele who came from a family of established humanists, and government bureaucrats. Women would continue to be dependent on male family members, and/or teachers for their introduction to the sciences until the universities opened to women in

1874. However, this dependence would decrease with the increased availability of scientific printed material from the sixteenth century onwards.

C. *Sixteenth Century Women, Printing, and the Sciences of the Quadrivium*

If one exempts Laura Cereta's writings, one would be hard pressed to find astronomical and cosmological references amongst the works of the women humanists of Quattrocento Italy. Matters would change during the sixteenth century, and such references would appear frequently enough in women's literary works of the period due, one suspects, to the availability of such material to the reading public. Alessandro's Piccolomini's books on Aristotelean-Ptolemaic cosmology (*Sphere of the Universe*) and star gazing (*On the Fixed Stars*) were used by his friend Laudomia Forteguerri, as Piccolomini himself informed his readers. The 1561 editions of the same works found their way into the convent of Florentine Domenican nuns of S. Jacopo a Ripoli, where Sister Fiammetta Frescobaldi (1523-1586) adapted them so they could be the first three parts of her own nine-part *Sfera del mondo* (never published), written for the instruction and entertainment of the other sisters.[116]

Sister Fiammetta, who had been unable to walk since she was twenty-five, knew Latin, and was self-taught by making use of the books available in the convent's library, or sent by friends and family.[117] As she described to her brother in her work *La sfera del mondo*, there was a desire on her part to know about the heavens, their motions, the fixed stars and the erratic ones (the planets), the celestial circles, zones, and other such matters, and was delighted when she was offered the opportunity to study Piccolomini's

work. Sister Fiammetta avoided the detailed information provided by the author, and went straight to his conclusions, which were easier to understand.

As far as adapting Piccolomini's work to her own *Sfera del mondo*, Sister Fiammetta divided his information into three parts: firstly, she described the sphere of the world briefly; this was followed by a description of the different celestial circles, which was an essential information for those wanting to recognize the celestial motions. The third part provided information that was found mostly in Piccolomini's *Fixed Stars*. There Fiammetta described the forty-eight constellations, the different stars and their magnitudes. This section also contained the earth's magnitude, and the distances from the centre of the universe (the earth's centre) to the different spheres, as had been provided by Piccolomini. The other volumes in her work pertained to geography and dealt with the description of lands, places and people of Europe, based on Pope Pius XI's *Cosmography,* Africa, based on Giovanni Lioni's *Africa*, Asia and the Occidental Indies, the latter based on works by Amerigo Vespucci, Fernando Cortes, and Francisco Pizzaro, among others. Sister Fiammetta stressed that Ptolemy's knowledge of the extension of land was imperfect, and that new knowledge had been added by the Portuguese discoveries. As the sources above indicate, Sister Fiammetta might have been enclosed in a convent, but belonging to one of the noblest Florentine families, who visited her often, she was very well informed on recent discoveries.[118]

The sister continued her interest in astronomical and meteorological occurrences in her *Diario dell' anno 1575 fino al 1586 e varie memorie.* Interspersed amongst convent news, the Domenican order, and events that affected Florence, Sister Fiammetta recorded eclipses of the moon and sun, the position of the sun in the zodiac, the appearances of

meteorites, and of comets in 1577, 1580 and 1582. Most importantly, she also recorded an unusual event. On March 7, 1584 (Florentine dating) she reported that the sun had an unusual red appearance. This red aspect then became yellow and dull. In addition, reliable observers informed her that they had noticed black "things" which moved in front of the sun's sphere in a varied manner. It appears that Sister Fiammetta recorded one of the few observations. which occurred before the invention of the telescope, of sunspots. Sunspots can be visible with the naked eye at sunset or sunrise; very few of them were ever recorded before the telescope because of the widespread Aristotelean belief amongst the learned that celestial bodies were supposed to be perfect and spotless. Sister Fiammetta, not being as learned as male astronomers, was incapable of prejudging the sun's appearance. [119]

Since Sister Fiammetta made her meteorological observations before the inventions of the thermometer, barometer and seismograph, she recorded in a qualitative manner the intensity and frequency of earth tremors and the weather for the days and months covered in her diary. Thus, contrary to the astrological predictions for a cold year of the physician and philosopher Baldassare Pisonelli of Bologna, which she had recorded in her diary, her own observations indicated that the 1582 year was an unusually hot one for Florence, where the heat lasted well into December.[120]

Other sixteenth-century women writers who demonstrated some knowledge of Aristotelean-Ptolemaic cosmology, usually expressed it through their poetry, or in Moderata Fonte's case, in a dialogue in defense of women entitled *Il merito delle donne* (1600). Thus Lucretia Marcelli, of whom very litle is known, in her poems published by Muzio Manfredi, showed a knowledge of the movements of the planets along the houses

of the zodiac, the influence of the stars on the sublunar regions, and the general movements of the heavens. A similar knowledge was also demonstrated by the founder of the Academy Correggiana, Veronica Gambara, in several of her poems.[121] Clara Maitrani in Luisa Bergalli's collection of poems from illustrious poetesses, besides referring to the movements of the heavens, also mentioned the influence of the sun on the elements below; while Vittoria Colonna, in the same collection, was aware that the moon received its light from the Sun.[122]

Moderata Fonte in her *Il merito delle donne* had her alter ego Corinna, divulge what was essentially Fonte's knowledge in cosmology and meteorology. Her principal sources for this section in cosmology and meteorology were the " cosmology " found in Book II of Pliny's *Natural History,* and in part in her uncle and mentor, Giovanni Nicolo Doglioni's *L' Anno* (Venice, 1587). Thus, like Pliny and Doglioni, Fonte referred to the fact that the motion of the planets, particularly of the sun and the moon, caused discord in the air and the waters. Discord in the air was responsible for thunder, lightning and, if trapped underground, earthquakes. Though its very rapid movement through the houses of the zodiac, the sun was responsible for heat, or cold, long, or short days. It warmed the world, gave virtue to the plants, stones, and moved animals to generation. The moon, the closest of planets, alone, or with other planets either caused rain, fogs or storms, or improved the weather. It was also responsible for tidal changes, and most importantly, its humidity caused diseases in man.[123]

Fonte's learning in cosmology, and astronomy, as well as that of most of the other women mentioned above, was probably drawn directly from the various books available in the market during the sixteenth century, including various editions of Pliny's *Natural*

History. Such knowledge was different from the one displayed by Cereta and Danti, which was based on mathematical calculations and direct observations. Although apparently Fonte was not taught geometry, she had been taught arithmetics, and according to her uncle, was able to understand any new subject quickly. With extra effort she might have become a practicing astronomer, but male family members' activities would often affect a woman's choice. Thus like her uncle, Fonte displayed her learning in her work in an encyclopedic manner, imposing on it a sequential order.[124]

As seen, some learning in astrology, cosmology and astronomy was fairly widespread among the female intellectual elite of the sixteenth and early seventeenth centuries. However, it is difficult to assess the extent of their knowledge in these subjects from literary works which were not conducive to mathematical subtleties. For instance, Magherita Sarrocchi (1560-1617) in her epic poem *Scanderbeide* (1601 and 1623), which sang the feats of George Scanderbecq, the hero of the Albanian resistance against the Turks, also demonstrated in her 1606 version the usual knowledge of what was essentially Ptolemaic-Aristotelean cosmology and astronomy.[125] Thus the sun was referred to by Sarrocchi as a planet, incorruptible and, which rotated around the earth, as did the heavens. Like many others, she also believed the stars, erratic or otherwise, influenced the sublunar regions.[126] It appears, however, that Sarrocchi's poetry demonstrated only a very minor aspect of her extensive scientific culture. In fact, her knowledge in the sciences went beyond Aristotelean natural philosophy and Euclidean geometry to include many of the works and discoveries that were carried out by two of the Academy of Lincei's most prestigious members: Luca Valerio and Galileo Galilei.

We know of this, not through any scientific publications on her part, but through hers and Luca Valerio's correspondence with Galileo.

The Neapolitan Sarrocchi, being orphaned at two, was brought to Rome by Cardinal Sorleti, and placed in the convent of S. Cecilia, where under the Cardinal's supervision, she was instructed in rhetoric, poetry, Greek letters, geometry, philosophy, and theology.[127] Sarrocchi was further instructed later in life by one of the best Italian mathematicians of the period, Luca Valerio, an ex-Jesuit and her friend and, eventually, companion. Being richer, and better connected to the high echelons of Roman society than the mathematician, Sarrocchi was able to act, in exchange, as Valerio's patron in that society. Apparently, her level of mathematical knowledge was such that Valerio referred to Sarrocchi as his equal in her ability to judge a theorem, possibly on the parabola, demonstrated by the Archimedean method of exhaustion sent to him by Galileo.[128]

If Sarrocchi was able to understand Galileo's theorem, one might assume she was equally able to understand her teacher's, Valerio, principal mathematical works: *De centro gravitatis solidorum, libri tres* (Rome, 1604), and *Quadratura parabolae per simplex falsum* (Rome, 1606). In the first book, Valerio was able to solve the problem of determining the centres of gravity of all the solids that Archimedes had considered in his work on *Conoids and Spheroids,* and that had concerned mathematicians like Commandino in the sixteenth-century. A skilful geometer and a virtuoso in the theory of proportions, as Baron suggests, Valerio used the Euclidean theory of magnitudes, and the computing of proportions, as found in books V and VI of Euclid's *Elements* to generalize in a series of important theorems the two major steps contained in the standard

exhaustion proof so that for a whole class of curves and solids, such as conoids and portions of spheroids, " it was no longer necessary to establish results by special methods".[129]

In his second work, Valerio provided a theoretical answer to all the criticisms Renaissance mathematicians had raised on the foundations of geometric static provided by Archimedes's squaring of the parabola. In addition, all matters dealing with the equilibrium of plane figures, as had been treated by Archimedes, Commandino, and Guidobaldo, were reorganized and reworked by Valerio into a deductive scheme comparable to the one found in Euclid's *Elements.*[130] According to Napoletani, Valerio remained a classical mathematician who functioned within the paradigm of Euclidean geometry; nevertheless his search for a general method, pushed this paradigm to the breaking point. Sarrocchi, as his very capable student, must have been exposed to far more complex mathematics than Cereta and Danti. Nevertheless, her only contributions to the subject appears to have been some geometric demonstrations found in Valerio's commentary on Euclid, which because of the dispersal of Valerio's manuscripts have been lost.[131]

Because of her close friendship with Valerio, and the mathematician's initial friendship with Galileo, Sarrocchi became exposed to subjects which began to depart dramatically, as chapter one indicates, from concepts found in Aristotelean natural philosophy. By June 1609, Valerio and Sarrocchi received Galileo's work on natural motion and horizontal projection. It was at that time that Galileo was able to demonstrate, according to Drake, against Aristotle, that the speeds in fall were directly proportional to times from rest, and also to explain the compositions of motion and vector

addition in deriving the parabolic trajectory found in horizontal projection.[132] Three years later (June 1612), Galileo was to send Sarrocchi his work *On Bodies that Stay atop Water*, whereby through a series of experiments, geometric demonstrations, and utilizing Archimedes principle, he pointed out that density, not shape--as Renaissance Aristoteleans would have it--determined whether a body floated or sank when literally placed in the water. The work was initially read by Sarrocchi, who then explained it to Valerio, which gives us another proof that her understanding of mathematical subjects was, as Valerio had suggested, as good as his own.[133] Most importantly, Sarrocchi and Valerio were kept informed about a series of discoveries Galileo made with the telescope. These discoveries were even more difficult to reconcile with Aristotelean philosophy than his work on floating bodies ever was.[134]

The first of these discoveries, the four Jovian satellites, and the mountain and craters of the moon were contained in Galileo's *Starry Messanger* sent to Sarrocchi and Valerio by May 1610.[135] By January 1611, Sarrocchi and Valerio were informed of Galileo's discoveries of the phases of Venus. It is possible that they were also informed at the same time of the latter's attempt to determine accurately the Jovian satellites' periods and construct tables of their motion. It would serve to explain Sarrocchi's statement that accurate knowledge of the satellites would be useful to judicial astrology. According to Sarrocchi the fact that their presences were not previously known clarified why Jupiter's effects on the sublunar region had proven so difficult to forecast accurately.[136]

By the spring of 1611, the pair already knew of the tripartite nature of Saturn, for Sarrocchi made mention of it in her letter to Guido Belloni of Perugia, as having observed it with her own eyes. During Galileo's visit to Rome in 1611, she was also

given the opportunity, along with others, to observe the Jovian satellites, and the phases of Venus with his telescope. As she indicated to Belloni, the phases of Venus were clear indication, or geometric demonstration, that Venus rotated around the Sun.[137]

Galileo's discoveries of sunspots were mentioned in the introduction of his *Bodies that Stay atop Water,* where he referrred to them as being contiguous to the surface of the solar body. The final version, *Letters on Sunspots*, was printed by the Academy of Lincei in 1613, after Luca Valerio had revised it, and Galileo had accepted some of the mathematician's suggestions. The work was finally read by Sarrocchi by August 1613.[138] One could say accurately enough that from 1610 to 1613 Valerio and Sarrocchi were admirers, and also defenders of Galileo's discoveries, as they had to observe them with their own eyes. Sarrocchi, herself, promoted such discoveries to her acquaintances, and was accused in 1612, of being too fond of Galileo to be able to judge his findings accurately. In spite of their admiration and defense of Galileo's astronomical discoveries at the time, they never ceased to encourage Galileo to continue his work in mechanics; perhaps, by being closer to seat of religious power, they might have been more aware than Galileo of the difficulties that could arise from such discoveries.[139]

For all of Sarrocchi's up-to-date knowledge in mathematics and natural philosophy, her friendship with Valerio and Galileo, and the fame of her intellectual gatherings in Rome, she was never made a member of the Academy of Lincei. Valerio had not such difficulties, for he was made a member of the academy on June 9, 1612.[140] This difference in treatment had to do in part with her gender, and the nature of the academy, but also it may have been due to the personalities , and interests of the people involved.

The founder's desire (Federico Cesi) to organize the Academy of Lincei in imitation of a religious order, would not make the academy amenable to the admittance of women among its male membership, however qualified these women might have been. In addition, the academy had other characteristics that made it different from other Italian academies dedicated mostly to literary subjects and conversations. The Lincei was essentially scientific in nature. According to Olmi, its members were encouraged to understand the natural world through the use of mathematics and natural experiences. They were also encouraged to publish their works so that they would be available to all. Luca Valerio might have been made one of its members with Galileo's support, but he also had the qualifications required for such a membership, his published mathematical works had made him well known in Rome and abroad.[141] Although very knowledgeable in mathematics and natural philosophy, Sarrocchi could not claim any scientific publications to her name. Her main opus, however epic, was of a literary nature, and consisted of her poem, *Scanderbeide.*

One should not discount that personal dislikes might have also kept Sarrocchi away from a membership at the academy. Sarrocchi was viewed by many of her contemporaries as a quarrelsome, demanding and proud woman. She was also blamed by Cesi and others for Valerio's decision in 1616 to drop out of the academy; a view shared in part by Baldini and Napoletani who feel that Galileo's possibly negative reaction to her poem, which he had been asked to correct, review, and improve might have eventually ended hers and Valerio's friendship with the philosopher. The Church's condemnation of the Copernican cosmology accepted by Galileo simply facilitated Valerio's decision to drop out of an academy, which he saw as pro-Galileo.[142]

One should also consider that it might have never occurred to Sarrocchi to be part of the Academy of Lincei program. Although Sarrocchi was interested in, and capable of absorbing the new studies in mathematics and natural philosophy propounded by Valerio and Galileo, she might not have been interested to go any further in scientific exploration. Sarrocchi was ready to defend Galileo's discoveries, after she had seen them with his telescope, and even explain them to others. She certainly discussed them with Valerio and others in her academy; however, it is doubtful that as a society woman of the period, Sarrocchi would be ready to engage in the experiments that led to Galileo's studies on motion and on floating bodies, as found his *Two New Sciences* and *Bodies that Stay atop Water.* Her letters to Galileo indicate clearly that, in spite of her praises for his physics, what really concerned her was not the physics, but her poem and the fact that Galileo was to review, correct, and improve it.[143]

Social forces might have been a determining factor in the fact that, in spite of her advanced mathematical knowledge, Sarrocchi never atempted to write a book on the subject, like Valerio had done, and instead relegated herself to a few geometric demonstrations in her friend's unpublished commentary on Euclid. Moreover, one should also consider that to be a mathematician in Rome, or in Italy, did not entail a high social status during Sarrocchi's and Valerio's time.[144] In addition, why should Sarrocchi, a proud and demanding woman, care to be one of many members within the Academy of Lincei, when she had her own academy, which allowed her to control what was discussed, and which allowed her the opportunity to shine.

Galileo's discoveries and publications also found their way into the convent of San Matteo di Arcetri, where his illegitimate daughters Virginia (b. 1600) and Livia (b.

1601), born of his relationship with the Venetian Marina Gamba, were placed in 1614 to become nuns of St. Claire in 1616 and 1617 respectively. As the parent solely responsible for his illegitimate children's upbringing, after Marina Gamba had contracted marriage with another man, Galileo made a choice for his children's future life which illustrates well how daughters mattered less than sons to a father: he chose to legitimize and raise personally his son Vincenzo (b. 1606), while placing his two daughters in a convent, where they would receive a mediocre education. [145] Nevertheless, Maria Celeste's character, and intelligence would allow her to overcome both her mediocre education, and her limited surroundings to gain the affection and respect of Galileo and his friends. Maria Celeste (Virginia), described by her father and his friends as a woman of exquisite intelligence, had asked Galileo in 1623 to send her his latest work, *The Assayer*.[146] The work dealt essentially with the controversy between Galileo and Orazio Grassi, mathematics professor at the Jesuit Collegio Romano, over the nature of comets, and the workings of the telescope. In it, Galileo also discussed " the structure of matter, the nature and speed of light, the multifarious sources of sound, relations of the senses to physical phenomena, the uses and interpretations of experiments ", and other related topics.[147]

It is difficult to judge how much of the work Sister Maria Celeste would be able to understand. For in addition to its complex natural philosophy, it contained several geometrical demonstrations in optics, which a person of Maria Celeste's ability might have been able to grasp. It also contained many passages in Latin taken from Grassi's work, *Libra astronomica ac philosophica* (1619), that Galileo used so he could contradict them. Latin was a language to which Maria Celeste admitted no knowledge in

1630, but also her willingness to learn it when it was required of her. Her Latin illiteracy stood in sharp contrast with the Latin literacy of Sister Fiammetta, and the one acquired by Magherita Sarrocchi, and Laura Cereta within convent walls.[148]

Maria Celeste also received instruments from her father; a particular favourite with the nuns was a pendulum clock made by Galileo, and discarded by him in his attempts to find an instrument which measured time accurately enough for astronomical observations. The clock had caused Maria Celeste initial difficulties, because of her inabiliy to make it function properly; but she was quickly able to recognize her mistakes. Galileo also sent her a spyglass, at her request, three years after the Congregation of Religious prohibited the use of such objects in monasteries.[149] The Church might have condemned Galileo, his book, *The Two Chief World Systems*, and Copernicanism, but, regardless of being a nun, Maria Celeste remained loyal to her father throughout; to her he was the man who had penetrated the heavens with the eyes of a lynx, and had seen what other had not seen before. Interestingly enough, many of the other nuns in Maria Celeste's convent shared in this loyalty, for Galileo had been helpful and generous to the convent and many of the nuns. Thus, they could only rejoice with Maria Celeste when her father escaped from the clutches of the Roman inquisition.[150]

Maria Celeste might have belonged to an enclosed order, but her father's troubles with the inquisition, and the difficulties that existed between Galileo and his son, thrust her in the middle of one of the greatest controversies of the scientific revolution, and forced her to take an active part in it. Thus, while her father was in Rome, being questioned by the inquisition, and then at Siena, under house-arrest, Maria Celeste was in charge of his affairs from within the convent walls. She gave permission for Galileo's

friends to remove from his residence at Arcetri all papers that might have compromised him.

Maria Celeste also corresponded with the wife of the Duke of Tuscany's ambassador in Rome. Friends of Galileo, such as Benedetto Castelli, came to visit her, and Galileo's letters circulated among Maria Celeste and his friends. The nun was also able to obtain a copy of the sentence passed on Galileo by the Church, something that the philosopher himself had been unable to obtain.

Maria Celeste could also act as a censor; in November 1633, when she had learned her father had taken up writing again, she asked him to send her the material he was working on, if Galileo thought she could understand it. Maria Celeste made such a demand, not because of a particular interest on her part on strengths of material structures, the topic of Galileo's concern at the time, but because she feared her father might continue to write on the Copernican system.[151] Thus an enclosed nun, with little formal scientific education, because of her intelligence, dynamic nature, and familial circumstances, became informed, and was able to participate in the latest, and most relevant, scientific debate of the period.

In spite of interdictions by the Church, there is some proof that Galileo's Copernican works, and astronomical works, were able to enter other convents, besides that of his daughter, not unlike what had happened to Piccolomini's *Sphere of the Universe*, in the 1500s. We have an example of such a penetration in Sister Arcangela Tarabotti's work, *Che le donne siano delle spezie degli uomini* (1651). In spite of being enclosed in one of Venice's convents, Tarabotti (1606-1652) was associated with the Venetian Academy of the Incogniti and its patron Giovanni Francesco Loredan.

It was through the patronage of the academy and its publisher that Tarabotti had been able to publish several of her works, which often defended women's right to choose the path they were to follow in life. Tarabotti had some philosophical differences with the academy's members; for instance, they, being men, did not always understand her attacks on a system which forced women into convents, often against their will. Nevertheless, Tarabotti and several of the members shared similar attitudes towards Galileo and Copernican cosmology.

The academy' s members were associated with the Paduan Aristotelean naturalists, who were the descendents of the medieval Averroists, and shared in their disbelief in the immortality of the soul, and a belief in Aristotelean cosmology.[152] Tarabotti also believed in this cosmology, or so it appears; as far as she was concerned, Galileo was a heretic, whose telescope's discoveries challenged the scriptures. After all, these discoveries had allowed Galileo to declare, against the scriptures, that the earth moved and that the heavens were made of corruptible matter.[153] Since Tarabotti's work attacking Galileo's discoveries was published in 1651, eighteenth years after Galileo's trial, one is never quite sure whether she really believed in the Aristotelean cosmological system, or was simply paying lip service to it. Nevertheless, Tarabotti's statements are interesting on two accounts: firstly, they indicate that, in spite of all the Vatican's interdictions, Galileo's findings in favour of the Copernican system had found their way even into convents. Secondly, they also show that after 1633 and prior to 1757, any Italian work, written by men or women, discussing cosmology, and astronomy would be affected by Galileo's trial and condemnation, and be characterized by caution, and therefore, cannot be really taken at face value. The Vatican's interdict on the

Copernican system, would also have an effect on the number of amateur astronomers practicing in Italy after 1633, and thus on the number of women who could be defined as astronomers, since this latter group was unlikely to belong to any institution of higher learning.

During the 1500s, women would also become increasingly interested in natural history, a field which would gain in importance from the sixteenth century onwards, and begin to develop into a discipline in its own right, independent of medicine.

III. *Women and Natural History*

An interest in natural history existed throughout the Middle Ages and the Renaissance, hence the existence of herbals for medical purposes, and of bestiaries. These latter works, descended from the Greek *Physiologus*, contained information on real and imagined animals, and sometimes, on plants and minerals. In addition, Pliny the Elder's *Natural History* remained in use throughout the Middle Ages; portions of the book were used for facts, anecdotes, and names. Humanists, in the fifteenth-century, drew from Pliny's work a classical vocabulary of scientific words, not available in any Latin author. The humanist Laura Cereta was such a case in point. In her letters to Sister Deodata Leno, which described a trip to the countryside around Lake Iseo, and to Europa Solitaria, which was an admonition about the false pleasure of a life in seclusion, Cereta drew from Pliny's vocabulary of birds and plants to describe the natural landscape, supposedly, around her.[154]

As discussed in chapter one, during the course of the sixteenth-century, this interest in natural history intensified and changed in nature with the foundation of botanical

gardens, and of private, and court collections, the undertaking of nature trips, and the appearance of natural history as a course at universities. Most importantly for women, there occurred throughout the century a real diffusion of printed works, often illustrated, which dealt with descriptive sciences. For example, during the sixteenth-century Pliny's *Natural History* went through scores of editions in Latin and in Italian.[155]

Some of these activities pertaining to natural history were also to affect women in a marginal way and can be detected in their writings. Some *naturalia*, such as corals, fishes' teeth, and objects made of precious stones, and ivory, could be found amongst Isabella d' Este's (1474-1539) collection of antiquities. Nevertheless, *artificialia* predominated in the collection; this was in part due to the fact that she might have collected to enhance her social prestige, and not for study reasons. But the fact that she collected in the first part of the sixteenth-century, might have also determined her choice of objects. The collection of her descendent, Duke Ferdinand (1587-1626), contained, similarly with other collections of the period, much more *naturalia.*[156]

Women in small numbers also visited botanical gardens and museum collections. For instance, women visited Bologna's Botanical Garden in order to view new plants brought from abroad, such as the Peruvian chrysanthemum (sunfower) plant cultivated therein. Three of these women were recorded by Ulisse Aldrovandi to have visited his museum at Bologna, two *studiose*: Ippolita Paleotti and Isabella Andreini, and a noble woman, and hopefully patroness, Caterina Sforza Santafini. The noble woman, who was visiting the town with the Marquis di Versi, one of Aldrovandi's patrons, came to the museum not alone, but followed by 14 or 15 coaches, in which there were fifty ladies and one hundred and fiftty gentlemen. This group took over not only the museum, but all the

other rooms of the house, including the *studiolo*, an area allotted by the naturalist to those friends with the greatest interest in natural history.[157] Ippolita Paleotti, the niece of his close friend and fellow naturalist, Cardinal Gabriele Paleotti, and Isabella Andreini, a famous actress and author, were given no such a privilege. Their names were not among those who visited his *studiolo*, in spite of the fact that they were considered learned women, and were authors of poems and prose.[158]

Francesca Fontana, Aldrovandi's second wife, described by Tugnoli Pattaro as his valid collaborator in research, undoubtedly, frequented the *studiolo*, but whether she did it when Aldrovandi's colleagues were present is difficult to ascertain. As it is difficult to assess how learned she was in natural history, and precisely what kind of assistance she provided to her husband. There is no evidence Fontana took part in the nature trips engaged by Aldrovandi in 1571 to various northern Italian sites for the purpose of studying and collecting. For the illustrations of the specimens found in his work, Aldrovandi employed professional artists. At his death, his museum collection, and his works were offered to the Bologna Senate in exchange of an income for his wife. Therefore, Aldrovandi never intended Fontana to continue in his footsteps.[159]

Nevertheless, in his autobiography, the physician described his second wife as a woman of incomparable beauty and wisdom, suitable, because of her intelligence, to any discipline and art. According to Aldrovandi, Fontana had assisted him in his vast correspondence with patrons, and other naturalists, and in assembling his " Lexicon of Inanimate Things". This latter work consisted of five volumes of collages, organized in encyclopedic manner, of indications, and/or definitions, often taken from other authors, of inanimate objects, or matters. For instance, from Giambatista della Porta's *Natural*

Magick one would be able to find out how parabolic mirrors could be made, so that they would burn obliquely, and into the infinite.[160]

Due to Aldrovandi's progressive blindness, Fontana also administered all his affairs. Furthermore, at his death, she was left with the task of completing the last of his works, which Fontana completed by 1606, when it appeared in print with her own Latin introduction. In it, Fontana thanked the university and senate for having employed her husband, and thus having allowed him to function as a naturalist. She also congratulated the senate for the acquisition of his collection and works, and thus ensured that they would be useful to future generations.

The work, *De reliquis animalibus exanguibus*, which followed an essentially Aristotelean classification, was divided into four book which dealt with *mollibus* (for example, squids, cuttle-fish, and polyps), *crustaceis* (crabs, lobsters, shrimps), *testaceis* (nautilus, clams, mussels), and *zoophytis* (sea urchins, sea cucumbers, and so on). The volume presented a mixture of observations, and factual and mythical information on the animals. It provided illustrations of the animals, alongside information on generation, genus, mating habits, and habitat, and it discussed their utility as food and as medicine. As fitted the period, proverbs, hieroglyphics, epithets, epigrams also served to define the animals, and were used for most species. It is impossible to know whether Fontana contributed to any of the volume's content, in addition to perhaps in its organization and printing. D. Franchini and others feel that the volume was solely Aldrovandi's effort, and there is no evidence to disagree with them.[161] As in many collaborations between husband and wife, Fontana's work could have been absorbed by her husband's.

If one exempts their recognition, based on practice, of the medicinal properties of many plants, most of the knowledge women had in natural history was learned from books and, with a few exceptions, had little basis on practical experience. It could be relegated usually to readings of Pliny's *Natural History*, and perhaps of Aristotle's biological works. Arcangela Tarabotti, in her *Che le donne siano dele spezie degli uomini*, punished the German author, who in his tract, *That Women Were Not Rational as Men*, had classified women as animals, by comparing him to a veritable bestiary. The behaviour of each individual animal used by Tarabotti to attack the German was most likely taken from readings of Pliny and Basil of Cesarea and his *Homilies on the Hexameron*.

Thus the German author became a bigger beast than an elephant, who used the tongue imprudently, like a talking cuckoo, a wolf dressed as a lamb, a crab that walked backward, an owl that could not stare at the bright rays of the sun and so on. Since the convent had no library, Tarabotti was forced to borrow from relatives, or friends, the books she would use as sources; and thus would have to commit many of these animal characteristics to memory. In that case, it would be possible to detect variations from the original source; and such is the case, for it was not a serpent that tore apart the womb of its mother, but a lion. The serpent, a viper, would devour the mother's breast.[162] But none of the women used Pliny's *Natural History* as extensively as Moderata Fonte in *Il merito delle donne.*

As seen before, Fonte had already made use of Pliny's Book II in the section of her work dealing with cosmology and meteorology. Book X, which discussed birds, was used in the learned Corinna's description of certain characteristics of birds, like the swan,

whose song predicted its death; the vain peacock, whose flesh was of great value, or the eagle, which had a generous nature, sharp eyes, and was the only bird that could stare at the sun.[163] Book IX was the source of her description of aquatic animals, such as the enormous whale, the friendly dolphin, the noble sturgeon, or the aggressive sword fish.[164] While Book VIII provided material for Fonte's section on terrestial animals like the lion, tiger, deer, wolf, dog, or bear. This latter in the best Aristotelean and Plinian tradition, delivered a shapeless mass at birth, that then was licked into the shape of a cub by the mother.[165] The author respected Pliny's animal division, but not the order with which he had arranged them in his work; in Fonte's case the order was reversed.

Fonte's references to the circulation of water between fountains, rivers, and seas were taken from Book II, and Book III was used in the geographical descriptions of the Italian rivers.[166] One might say that Fonte was similarly a liberal translator of parts of Pliny's *Natural History* as Christine de Pizan had been a translator of book one of Aristotle's *Metaphysics*. Since the works of both ladies were aimed at general audiences, one suspects that these works must have been as effective, if not more so, at popularizing and spreading the scientific knowledge contained in them, as the translations of scientific texts carried out by women in later centuries.

As a topic which was by nature descriptive, and which did not require, neccessarily, any association with institutions of higher learning, natural history remained popular amogst women in later centuries. However, women's approach to natural history modified, to reflect the subject's development away from medicine, and branching out into the increasingly specialized fields of botany, zoology and minerology.

As the pages above indicate, prior to 1633, Italian women were exposed to a variety of sciences, with this exposure decidedly increasing after the advent of printing. What Italian women did little of, prior to 1633, was to write works entirely dedicated to the sciences. Works such as Trota's *Practica*, Laura Cereta's letters entirely dedicated to astrology and Isabella Cortese's *The Secrets of the Ladies* remained a rarity amongst Italian women, for the period under discussion. Other scientific works by women were simply never published, such as Frescobaldi's *Sfera del mondo*, Danti's commentary on Euclid, Fedele's *Scientiarum ordine*, or Sarrocchi's geometrical demonstrations. The other women displayed their learning in the sciences in their poetry, or their prose, media which did not encourage extensive expositions of the subjects.

One might say that the literary forms, and subject matters women chose, indicate the superficiality of their scientific knowledge, which might have been true in many cases. Men were not stopped by their superficial learning, as women might have been. For instance, a generalized knowledge of Aristotelean cosmology and meteorology, and of calendar reform did not prevent Fonte's uncle, Giovanni Doglioni from writing a book on the subjects. The niece with scientific learning similar to his own, used it to write a chapter in her work in defence of women. It is fair to say that her interets lay elsewhere. One also suspects that Teodora Danti's commentary on Euclid was never intended for publication, but was meant as a teaching manual for her nephews, and young brother, just as Frescobaldi's *Sfera del mondo* was written exclusively for the nuns at her convent.

Society did not expect, and men did not encourage, women to publish in the sciences as they might have encouraged publications in literature, and women of the period seemed to have obliged. After all, many of the women discussed were associated with

academies, where conversations in natural philosophy and mathematics took second place to those on literature, and perhaps, moral philosophy. It seems natural that these women would have publications of the latter nature, rather than the former.

One should certainly take into account that most learned women's interests did not rest with the sciences, or if it did, as in Cereta's case, it did not remained constant. In her correspondence with Galileo, Sarrocchi was more concerned with her poem, than with the scientific works he sent her. Therefore it is fair to assume that the sciences were not high priority among the women discussed in this chapter, but were considered subjects that enriched their culture. No doubts, a view also shared by many men who participated in most academies. While astrology might have been fashionable, the other sciences did not have the allure they were to have in the eighteenth-century.

Still women were exposed in varying degrees to some form of material of a scientific nature. Such material even entered convents, as the examples of sisters Frescobaldi, Maria Celeste, and Tarabotti demonstrate. There are no doubts that many other examples can be found by a throrough investigation of convent education. That Sarrocchi, and Cereta had received an extensive education within convent walls is further proof that there were nuns with considerable education in some Italian convents. Arcangela Tarabotti, herself, taught the two daughters of her friend, the French ambassador in Venice, Grémonville.[167]

Many of the women discussed above had some knowledge of Aristotelean-Ptolemaic cosmology, often associated with an interest in astrology. This knowledge appears to have been more widespread in the sixteenth and early seventeenth centuries, when due to the spread of printing, several Italian works, or translations, on the subject came to the

fore. Some women, like Sarrocchi, Cereta, and Danti achieved high levels of such knowledge for the times.

Undoubtedly, the condemnation of the Copernican system by the Church, and Galileo's trial, dampened the interest many might have had in cosmology, astronomy, and even astrology. In one hand, the controversy between Galileo and the Church, and the publication of his Copernican opus *Dialogue Concerning the Two Chief Systems* (1632) did much to publicize the Copernican system, and most likely caused an increasing number of intellectuals (men and women) to doubt the validity of Aristotelean-Ptolemaic cosmology.[168] In the other hand, the trial and condemnation of any work supporting the Copernican system by the Church ensured that this system would never be used as Aristotelean-Ptolemaic cosmology had been by many women in their poetry and prose. Silence on the subject would then be preferable. If silence was not observed, caution would then have to be followed, when discussing cosmology in print, lest one should meet the same fate as Algarotti's *Newtonianism for Ladies.*

In the 1500s, there was also an increased interest in natural history, brought about by several translations of Pliny's *Natural History*, the discovery of America, and the appearance of many museums and botanical gardens; still there seemed to have been less women interested in the subject than in cosmology and astrology. Nevertheless, natural history offered an early collaboration between husband and wife, that of Ulisse Aldrovandi and Francesca Fontana. Fontana was to face the same problems other women were later to face in these partnerships: her contributions, whatever they might have been, could be absorbed by her husband's.

Many more women were perhaps familiar with some elementary and/or practical form of the healing arts. Many had knowledge of the medicinal properties of plants, and even minerals. Nursing members of one's family, or community, in the case of nuns, under the supervision of physicians, was part of a woman's duty. If one also takes into account the women physicians of Salerno in the Middle Ages, and then in later centuries, women who practiced some kind of licensed, or unlicensed low-level medicine in the towns, and country areas, and who only appeared in the sources when they were brought before the *protomedicato,* this number was extensive indeed.

Regardless of their level of expertise, the women discussed in this chapter represented important precedents, not only for the women who would later receive degrees from, and teach at universities and related institutions, be made members of, or found, scientific academies, collaborate with family members, and/or publish scientific works, but also for the men, who would support them in their endeavours. They demonstrated that women could be learned in the sciences and practice them, as Trota, Cereta, and Danti had done; teach male students and deliver orations at universities, like Trota, Danti, Fedele and Calderini; be learned in the healing arts like Maria Celeste; and be licenced physicians, like the women of the Medical School of Salerno; be members of, and found academies, like Sarrocchi, Gambara, and others; be collectors, like Isabella D' Este; be translators of ancient science like De Pizan, and Fonte; act as patrons to natural philosophers, like Gambara, Isabella D' Este, and Sarrocchi; and even write on the subject enough so that their learning could be detected by future generations. If one allows for the changes which occurred in the sciences, in universities, and society at large throughout the centuries, one can say that it is possible to find examples in the past of

essentially all the scientific activities women would engage in later centuries, as the following chapters will attempt to demonstrate. These women, their learning, and activities provided proof to the women who were to follow in their footsteps, and to the men who were to assist them, that, yes, some women, if not all, could be learned and active in the sciences.

[1]Paul Lawrence Rose, *The Italian Renaissance of Mathematics. Studies on Humanists and Mathematicians from Petrarca to Galileo,* (Geneva: Droz, 1975), pp. 26-75, 78, 293; Nancy Siraisi, *Taddeo Alderotti and His Pupils: Two Generations of Medical Learning,* (Princeton: Princeton University Press, 1981), pp. 25-71.

[2]Siraisi, *Medieval & Early Renaissance Medicine*, pp.13, 27; for Calderini see Pizan, pp. 154-55; for Bocchi see Pellegrino Orlandi, *Notizie degli scrittori bolognesi e dell' opere loro stampate e manoscritte*, (Bologna: Pisani, 1714); for Giliani see Vittoria Ottani, Gabriella Giuliani-Piccari, " L' opera di Anna Morandi Manzolini nella ceroplastica bolognese " in *Alma Mater Studiorum*, pp. 81, 84, 92n; Siraisi, *Taddeo Alderotti*, p. 112; Calenda see Kristeller, pp. 102-03, 115n; for Gozzadini see Cherubino Ghirardacci, *Della Historia di Bologna*, (Bologna: Giovanni Rossi, 1596), Prima Parte, libro VI, pp. 158-59, 161, 163, 166, libro VII, p. 203; for Fedele see King and Rabil Jr., *Her Immaculate Hand*, pp. 69-73; Berti Logan, pp. 790-91.

[3]Siraisi, *Medieval & Early Renaissance Medicine*, pp.13, 27, 35, 44-46, 57, 147, 176.

[4]For the Madrid manuscript and Trota see John F. Benton, " Trotula, Women's Problems and the Professionalization of Medicine in the Middle Ages, *Bulletin of the History of Medicine*, Vol. 59, no. 1, (Spring 1985), pp. 32-33, 41-45. For the manuscripts in Florence and Vienna see Giulia Orofino, " L'immagine della malattia del medioevo: due testimonianze di età sveva ", *Medicina nei secoli, arte e scienza*, Vol. 8, no. 1, (1996), pp.43-58.

[5]Benton, pp. 40-42, 44.

[6]*Ibid.*, pp. 32-34, 42-43, 47-48.

[7]Monica Green, " Women's Medical Practice and Health Care in Medieval Europe ", *Signs*, Vol. 14, no.2 (Winter, 1989), p.453; Benton, p. 42.

[8]Salvatore De Renzi ed., *Collectio Salernitana, ossia documenti inediti e trattati di medicina appartenenti alla Scuola Medica di Salerno,* Vol. II, (Naples: Filiatre-Sebezio, 1853), pp. 52-56, 344-345.

[9]The pages referred above are only taken from the sections designated as "Trot" and "sine nomine" in *Collectio Salernitana,* Vol. II, pp. 160, 163, 165-167, 175, 180-181, 188-190, 253, 259-260, 262-265, 317-318; Thorndike ed., *The Herbal of Rufinus*, see Introduction, p.xvi.

[10]The herbals are found in Florence, Biblioteca Medicea Laurenziana, ms. 73.16 and at Vienna, Österreichische Nationalbibliothek, ms. 93. See Orofino, pp.47-48; Benton, pp. 33, 44, 50; Green, p.453n.

[11]Green, pp. 441-43.

[12]P.D. Placido Tommaso Lugano ed., *I processi inediti per Francesca Bussa dei Ponziani (Santa Francesca Romana) 1440-1453*, (Vatican City: Biblioteca Apostolica Vaticana, 1945), pp. 170-73, 234, 235, 242-43, 282-83; Siraisi, *Medieval & Early Renaissance Medicine*, pp. 41, 44-45, 147, 176.

[13]See A.S.B.: *Archivio di Studio*: Collegio di Medicina, nos. 213, 214, 236 for specific cases; for the role of *protomedicato* and women see Gianna Pomata, *La Promessa di guarigione: malati e curatori in Antico Regime Bologna XVI-XVIII secolo*, (Bari: Laterza, 1994), pp. 15-60, 158-63, 191n.

[14]For a biographical note on Isabella Sforza of Piacenza see Gamba, " Isabella Sforza " in his *Donne Italiane del secolo decimosesto,* p. 57; Isabella Sforza, *Della vera tranquillità dell' anima*, (Venice, 1544), pp. 10r-v, 34v-35r.

[15]For Giovanni Marinelli's use of Aristotle see G. Marinelli, *Le medicine*, pp. 60v, 96v, 235r-238v; Aristotle, *On the Generation of Animals,* Book I: 726b-730a, Book II: 732a, 737a.

[16]Lucrezia Marinelli, *Della nobiltà et eccellenza delle donne,* pp. 33v, 41v, 45v-46r.

[17]It is difficult to know whether Tarabotti had access to the original works by Aristotle and Galen, or whether, as Medioli believes, she borrowed her information from one of the many antologies that were available in the 1600s. Tarabotti might have borrowed the works from friends, or relatives, and she would have been able to read them, for she knew Latin. See Tarabotti, *Che le donne siano...*, " Disinganni: 10, 28, 39, 42, 54 ", pp. 18, 43, 65, 68, 91-92 respectively; Medioli, " Strumenti culturali..." pp. 13-143; Galen, *On the Usefulness of Parts...*, fourteenth book, II , 317-321, pp. 642-644.

[18]See Piccolomini, *Institutione morale...*, p.549; Antoniano, pp. 27r-28v.

[19]Battista da Montefeltre, " Lettere inedite. Nota di A. Fatti e B. Felici Angeli", *Rendiconti della Reale Accademia dei Lincei: Classe di scienze morali, storiche, e filologiche*, serie 5a., Vol. XXVI, (1917), pp. 201-203, 205, 207, 212.

[20]For discussions on the feminist, and literary aspects of Moderata Fonte's *Il merito delle donne*, and also for a detailed biography of the author see Chemello, " Giuoco e dissimulazione...", pp. IX-LXVI; Stephen D. Kolsky, " Walls of Knowledge: Moderata Fonte's *Il merito delle donne*, *The Italianist*, no. 13, (1993), pp. 57-96; Collina, pp. 142-64; Paola Malpezzi Price, " A Woman's Discourse in the Italian Renaissance: Moderata Fonte's *Il merito delle donne*, *Annali d' Italianistica*, Vol. 7, (1989), pp. 165-81; Margaret F. Rosenthal, " Venetian Women Writers and Their Discontent ' in *Sexuality and Gender in Early Modern Europe: Institutions, Texts, Images*, James G. Turner ed., (Cambridge: Cambridge University Press, 1993), pp. 107-32.

[21]For the coincidences which existed between Fonte's and Rufinus's remedies and cures see Fonte, pp. 114-130; *The Herbal of Rufinus*, pp. 19rb-vb, 20 rb-va, 24 ra-rb, 23 rb, 17rb, 29 vb-30 rb, 66va-vb, 74rb-va, 102 rb-va, 90 ra-rb, 94 vb-95ra, 94ra-va, 46 ra, 53 rb, 62 ra, 63 ra, 22 vb, 64 ra, 98 va, 50 rb, 43 vb, 65 ra, 63 va, 110 rb, 72 rb, 34 vb, 46 vb, 7 rb, 77va-vb, 71 rb; Thorndike ed., *The Herbal of Rufinus*, pp.xv-xxiv; for the humours see Siraisi, *Medieval and Renaissance Medicine*, pp. 104-06.

[22]Canoness Semidea Poggi's letter is found in G. L. Masetti-Zannini, " Una canonichessa erborista: Semidea Poggi (sec. XVI-XVII) ", *Strenna storica bolognese*, Anno XLV (1995), pp. 396-97.

[23]See Maria Celeste's letters nos. XVIII, XIX, XXV, XXVIII, XXXIII, XXXVIII, XXXIX, LVII, LXVII, LXVIII, LXIX, LXXI, CI, LIII, in Enrica Viviani della Robbia, *La figlia di Galileo*, (Florence: Sansoni, 1942), pp.22, 28, 31, 37, 44, 47, 74-75, 85, 86, 88, 90, 138, 69; Fonte, pp. 121, 119, 118, 116, 115, 120; Pliny, Book XIV: 21, Book XXIII: 29.

[24]See letters nos. XLII, XXXIII, LXXXIX, LXXII, in Viviani della Robbia, pp. 51, 37, 116-17, 91.

[25]See letter no. LXXVII in *Ibid.*, p. 30.

[26]Eamon, pp. 3-9, 135-38, 164-65, 194, 290; Isabella Cortese, *I secreti delle signore di Isabella Cortese nei quali si contengono cose minerali et medicinali artificiose et alchimiche, et molte dell' arte profumatoria appartenenti a ogni gran signora*, (Venice: Nicolò Tebaldini, 1603.

[27]Cortese, pp. 2r-v, 29-32; Eamon, pp. 137, 164-65, 394n.

[28]For Italian authors admiration of ancient learning as pertained to medicine and natural history see Findlen, *Possessing Nature...*, pp. 24-256; see also the chapters that pertain to Italy in A. Wear, R.K. French, I.M. Lonie, *The Medical Renaissance of the Sixteenth Century*, (Cambridge: Cambridge Univeristy Press, 1985); for mathematics see Rose, pp. 159-242; Cortese, 2r-v; Eamon, p. 194.

[29]Cortese, pp. 3r, 3-16.

[30]*Ibid.*, pp. 3v-4r, 5r, 19-21, 23-62, 86, 90; Eamon, pp. 164-65; Paracelsus, " A Manual of Paracelsus the Great " in *The Hermetic Writings of Aureolus Philippus Theophrastus Bombast of Hohenheim, Called Paracelsus the Great,* Vol. I: *Hermetic Chemistry*, A.E. White ed, (Berkeley: Shambhala, 1976), pp. 306-16, 320-21, 342, 344-46, 349, 353, 360, 367, 375, 380, 387; Gareth Roberts, *The Mirror of Alchemy. Alchemical Ideas and Images in Manuscripts and Books from Antiquity to the Seventeenth Century,* (Toronto: University of Toronto Press, 1994, pp.65-95.

[31]Cortese, pp. 4v-8v, 84-94, 98-205.

[32]Cortese, pp. 19-21; Eamon, pp. 164-65.

[33]Baldini, " L' attività scientifica nel primo settecento ", pp. 510-11; Carolina Coronedi Berti, " Appunti di medicina popolare bolognese ", *Rivista di letteratura popolare*, Vol. I, fasc. 1, (1877), pp. 1-12; for Coronedi Berti see Giancarlo Roversi, " Donne di penna, poetesse, letterate ed erudite del XIV al XIX secolo " in *Donne celebri dell' Emilia Romagna e del Montefeltro dal medioevo all' ottocento*, G. Roversi ed., (Bologna: Grafis, 1993), pp. 156-58.

[34]Kristeller mentions a few writers in the Italian vernacular before the sixteenth-century, see Kristeller, p. 92.

[35]Lynn Thorndike, *A History of Magic and Experimental Science*, Volumes III and IV: *Fourteenth and Fifteenth Centuries*, Vol. III, (New York: Columbia University Press, 1934), pp. 32-33, 611-613.

[36]For the influence of astrology and natural philosophy at universities in general see Siraisi, *Medieval and Early Renaissance Medicine,* pp. 67-68. For Bologna see Siraisi, *Taddeo Alderotti* pp. 140-145.

[37]Christine de Pizan, *La vision--Christine, Introduction and Text,* A Dissertation Submitted to the Faculty of the Graduate School of Arts and Sciences of the Catholic University of America in Partial Fulfilment of the Requirements for the Degree of Doctor of Philosophy b Sister Mary Louis Towner, M.A., (Washington: Catholic University of America, 1932), fol. 58v, lines 8-9; Christine de Pizan, *Le Livre du Chemin de Long Estude,* Robert Peischel ed. (Geneva: Slatkine Reprints, 1974), Book I, line 1575-1576.

[38]Christine de Pizan, *Le livre de la Mutacion de Fortune,* Susanne Solente ed., (Paris: A. Picard, 1966), Tome I, lines 400-468, 1337, 1361; Pizan, *La vision,* pp. 53v-58r; 62r and v; Marie Josèphe Pinet, *Christine de Pisan, 1364-1430. Étude Biographique et Littéraire,* (Paris: Honoré Champion, 1927), p. 377.

[39]Pizan, *La vision,* pp. 60v, 67r-68r.

[40]For the sources Pizan used in *Epistre* see Introduction of Christine de Pisan, *The Epistle of Othea Translated from the French Text of Christine de Pisan by Stephen Scrope*, F. Bühler ed. (London: Oxford University Press, 1970), pp. XXVII-XXVIII; for Geber and Nicholas of Lynne see Thorndike, *A History of Magic*, Vol. III, pp. 41-42, 523-524 and *Epistle of Othea*, p. 134 n.

[41]Pisan, *The Epistle of Othea*, pp. 16-23, 134-138; for the standard association of heavenly bodies with sublunar ones see Grant, p. 577.

[42]Christine de Pizan, *La Mutacion de Fortune*, Tome IV, p. 59, lines 23000-23012; *The Sphere of Sacrobosco and Its Commentators*, Lynn Thorndike ed., (Chicago: University of Chicago Press, 1949), pp. 121-122. For the teaching of the *Sphere* see Siraisi, *Medieval and Early Renaissance Medicine*, pp. 67-68; Siraisi, *Taddeo Alderotti*, pp. 140-141.

[43]Pizan, *La Mutacion de Fortune*, Tome II, p. 99, lines 7053-7067, p. 103, lines 7173-7212, pp. 112-113, lines 7457-7484, p. 116, lines 7545-7595, pp. 117-120, lines 7596-7672. For her sources see Solente's Introduction of Pizan, *Mutacion*, pp. L-LXII.

[44]*Ibid.*, pp. L-LVII, Tome II, pp. 121-122, lines 7673-7720.

[45]*Ibid.*, Tome II, p. 84, lines 6728-6751. For Cecco d' Ascoli determinism see Siraisi, *Taddeo Alderotti*, p. 60.

[46]Marie-Josèphe Pinet, *Christine de Pisan*, pp. 424-425.

[47]Pizan, *Le Livre du Chemin*, pp. 76-77, lines 1760-1769; *Sphere*, p. 119; Grant, pp. 422-423.

[48]Pizan, *Le Livre du Chemin*, pp. 79-81, lines 1825-1876. Sacrobosco attributed two movements to the heavens, one from east to west, and another oblique to this, and in the opposite direction, of the inferior spheres (the planets), see *Sphere*, pp. 119-120, 140. Others attributed a daily motion from east to west to the tenth sphere, which carried with it the eighth sphere of the fixed stars and all the planets spheres, and a west to east motion of the ninth sphere that carried the eighth sphere plus the planetary spheres, see Grant, pp. 316-318, 493. Christine seems to have combined these motions without making referrence to the different spheres.

[49]Pizan, *Le Livre du Chemin*, pp. 82-83, lines 1830-1932; *Sphere*, pp. 123-124; Piccolomini, *Sfera del mondo*, pp. 7r-25v.

[50]*Sphere*, p. 20n; Grant, pp. 448-449.

[51]Pizan, *Le Livre du Chemin*, pp. 86-87, 94-95, lines 1985-2003, 2175-2188; Aristotle, *Del cielo*, Book II, 9, 290b-291a; Grant, p. 210; Towner, "Introduction" in Pizan, *La vision*, p. 40.

[52]Towner, "Introduction "in Pizan, *La vision,* pp.37-38.

[53]Pizan, *La vision,* Fol. 30r-30v, 32v-33r, 33v, 34r, 34v, 35v-36v.

[54]*Ibid.*, Fol. 36v-39r; Aristotle, *Metaphysics,* Book I, 8: 988b-990b.

[55]Pizan, *La vision,* Fol. 35v, lines 31-32; Aristotle, *Metaphysics,* Book I, 6: 987a-988b, 7: 988b, 9: 991b-993a.

[56]Aristotle, *Metaphysics,* Book I, 5: 986a; Aristotle, *Del cielo,* Book II, 13: 293a.

[57]Pizan, *La vision,* Fol. 34r-35v. Aristotle in *De caelo* referred to the counter-earth being in opposition to the earth and therefore not visible and not in the tenth sphere. This was also stated by Nicole Oresme, *Le Livre du ciel et du monde,* A. D. Menut and Alexander Denomy eds., (Madison: University of Wisconsin Press, 1968), p. 515.

[58]Aristotle, *Metaphysics,* Book I, 8: 98b-990a.

[59]Pizan, *La vision,* Fol. 34v-35v. For the figurate numbers of the Pythagorean school see Boyer, *A History of Mathematics*, pp. 54-55.

[60]Nicole Oresme in *Le Livre du ciel et du monde* demonstrated one such Pythagorean number series when discussing the music of the spheres, see Oresme, pp. 479-481. For the importance of Pythagorean numerology in astrology see Ann Geneva, *Astrology and the Seventeenth Century Mind: William Lilly and the Language of the Stars,* (Manchester: Manchester University Press, 1995), pp. 18-19, 37.

[61]Oresme, pp. 471, 473, 515-519, 543, 589, 591-603.

[62]For her references to the other works of Aristotle and Roger Bacon's *De celestibus* see Pizan, *La vision*, Fol. 32v, 33r, 34v, 36r, 36v, 37r. However, it is also possible that she was not familiar with these works, and that the references came from the Latin commentaries she used for her liberal translation.

[63]Kristeller, " Learned Women...", p. 95; Rose, pp. 292-294; Findlen, *Possessing Nature,* pp. 249-50; King, Rabil Jr., *Her Immaculate Hand*, pp. 33-153; Masetti-Zannini, *I Motivi storici per l' educazione femminile*, Vol. II, pp. 7-70.

[64]See Tomasini's introduction in Cassandra Fedele, *Fidelis Cassandrae Venetae Epistolae et Orationes Posthuma numquam antehoc editae I ac Phillipus Tomasinus,* (Padua: Francesco Bolzettano, 1636), pp. 18-26, 34-42, 195-210; King and Rabil. *Her Immaculate Hand,* p. 126; King, *Women of the Renaissance*, p. 198.

[65]L. Marinelli, p. 15r; Cesira Cavazzana, " Cassandra Fedele, erudita veneziana del rinascimento ", *Ateneo veneto,* 29, 2 (1906), pp. 364-365.

[66]For her struggles to learn philosophy see letters, V, VI, VII, the last two to Philomusus Pisaurensis in Fedele, pp. 7-10.

[67]Cavazzana, pp.88-90.

[68]King and Rabil, *Her Immaculate Hand,* pp. 135, 138-140.

[69]See letter VI to Philomusus; Aristotle, " On Interpretation " in *Logic*, chapter 9, 18b, 15-20.

[70]See letter CX to Bartolomeo Scala in Fedele, pp. 165-166; Aristotle, *On the Soul*, Book II, 3: 414a 415b, Book III, 3: 427a-429b.

[71]Letter CX in Fedele, pp. 165-166; Plato, *Timeus,* 69 D-E.

[72]"Oratione--In gymnasio Palatino pro Bertucio Lamberto" in Fedele, p. 97. For the translation see King and Rabil, *Her Immaculate Hand,* pp.70-73; Aristotle, *On the Parts of Animals,* Book II, 16: 659b, lines 30-35.

[73]King and Rabil, *Her Immaculate Hand,* pp. 48-49; Cavazzana, pp. 364-366, 368-369.

[74]Kristeller certainly places her amongst the humanists, see Kristeller," Learned Women ", p. 97.

[75]For a study of her Protestant faith see Roland H. Bainton, *Women of the Reformation in Germany and Italy,* (Minneapolis: Ausburg Publishing House, 1971), pp. 253-268.

[76]For the humanist studies engaged by Morati's teachers and friends see Claudio Moreschini, " Per una storia dell' umanesimo latino a Ferrara ' and Sabrina Chiellini, " Contributo per la storia degli insegnamenti umanistici dello studio ferrarese (XIV-XVII secolo)" both in *La rinascita del sapere: libri e maestri dello studio ferrarese,* Patrizia Castelli ed., (Venice: Marsilio, 1991), pp. 168-188, 210-245.

[77]See Celio Calcagnini to Olimpia Morati in Olimpia Morati, *Olympiae Fulviae Moratae Foeminae doctissimae ac plane divinae Opera Omnia cum eruditorum testimonis*, (Basileae: Pernae, 1580), pp. 79-81. For Calcagnini's diplomatic service see T. Ascari, "Calcagnini, Celio" in *D.B.I.*, Vol. 16, pp. 492-498. For his role in ensuring Morati be accepted at court see Lanfranco Caretti, " La vita di Olimpia Morata " in Olimpia Morata, "Epistolario (1540-1555)", *R. Deputazione di Storia Patria per l' Emilia e la Romagna Sezione di Ferrara*, Vol. XVIII, (1940), p. 37.

[78]Letter of Fulvio Pellegrino Morato to his daughter, 1540 in Morati, *Opera Omnia*, pp.65-71; Guazzo, pp.74-76.

[79]Olimpia Morati to Chiliano Sinapio, letter no. 3 in Morata, " Epistolario ", pp. 59-61; Bainton, p.253.

[80]See Introduction in Olimpia Morata, " Opere, Volume Secondo: Orationes, Dialogi et Carmina" Lanfranco Caretti, ed., *Deputatione Provinciale Ferrarese di Storia Patria, Atti e Memorie nuova serie,* Vol. XI, parte II, (1954), p. 6.

[81]King, *Women of the Renaissance*, pp 202-03; ' Dialogo di Teofila e di Filotima (1551-52)' and ' Carmina 'in Morata, " Opere ", pp. 39-46, 49-51. For her overwhelming concern with Lutheranism see letters no. 40, 41, 45, 23, 26; for her students see letters no. 24, 46, 39 in Morata, " Epistolario ", pp. 70-71, 79-80, 84-85, 99-104, 105-09, 115-18.

[82]Rose, pp. 15, 123-124.

[83]*Ibid.*, pp. 16, 122; letter no. 7 to Johannes Sinapius , Ferrara, March 30, 1550 in Morata, " Epistolario ", pp. 63-64.

[84]See letter no. 3 to Chilea Sinapius in Morata, " Epistolario ", pp. 59-61; Aristotle, "Topics " in *Logic*, Book VI, Chapter 13, 158a.

[85]For the translation of her Greek *Carminum* see Bainton, p. 254.

[86] See " Dialogo di Lavinia della Rovere e di Olimpia (1550) in Morata, " Opere ", p.36.

[87]Albert Rabil Jr., *Laura Cereta Quattrocento Humanist,* (Binghamton, New York: Center for Medieval & Early Renaissance Studies, 1981), p.25.

[88]Her Latin, classical in nature, has a complexity, which is not found either in Fedele or Morati's Latin; for a study of her Latin see Rabil, *Laura Cereta,* pp. 113-117. For her proficiency in Greek see letter III to Benedicto Arsago Papiensi in Rabil, *Laura Cereta*, p. 135; letter no. 36 to Michaeli Baeti Physico in Cereta, *Epistolae*, p. 81. For the letters see Tomasini's version; for the oration and additional letters not published by Tomasino, plus summaries of her letters see Rabil, *Laura Cereta,* pp. 118-163, 52-108. Diana Robin translated many of her letters, unfortunately, she leaves out several which were scientific in nature. For Cereta education in the convent see letter no. 59 to Nazaria Olympica in Cereta, pp.145-54; see also Diana Robin, *Laura Cereta: Collected Letters of a Renaissance Feminist,* (Chicago: University of Chicago Press, 1997), pp. 24-27. For learning amongst the sisters of St. Clare see Gabriella Zarri, *Le sante vive: profezie di corte e devozione femminile tra '400 e '500,* (Turin: Rosenberg & Sellier, 1990), pp. 21-22.

[89]See letter no. LIX, November 5, 1486 to Nazaria Olympica entitled " Digest of her own life " in Cereta, *Epistolae,* pp. 148-150. For a translation of the letter and Robin's opinion on Cereta's father as a teacher see Robin, pp.23-29, 52-53; Rabil, 4-5.

[90]See letter No. 69 to Ludovico Cendrata entitled " Lament on the Beginning and Reasons of Military Matters, About The Brescian War and Celestial Portents, dated

March 15, 1486 in Cereta, *Epistolae,* pp. 210-214. Cereta tells us that when twelve years old, she was living at the shore of Lake Iseo, where her father was the prefect and responsible for fortifying the town. While there she observed a celestial portent described in the letter, whether she engaged in such astronomical observation alone, or with her father is not clear from the letter. At twelve, it is most likely she observed it with her father, although it is the I she used in the description. See letter no. 69; Robin, pp.169-174. For the mathematics required for the fortification of towns see A.G. Keller, " Mathematicians, Mechanics and Experimental Machines in Northern Italy in the Sixteenth-Century " in *The Emergence of Science in Western Europe,* Maurice Crossland ed., (New York: Science History Publication, 1976), pp.15-21.

[91]M. Palma, "Cereto, Laura", *D.B.I.* Vol. 23, pp. 729-730.

[92]See letter no. I , June 7, 1486 in Cereta, *Epistolae,* pp. 11-12; Rabil, *Cereta,* p. 74. For her cosmology and astronomy see letters I, XII, XXX, XXXIII, XLII, LV, LVII in Cereta, *Epistolae,* pp. 11-12, 28-32, 62-65, 71-72, 80-81, 89-91, 124-129, 133-137, and letter VII of Rabil, *Cereta,* pp. 142-143.

[93]See letters LV of October 31, 1485, and LVII of October 15, 1485 in Cereta, *Epistolae,* pp. 124-129, 133-137; Rabil, *Cereta,* pp. 63-65. Cereta mentioned and appeared to have used as a source of information for the heavenly bodies' influence over plants a lost work by Xenocrates, a physician of the the first century B.C.. In fact, one of the plants she mentioned, asphondali, cannot be found in the *Herbal of Rufinus*, a common source for the medicinal value of plants during the Middle Ages. It was, however, referred to by Pliny the Elder as having medicinal value, according to Xenocrates. Thus one suspects her actual source might have been Pliny the Elder, *Natural History,* Book 21: 108-110. As Robin points out Pliny the Elder was also Cereta's source of information for the birds in her letter to Deodata di Leno, and for the trees in her letter to Europa Solitaria, see letters LXIII, December 12, 1487 and letter LXX, February 29, 1487/1488 in Cereta, *Epistolae*, pp.168-177, 214-20; Robin, pp.117-128; Pliny the Elder, Book 10: Birds: 3, 25-27, 45, 78, 98, 118-120, Book 16: Wild Trees: 11, 24, Book 15: Fruit Trees: 1-8, 24, 25, 27, 35-38. For information o the medicinal value of all the herbs mentioned by Cereta, excepting asphondili see the *Herbal of Rufinus;* Jacques Andrè, *Être médecin à Rome*, (Paris: Belles Lettres, 1987), p. 217.

[94]For Cereta's astronomical observations in the country see letter XII to Angelo Capello, June 5, 1486; for her use of the astrolabe see letter LV to Alberto de Albertis, October 31, 1485, all in Cereta, *Epistolae,* pp., 29-30, 128; for proof that she observed the heavens herself see letter VIII to Michele Baeto, July 6, 1486 in Rabil, *Cereta,* pp. 142-143.

[95]Siraisi, *Medieval,* pp. 67-68; Siraisi, *Taddeo,* pp.140-143.

[96]For an example of a treatise on the astrolabe see Ignazio Danti, *Trattato dell' uso et della fabbrica dell' Astrolabio di F. Egnatio Danti dell' Or. di S. Domenico con l' aggiunta del Planisfero del Roias,* (Florence: Giunti, 1569).

[97]The Alphonsine Tables contained a table of conversion of the hours, minutes, and seconds, days and sexagesimals of day in degrees; a table of the equation of the days for all the degrees of longitude of the sun; a table to reduce the years in sexagenes, or sixtieth of different order, and a table of the average movement of the stars and of the aux. These tables were for the Toledo Meridian and had to be adjusted for other meridians, see M. Delambre, *Histoire de l' Astronomie du Moyen Age,* (Paris: Coucier, 1819), pp. 251-54.

[98]See letter VIII to Michele Baeto of July 6, 1486 in Rabil, *Cereta,* pp. 142-143. For the position of astrologers at court see Rose, pp. 6-15.

[99]See letters V to Ludovico Leno, her uncle, of July 6, 1485, XXX to Augusto Emilio of February 6, 1487, XXXIII to Giovanni Oliverio of August 1, 1486, XXXVI to Michele Baeto of July 8, 1486, XLII to Friar Thomas in Cereta, *Epistolae,* pp. 20-21, 62-65, 71-72, 80-81, 89-91.

[100]The sun's absolute distance could be computed by Aristarchus eclipse diagram, as fully developed by Hipparchus, and then by Ptolemy in his *Almagest.* The moon's absolute distance could be determined by lunar parallax. Al-Farghãni did not use the method for the sun's distance, but it was given by Peurbach. Of course we do not know whether Cereta was familiar with Peurbach. See James M. Lattis, *Between Copernicus and Galileo: Christopher Clavius and the Collapse of Ptolemaic Cosmology,* (Chicago: University of Chicago Press, 1994), pp.58-59, 77-78; Albert Van Helden, *Measuring the Universe: Cosmic Dimensions from Aristarchus to Halley,* (Chicago: University of Chicago Press, 1985), pp. 6-7,16-20, 28-31, 41-42; Piccolomini, *Sfera del mondo,* p. 55r.

[101]Letter XXX to Augusto Emilio, February 6, 1487 in Cereta, *Epistolae*, p. 63; for Al-Farghãni's assumption see Van Helden, pp.30-31.

[102]Letter LIX, November 5, 1486 to Nazaria Olympia in Cereta, *Epistolae,* p.153.

[103]Letter LXXII to Cardinal Sforza, February 28, 1488 in *Ibid.*, p. 228; Rabil, *Cereta,* pp. 22-23; Ottavio Rossi, *Elogi Historici di Bresciani Illustri*, (Brescia, 1620), p. 200.

[104]For Mondella's reference to Cereta and her brother Daniele see footnote 9 of Rabil's introduction in Rabil, *Cereta*, pp. 30-31; see also Vincenzo Peroni, *Biblioteca Bresciana,* (Brescia, 1818-1823), Vol. I, pp. 250-251, Vol. II, pp. 282-284; Helio Caprieli, *Chronica de rebus Brixionorum,* (Brescia, 1505) , p. V; Rossi, p.200.

[105]Tiziana P. Marangon, " La Miscellania Astrologica del prototipografo Padovano Bartolomeo Valdizoceo e la diffusione di testi astrologici e medici fra i lettori padovani del '400 ", *Quaderni per la storia dell' Università di Padova*, Vol. 11, (1978), pp. 87-106.

[106]Canonici Fachini places her date of birth at 1498, following in the footsteps of Lione Pascoli, who referred to her date of birth at around 1498. However, Danti would have to have been born at least eight to ten years earlier, since in 1498, when her father translated Sacrobosco's *Sphere* from the Latin, she was already old enough to draw advantage from it. See Canonici Fachini, p. 109; Lione Pascoli, *Vite de' Pittori, Scultori, e Architetti*

Perugini, (Roma: Antonio di Rossi, 1732), pp. 75-76; Egnatio Danti, " Proemio " in Giovanni Sacrobosco, *La Sfera di M. Giovanni di Sacrobosco Tradotta da Pier Dante de Rinaldi, con la Annotazioni del medesimo Et con l' aggiunta delle Figure & d' altre Annotazioni,* (Perugia: Rastelli, 1574).

[107]Teodora as well as several of the men were also described as painters, see Pascoli, pp. 23-25, 57-59, 82-83, 137-143, 147-151, 155-156; see also Augusto Oldoini, *Athenaeum Augustum uniquo perusinorum scripto Publice exponantur studio,* (Perugia : Ciani & Residi, 1578) , pp. 283, 314.

[108]See Pier Vincenzo Danti's letter to his mathematics professor Alfonso Alfani in the introduction to Sacrobosco, *La sfera.* Although Danti's translation of Sacrobosco's *Sphere* predated Piccolomini's *Sfera* by forty-two years, it was not published until 1544, therefore Piccolomini's work still remains a pioneer publication of a scientific text adapted or translated into Italian, and destined to the education of women. For dates of publication of Danti's translation, see Oldoini, p.283.

[109]Lattis, p. 6; Sacrobosco, *La Sfera,*, pp. 57, 59.

[110]Sacrobosco, *La Sfera,* pp. 2-5, 11, 17-18; for an explanation of trepidation and the observational errors which gave rise to this phenomenon see Lattis, pp. 71-73, 83-84.

[111]Sacrobosco, *La Sfera,* pp. 31-33.

[112]*Ibid.*, p. 57; Sacrobosco, *Sphere*, pp. 49, 141.

[113]E. Danti, " Proemio " in Sacrobosco, *La Sfera;* Oldoini, pp. 313-314.

[114]Ignazio Danti was supposed to have inherited manuscript material from both his aunt and father. As he made use of some of his father's work in his *Trattato del Radio Latino inventato dal Sig. Latino Orsini,* (Rome, 1583), there is no reason why he should not have used material from his aunt in his *La pespettiva di Euclide nella quale si tratta le cose che per raggi diritti si veggono,* (Florence, 1573), without giving her credit, see Pascoli, pp. 75-79, 147-151; Gio: Battista Vermiglioli, *Biografia degli scrittori Perugini e notizie delle opere loro,* (Perugia: Baduel, 1829), Vol. 1: A-D, pp. 2-3, 366-370.

[115]Pascoli, p.77.

[116]Alessandro Piccolomini, *Lettura del S. Alessandro Piccolomini infiammato, Fatta nell' Accademia degli Infiammati la Domenica prima di febbraio nel XLI,* (Bologna, 1541). For a biographical sketch of sister Fiammetta Frescobaldi see Elissa B. Weaver, " Fiammetta Frescobaldi " in *An Encyclopedia of Continental Women Writers,* Katherine M. Wilson ed. Vol. I: A-K, (New York: Garland Publishing Inc., 1991), pp.426-427; for more detailed information on her life and works see Pierattini, Vol. 56, pp. 101-116, 233-240, Vol. 57, pp. 106-11, 260-269, Vol. 58, pp. 28-38, 74-84, 226-234, 258-268.

[117]Pierattini, Vol. 57, pp. 106-108; Weaver, p. 436; the reasons for writing her work are found in the introduction of Frescobaldi, Suor Fiammetta, " Prato fiorito nel quale come

risplendenti fiori sono poste molte attioni eroiche, ca. 1575" in B.N.F.: *Conventi sopressi,* C.2.504.

[118]See Sister Fiammetta's letter to her brother, Florence May 25, 1568 in Appendix II of Pierattini, Vo. 58, pp. 263-266; for some of her sources see Vol. 57, pp. 108, 264-265.

[119]For Sister Fiammetta's records see A.S.M.N.F.: *Diario dall anno 1575 fino all' anno 1586 e varie memorie, Suor Fiammetta Frescobaldi,* July 7, 1576, November 9, 1577, February 25, 1578 (1579 modern dating); George Sarton, " Early Observations of Sunspots ", *Isis,* Vo. 37, Pts. 1&2, nos. 107 & 108, (May, 1947), pp.69-71; for the invention of the telescope see Drake, pp. 157-162.

[120]A.S.M.N.F.: *Diario,* pp. 111r-123r.

[121]For Lucretia Marcelli's poems see Muzio Manfredi, *Per Donne Romane rime di Diversi Raccolte et dedicate al Signor Giacomo Buoncompagni,* (Bologna: A. Benacci, 1572), pp. 116-120, 235-238; the verse from the second poem refers to her studies in astrology. For Gambara see poems 23, 43, 54, 65 in Vittoria Gambara, *Le Rime*, Alan Bullock, ed., Italian Medieval and Renaissance Studies, 6, (Florence: Olschki, 1995), pp. 81, 104, 123, 166.

[122]See Matraini and Colonna's poems in Luisa Bergalli, *Componimenti Poetici delle piu illustri Rimatrici d' ogni secolo raccolti da Luisa Bergalli,*(Venice: Amore, 1726) , Vol. I, pp. 36-40, 167-176.

[123]Fonte, *Il Merito...*, Chemello ed., pp. 81-83; Pliny, Book II: " Cosmology, 4: 21-14, 6: 46-47, 17: 81, 42: 111, 60: 150-153, 99: 212-219, 100: 219, 101: 220, 102: 221; Gio: Nicolò Doglioni, *L' anno dove si ha perfetto et pieno raguagliodi quanto può ciascun desiderare, si d' intorno alle cose del moto celeste, et elementare, come d' intorno à quelle de' tempi et del calendario. Et insegna anco à sapere le Feste mobili e il fà della Luna perfetamente secondo la reforma gregoriana,* (Venice: Rampezeto, 1587), pp. 1v, 4r-6v, 10r-11v, 23r, 48v.

[124]See Doglioni's biography of Fonte in Fonte, *Il Merito...*, Chemello ed., pp. 6-9; for the encyclopedic approach to knowledge of both uncle and niece see Kolsky, pp. 80-81.

[125]Margherita Sarrocchi, *La Scanderbeide poema Heroico della Signora Margherita Sarrocchi, Dedicato all' Illma. ed Eccma Sig. D. Costanza Colonna Sforza, Marchesa di Caravaggio con privilegio per Anni XX,* (Rome: Levido Eacri, 1606); Giovanni Vittorio Rossi, *Janii Nicii Erythraei Pinacotheca imaginum illustrium doctrinae vel ingenii laude qui auctore superstite obierunt, editio nova,* (Leipzig: T. Futsch, 1712), p 260; Ugo Baldini, Pier Daniele Napoletani, " Per una biografia di Luca Valerio. Fonti edite e inedite per una ricostruzione della sua carriera scientifica ", *Bollettino di storia delle scienze matematiche*, Anno XI, no. 1, (June, 1991), pp.59-60.

[126]*Scanderbeide,* (1606), canto terzo, stanzas 1, 34, 81, 88, canto settimo, stanza 12, canto nono, stanza 7, canto 12, stanza 61.

[127]Sarrocchi is another proof that in some Italian convents there were highly educated nuns, such as Frescobaldi, who could then teach their boarding students far more than the contents of sacred books. See Bartholomaei Chioccarelli, " Illustres scriptores regni Napoletani " in Baldini and Napoletani, pp. 135-136, 141-142; Zarri, pp. 21-22.

[128]For a biography of Luca Valerio see Baldini and Napoletani, pp. 12-16, 59-69; see letter 217 of Valerio to Galileo , April 14, 1609 in Galileo Galilei, *Le Opere,* Edizione Nazionale, (Florence: Barbera, 1900), Vol. X, p. 241. Galileo became engaged on a detailed analysis of the parabolic projectile trajectory in 1608, see Drake , p. 119. For Galileo's lemma on the parabola see day 2 Galileo Galilei, *Discorsi e dimostrazioni matematiche intorno a Due Nuove Scienze*, Adriano Cerugo e Ludovigo Geymond,eds., (Turin: Boringheri, 1958), pp. 156-159.

[129]Margaret E. Baron, *The Origins of the Infinitesimal Calculus,* (New York: Dover Publications, 1969), pp. 101-107; for a more detailed explanation of Valerio's mathematics see Daniele Napoletani, " Metodo e statica in Valerio con edizione di due opere giovanili ", *Bollettino di storia delle scieze matematiche*, Anno II, no. 1 (giugno 1982), pp. 46-69.

[130]Napoletani, pp. 46-69.

[131]Baldini and Napoletani, pp. 70-72, 136, 141.

[132]Aristotelean natural philosophers held that a body moved either naturally (for the sublunar region, up and down), or by force. Thus for forced motion once the impressed force was overcome, the projectile would fall straight down to earth, not in a parabolic path, see letter 221 of Luca Valerio to Galileo of May 29, 1609 in Galileo, *Le Opere,* Vol. X, pp. 244-245; Drake, pp. 58-69, 108-110.

[133]To Galileo, bodies denser than water floated because they rested below the surface of the surrounding water, in a little depressed region containing not just the body, but also air. The phenomenon of surface tension was to be analysed only in the eighteenth-century. See Galileo Galilei, " Discorso intorno alle cose che stanno in su l' acqua " in *Opere,* Arrigo Pacchi ed., (Naples: Rossi, 1969), pp. 69-169; Drake, pp. 164-167; see letter 696 of Sarrocchi to Galileo of June 9, 1612, letter 746 of Valerio to Galileo, August 23, 1612 in Galilei, *Opere,* Ediz. Naz., Vol. XI, pp. 324, 380-81; Baldini and Napoletani, p.52.

[134]See Notae in consessu Lynceorum exceptae Anno 1616 24 Martii in Galilei, *Opere,* Ediz. Naz., Vol. XIX, pp. 267-68; for a translation see Baldini and Napoletani, pp. 12-21, 121n.

[135]Letter 321 of Valerio to Galileo of May 29, 1610 in Galilei, *Opere,* Ediz. Naz., Vol.X, pp. 362-63; Drake, pp. 134-35.

[136]Letter 469 of Valerio to Galileo of January 28, 1611 in Galilei, *Opere*, Ediz. Naz., Vol. XI, p.37.

[137]Letter 574 of Sarrocchi to Guido Bettoli of August 27, 1611 in Galilei, *Opere*, Ediz. Naz., Vol. XI, pp. 177-78; see "Avvisi di Roma " for April 16, 1611 in J.A.F. Orbaan ed., *Documenti sul Barocco in Roma*, (Rome: Società alla Biblioteca Valliscelliana, 1920), p. 283.

[138]Letters 833 of Galileo to Federico Cesi of January 25, 1613, and 919 of Valerio, August 31, 1613 in Galilei, *Opere*, Ediz. Naz., Vol. XI, pp. 465-67, 559-60; Galilei, " Discorso intorno alle cose...", T. I, pp. 70-71; Drake, pp. 155-62.

[139]Letters 321: May 9, 1610, 396: September, 1610, 415: October 23, 1610 in Galilei, *Opere*, Ediz. Naz., Vol. X, pp. 362, 434, 452; letters 469: January 28, 1611, 531: May 20, 1611, 565: July 30, 1611, 574: August 27, 1611, 575: August 27, 1611, 604: November 11, 1611, 643: January 13, 1612, 696: June 9, 1612, 919: August 31, 1613 in *Ibid.*, Vol. XI, pp. 37, 104, 166, 177, 178, 206-07, 231-32, 261-62, 324, 360; see also Sarrochi to Galileo of October 12, 1611 in Carlo Arduini ed., *La primogenita di Galileo Galilei rivelato dalle sue lettere*, (Florence: LeMonnier, 1864), pp. 590-91.

[140]For reference to her academy and Valerio's Lincei membership see letters 643 and 695 in Galilei, *Opere*, Vol. XI, pp. 262, 323; for her fame as a learned woman see Julius Caesar Capacius, " Magarita Sarrocchia " in *Illustrium mullierum et Illustrium Letteris Virorum Elogia*, (Naples: Carlinum et Vitalem, 1608), p. 203; Rossi, pp. 259-61; Chiccarelli, pp. 135-36; " Mortuorum Liber Ecclesiae Sanctissimi Salvatoris In Suburra regionis Montium Ab anno 1616 mense Iulio Rectore Hyppolyto Strada. Atto di morte di Margherita Sarrocchi " in Baldini and Napoletani, p. 124; see also Bettoli's letter to Sarrocchi of June 4, 1611 in Favaro, pp. 575-576.

[141]For an analysis of the Academy of Lincei see Olmi, *L' Inventario del mondo*; Mario Biagioli, " Knowledge, Freedom, and Brotherly Love: Homosociality and the Accademia dei Lincei ", *Configurations*, (1995), Vol. 2, pp. 139-166; Gabrieli felt Galileo had a part to play in Valerio's admittance to the Lincei, see Giuseppe Gabrieli, " Luca Valerio Linceo e un episodio memorabile della vecchia Accademia", *Rendiconti della Accademia dei Lincei: Classe di Scienze Morali*, serie 6, Vol. (, (1933), pp. 698-99; Baldini and Napoletani, pp. 51-52.

[142]For the blame placed on Sarrocchi for Valerio's withdrawal from the academy see letter 753 of Ludovico Cardi da Cigoli to Galileo of August 31, 1612 in Galilei, *Opere*, Ediz. Naz., Vol. XI, p. 387. and letter of Cesi to Faber of November 6, 1617 in Baldini and Napoletani, p. 121; Galileo did not care for Torquato Tasso and his epic *Gerusalemme liberata*, which influenced Sarrocchi's *Scanderbeide*, see Baldini and Napoletani, p. 68 and " Considerazioni sul Tasso " in Galilei , *Opere*, Ediz. Naz., Vol. X; Rossi, pp. 260-61; for Valerio's reasons for leaving the academy see " Notae in consessu..." in *Ibid.*,Vol. XIX, pp. 267-68.

[143]Letters 579: September 10, 1611, 636: January 13, 1612, 696: June 9, 1612 in Galilei, *Opere*, Ediz. Naz., Vol. XI, pp. 206-07, 256, 261-62, 324; see also letters of July 29, 1611, October 12, 1611, and October 15, 1611 in Arduini, pp. 586-88, 590-92; for

Galileo's experiments see Drake, pp. 9-31, 83-129; Galilei, " Discorsi intorno alle cose...", pp. 69-169.

[144]Baldini and Napoletani, pp. 8, 134; for the status of mathematicians in Italy see Mario Biagioli, " The Social Status of Italian Mathematicians ", *History of Science*, Vo. 27, part 1, no. 75 (March 1989), pp. 41-95.

[145] Vincenzo was to marry into an important Florentine family, see letter XXXIV in Viviani della Robbia, pp. xi-xviii, 38-39.

[146]For Galileo's description of his eldest daughter see letter CCXVII of Galileo to Elia Diodati of July 22, 1634, the time of her death in Galileo Galilei, *Epistolario*, (Livorno: F. Vigo, 1872), Vol. II, pp. 107-08; Aggiunti's letter to Galileo, and Maria Celeste's letter XII to her father of November 21, 1623 in Viviani della Robia, pp. xliv, 12.

[147]Drake, pp. 180, 183.

[148]Galileo Galilei, *Il Saggiatore*, Libero Sosio ed., (Milan: Feltrinelli, 1965), pp. 34-36, 148-150, 154-59, 175, 216-20; letter LI of Maria Celeste to father, October 18, 1630 in Viviani della Robbia, p. 64.

[149]Letters XLII of January 29, 1629 (1630), XLIII of February 19, 1629, and LIII of Day of the Dead, 1630 of Maria Celeste to father, Viviani della Robbia, pp. 51-52, 54, 69; Mario Rosa, " The Nun " in *Baroque Personae*, Rosario Villari ed., (Chicago: University of Chicago Press, 1995), pp. 199-200; for Galileo's work with clocks see Edoardo Proverbio, " Galileo e il problema della misura del tempo " in *Novità celesti e crisi del sapere. Atti del Convegno Internazionale di Studi Galileiani*, P. Galluzzi ed. (Florence: Giunti Barbera, 1984), pp. 63-72.

[150]The convent was financially strapped, and Galileo was generous towards it on many occasions. Galileo also bought a property at Arcetri so he could be close to his daughters. He did also many personal favours to the sisters, see " Memoriale di Suor Maria Celeste", and letter XII to her father; for an example of the many favours he did to the sisters see letter XCIV of June 18, 1633; for the joy experienced by the sisters after his release from Rome and placed into house-arrest in Siena see letters XCVII of July 13, 1633, and CVII of September 3, 1633, all in Viviani della Robbia, pp. 13-17, 124-27, 130, 149-51.

[151]Letters LII: October 28, 1630, LIII : November 2, 1630, LXXVII: February 26, 1632, LXXVIII: March 5, 1632, LXXIX: March 12, 1633, LXXXI: April 9, 1633, LXXXIII: April 16, 1633, LXXXVI: April 30, 1633, LXXXVIII: May 7, 1633, LXXXIX: May 14, 1633, XCVII: July 13, 1633, XCIX: July 23, 1633, CXI: October 3, 1633, CXII: October 8, 1633 in Viviani della Robbia, pp. 65, 68-69, 96-99, 99-101, 101-03, 105-06, 107-08, 111-12, 113-15, 116-18, 130-32, 133-35, 159-61, 175-76; for what Galileo was writing while at Siena see Drake, pp. 207-08.

[152]Letizia Panizza, " Introductory essay " in Tarabotti, *Che le donne siano delle spezie degli uomini*, pp. vii-xxxv; Francesca Medioli, " Introduzione " and " Chiavi di lettura "

in Arcangela Tarabotti, *L' inferno monacale,* F. Medioli, ed., (Turin: Rosenberg & Sellier, 1990), pp. 9-15, 11-174; for the Academy of the Incogniti see Spini, pp. 149-259.

[153]Panizza, p. x; Tarabotti, *Che le donne...*, p. 11, 11n.

[154]For natural history in the Middle Ages see Jerry Stannard, " Natural History ' in *Science in the Middle Ages,* David C. Lindberg ed., (Chicago: University of Chicago Press, 1970), pp. 429-460; for the changing uses of Pliny's *Natural History* see Nauert, Jr., pp. 72-85; for Cereta see letters LXIII of December 12, 1487 to Deodata Leno and LXX of February 29, 1487 to Europa Solitaria in Cereta, *Epistolae,* pp.168-77, 214-20; Robin, pp. 114-128.

[155]For the rise of the museum, botanical gardens, and the teaching of natural history in Italy see Findlen, *Possessing Nature,* pp. 48-150, 241-287; Olmi, *L' inventario...*, pp. 255-313; Nauert Jr., p. 76; Pattaro, pp. 58-59, 152; Dario A. Franchini et al., *La scienza a corte. Collezionismo eclettico, natura e invenzione a Mantova fra Rinascimento e Manierismo,* (Rome: Bulzoni, 1979), pp. 8-86, 127-136.

[156]Olmi, p. 256; Franchini, pp. 86-90, 127-136; C. Malcolm Brown, " 'Lo insaciabile desiderio nostro di cose antiche': New Documents on Isabella D' Este's Collection of Antiquities" in *Cultural Aspects of the Italian Renaissance. Essays in Honour of Paul Oskar Kristeller,* Cecil H. Clough ed., (Manchester: Manchester University Press, 1976), pp. 325-353.

[157]B.U.B. *Aldrovandi* Ms. 35, XXII: Lettera di Ulisse Aldrovandi a Mons. Teseo Aldrovandi sopra i vari affari domestici, Bologna, May 29, 1576 (copy), pp. 203v-204r; B.U.B. *Aldrovandi*, Ms. 110-I: Catalogus virorum qui musaeum nostrum et manu propria, pp. 43, 224, 332, II: Catalogus virorum qui visitarunt musaeum et propio chyrograpo se subscripserunt in Liris musaei, juxta ordinem, locorum, oppidorum, civitatem et regionem, ubi nati sunt, pp. 224-332, III: catalogus virorum qui nostra studia adjuvant; Paula Findlen, " Courting Nature " in *Cultures of Natural History*, pp. 66-67.

[158]Very little is known of Ippolita Paleotti, see Giovanni Fantuzzi, *Notizie degli scrittori bolognesi,* (Bologna: Tommaso d' Aquino, 1782-1788), Vol. VI, p. 259; Maria Bandi Buti ed., *Poetesse e scrittrici*, (Rome: Istituto editoriale italiano, 1942), Vol . II, p. 104; Giulio Giacoboni, *Hippolytam Paleottam Crassam Julii Jacoboni Panegyricus,* (Bologna: J. Rossium, 1581). For Andreini see Stanley Longman, " Isabella Andreini " in *An Encyclopedia of Continetal Women Writers,* Vol.I, pp. 38-39; L. Pannella, " Candi, Isabella " *D.B.I.,* Vol. 17, pp. ; for the differences between Aldrovandi's *studiolo* and museum see Findlen, *Possessing Nature...*, pp. 108-146; Olmi, pp. 91-98.

[159]Tugnoli Pattaro, p. 152; Olmi, pp. 61-91.

[160]See B.U.B. *Aldrovandi* Ms. 96: "Ulysiss Aldrovandi Lexicon rerum inanimetarum ", all five volumes, but particularly Vol. V, pp. 16r-29r, 550r.; Aldrovandi's will is found in G. Fantuzzi, *Memorie della vita di Ulisse Aldrovandi, medico e filosofo*, (Bologna: L. dalla Volpe, 1774), pp. 69-73.

[161]See introduction by Fontana, and body of Ulisse Aldrovandi, *De Reliquis Animalibus exanguibus libri quator, post mortem eius editi. Nempe De mollibus, crustaceis, testaceis, et zoophytis. Ad illustrisssimum Senatum Bononiesem,* (Bologna: Battista Bella Gamba, 1606); Franchini et al., p. 14; Fantuzzi, *Memorie* ..., p. 69.

[162]Tarabotti, *Che le donne siano...,* " Disinganni 16, 49, 54, 27, 20, 7 ", pp. 26, 78, 91, 44, 31-32, 14 respectively; Pliny , Books IX: 5-6, 98-99, XI: 25-26; Basileo di Cesarea, *Sulla Genesi (Omelie all' esamerone),* Mario Laldini, ed. (Redazione Lorenzo Valla, 1990), Omelie VII: 3-7, VIII: 7-6, IX: 5, 6-11.; Medioli, " Strumenti culturali...", pp.137-43.

[163]Fonte, pp. 92-95; Pliny, Book X: paragraphs 15 (raven), 22-24 (peacock), 2 (phoenix), 3-4 (eagle), 32 (swan), 34 (swallow).

[164]Fonte, pp. 92-95; Pliny, Book IX, paragraphs, 3, 7-9, 27, 41, 42, 43, 45, 49, 51, 67.

[165]Fonte, pp. 104-106; Pliny, Book VIII: 19, 25, 34, 54, 61, 65, 70.

[166]Fonte, pp. 97-99, 101-103; Pliny, Book II: 100-110, Book III: 19-24.

[167]Medioli, " Strumenti culturali...", p. 140.

Chapter IV

Women as Patrons of Sciences

Londa Schiebinger in *The Mind Has No Sex* has emphasized the role aristocratic women played as patrons of men of science, and as consumers of scientific knowledge. The resources, which aristocratic women had at their disposal, enabled them to exchange their patronage, or public recognition, for tutoring from men of lesser rank, but with scientific knowledge to impart. Schiebinger referred to aristocratic European women in general, who lived in the seventeenth and eighteenth centuries.[1] On the whole, it may be said that wealth, social position, and an interest in science determined whether women became patrons in Italy to their favorite natural philosophers. As seen in chapter three, there were women patrons with an interest in science prior to the seventeenth century. Isabella d' Este acted as patron to the men who helped her expand her collection of *artificialia* and *naturalia*. Natural philosophers, attending Veronica Gambara's academy, discussed natural philosophy therein in exchange for her patronage. Caterina Sforza's visit with her entourage to Aldrovandi's natural history museum added prestige to both Aldrovandi and his collection, and served to portray her as a woman of some learning in natural history. Margherita Sarrocchi could offer the relatively poor, but brilliant mathematician, Luca Valerio, her material resources in exchange for his tutoring in advanced mathematics. She also used her social prestige to initially defend Galileo's astronomical discoveries from attacks from skeptics.[2]

In the second half of the seventeenth-century, the first woman to receive a degree in philosophy from the University of Padua, Elena Piscopia, used her European-wide fame

not to promote her own philosophical writing, but the work of her own mathematics' teacher, Carlo Renaldini; and Princess Maria Mancini Colonna's astrology teacher, Giuseppe Terzi, was given a position in her brother's household in France, most likely, in exchange for the tutoring he had rendered her.[3] This pattern of exchange between women patrons and men of science was to continue into the first half of the nineteenth-century. Women patrons would aid natural philosophers politically in their acquisition of government-controlled positions, and/or financially, through gifts. In exchange, the women, usually excluded from university degrees and positions, and from memberships in scientific academies, would get the men they patronized to teach them, or/and join them in their *conversazioni*, or academies they had founded. As a group, patrons were also more likely to be affected by fashions in science. Thus, women patrons, who were active in the first half of the eighteenth century, demonstrated an interest in Cartesian and Newtonian natural philosophy, and on the Newtonian-Leibnizian debate on live forces; whereas those women active in the late 1700s and early 1800s appeared to have been mostly interested in natural history and its branches, botany, minerology and zoology, as well as in Lavoisierian chemistry and meteorology.

Women's approach to patronage changed from earlier times to reflect the changes that occurred in the sciences, as well as the sciences increased popularity in the eighteenth century. As methods of experimentation and observation came to dominate scientific studies from the seventeenth century onwards, particularly in the eighteenth century, women patrons were more willing than in the past to engage in their own experiments and observations. As the sciences increased in popularity in the eighteenth century, the number of women who engaged in some form of patronage also increased.

Their numbers would decrease following the collapse of the Napoleonic Empire, when the elite's interest would be directed not towards the sciences, but towards the unification of Italy. Although some women patrons were very knowledgeable in specific scientific fields, on the whole, of the activities carried by women, scientific patronage required the least specialization in the sciences on the part of those who undertook them.

Surviving records indicate that not a negligible number of elite women organized *conversazioni*, or salons in the eighteenth and early nineteenth centuries which were attended by natural philosophers. These men bothered to attend such gatherings because they came to realize that if the ladies who ran them were powerless to attend university courses, they had, nevertheless, the financial and political power to assist those who befriended them. In a 1766 letter to the Swiss naturalist Charles Bonnet, the naturalist Lazzaro Spallanzani referred to the fact that not a man's merit, but Venetian ladies determined who was to become a lecturer at the University of Padua (the Republic of Venice's university). Examples of women organizing *conversazioni*, which were attended by natural philosophers, exist not only for Venice, but for Naples, Padua, Siena, Bologna, Milan and other towns. For instance the Duchess of Limatola, learned in the science of metaphysics, ran such a gathering in Naples, as referred to by Paolo Mattia Doria in his *Ragionamenti* of 1716. The mother of the naturalist Alberto Fortis (1741-1803), Countess Francesca Capodilista, had her *conversazioni* in Padua attended by natural philosophers and physicians associated with the University of Padua, such as Giuseppe Toaldo, Giovanni Arduino, Leopoldo Caldani, and Antonio Vallisneri Jr. Whereas the Marchioness Elisabetta Ratta, partial to Newtonian philosophy, had her

Bolognese salon attended, at least by another Newtonian, Francesco Maria Zanotti, Secretary of the Academy of Sciences of Bologna.[4]

As women patrons, as a rule, left few records of their activities behind them, it is often impossible to know, with a few exceptions, what scientific topics might have been discussed in their *conversazioni*, or even how they bestowed their patronage. Thus the women to be discussed below will be those of whom some records survive of their relationship with established natural philosophers. Furthermore, the examples of Laura Bentivoglio Davia, Clelia Grillo Borromeo, Faustina Pignatelli, Isabella Teotochi Albrizzi and a few others serve to illustrate that in the mechanism of exchange which existed between women patrons and male natural philosophers, the women were more in need of the established natural philosopher, than the other way around. A natural philosopher with an established scientific reputation would enhance the prestige of the *conversazioni* he chose to attend, as well as the learning of the women who ran them. Whereas, if one leaves off financial rewards, women patrons were likely to be most needed when the natural philosopher was launching his career. The first woman patron to be considered is Laura Bentivoglio Davia (1689-1766), a descendent of the Bentivoglios, the old lords of Bologna during the Renaissance.

I. *Laura Bentivoglio Davia as a Patron to Physician Giovanni Bianchi*

Laura Bentivoglio Davia was the subject of considerable gossip in Bologna due to her marriage, against her parents wishes, to the Marquis Francesco Davia, her cousin on their mothers' side, but coming from a recently enobled family. The marriage turned out to be an unhappy one due to the husband's strange character, and dissipate life, so much

so that Bentivoglio Davia attempted to divorce her husband, with the approval of her parents. A separation was agreed to, and Bentivoglio Davia and her children went to live in Rimini with her husband's uncle, the scientifically learned Cardinal Giovanni Antonio Davia, Archbishop of Rimini.[5]

In Rimini, the Cardinal had founded an academy in the episcopal residence, directed by A. Leprotti, the Cardinal's physician and professor of philosophy at the Rimini Seminary, and attended by the town's most learned men. Bentivoglio Davia, residing at the palace, and keeping house for her uncle-in-law, could not but be part of the academy, if only in an informal way. In fact, her initial studies in natural philosophy and mathematics can be traced to that period of residence at Rimini, where she had as teachers first Antonio Leprotti, and then the physician Giovanni Bianchi (1693-1775).[6] Her knowledge of languages like German, French and, apparently, Latin, most certainly predated her arrival at Rimini, and would facilitate her study of natural philosophy and mathematics, and increase the willingness of physicians and natural philosophers to teach them to her.[7]

What Leprotti and Bianchi actually taught Bentivoglio Davia is far more difficult to surmise, firstly, because Bentivoglio Davia was not to publish anything remotely scientific, and secondly, because there was, it appears, a real attempt on her part to aggrandize herself, in view of the rapid rise to fame of a truly learned bourgeois lady, Laura Bassi. The latter was to receive in 1732 a degree in philosophy at the University of Bologna, a lectureship at the university, and a membership at Bologna's Academy of Sciences. A membership to the same academy was also offered in 1732 to another learned lady, the Neapolitan, Princess of Colobrano, Faustina Pignatelli. Bentivoglio

Davia, perhaps desirious of achieving similar status within the academy, as shall be seen, tried hard to convince the learned of Bologna of her own learning.

As a Newtonian, Leprotti might have introduced Bentivoglio Davia to Newtonian philosophy, through a reading of Newton's *Opticks*, available in the Cardinal's library in the original English, and in the 1722 French version. It appears, however, that at the time of Leprotti's stay in Rimini, the marchioness probably did not have the mathematical background to fully appreciate the *Opticks*, and consequently, the far more mathematically complex *Principia Mathematica* by Newton would have been decidedly out of her reach. This assumption is based on the fact that several years later, in 1726, after having learned, what might have been very elementary algebra from Francesco Zanotti, Bentivoglio Davia asked Bianchi to return to her Eustachio's Manfredi's version of the *Elements of Euclid*, which he had been copying, and which she wanted to study. The Cardinal had two manuscripts by Eustachio Manfredi in his library: one called the *Elements of Geometry*, and another called the *Elements of Geometry, Plane Trigonometry, and Logarithms.* It is difficult to know to which manuscript Bentivoglio Davia was referring. Even if it were the *Elements of Geometry, Plane Trigonometry, and Logarithms*, the work was essentially a basic text of elementary geometry and trigonometry for students with no background on the subject, as it appeared in its published form in 1755.[8]

The fact that Bentivoglio Davia was only at the beginner's level in mathematics at the time of her return to Bologna in 1726, leads one to question how much truth there was in studies' certificate provided by Giovanni Bianchi to the marchioness, at her request, particularly since Bianchi himself might have borrowed the Manfredi manuscript for his

own use. The duly notarized certificate listed the subjects Bentivoglio Davia was supposed to have studied under Bianchi's tutorship, while she resided in Rimini, such as universal philosophy, logic, metaphysics, physics, ethic and geometry. However, while studying medicine at Bologna, Bianchi had admitted to Leprotti his own ignorance, and little understanding of the mathematical arguments undertaken by Francesco Zanotti, Rondelli, and Castelvetri in their lectures, in spite of his best efforts. By 1730, he seemed to have improved his mathematical skills, but, as Fabi points out, his forays into astronomy were entirely descriptive, and remained mediocre, as compared to his work in anatomy, and natural history.[9] Therefore, how could Bianchi have instructed Bentivoglio Davia in anything, but the most elementary geometry, for as seen, he had little knowledge of the subject himself to enable him to teach it to others. At best, it could be said that they attempted to learn the *Elements* of Euclid together, as might be indicated by a 1724 poem by Zanotti dedicated to Bentivoglio Davia, which referred to her studying the squaring of the circle. But one suspects that the marchioness might have made more progress in mathematics only after her return to Bologna, when she came under the guidance of someone like Francesco Zanotti, whose understanding of the subject, by Bianchi's own admission, was, and would remain, far superior to his own.[10]

Much praise was thrusted upon aristocratic women by learned men of inferior social status, who found benefit in the exercise. Without any works remaining from women like Bentivoglio Davia, whence one can accurately assess their knowledge, what they really studied and learned remains speculative. But, perhaps, it is reasonable , if not generous, to say that by 1744, when abbot G.M. Ortes sent Bentivoglio Davia his biography of the mathematician Guido Grandi, she had learned enough mathematics to

understand and to appreciate, as she herself stated, Grandi's mathematical works, including his *Quadratura circuli et hyperbolae* (1703), the first published work in Italy in which infinitesimal calculus made its appearance.[11]

It is impossible to know with any certainty what was covered by Bianchi and studied by Bentivoglio Davia, under the general mantle of universal philosophy, logic, physics and metaphysics, as stated in the certificate. As already seen, at the time neither of them had the mathematical skill to understand the subtleties of Newton's *Mathematical Principles of Natural Philosophy*, except in its most descriptive terms. In fact, unlike Leprotti, they then rejected Newton's philosophical system. In a letter to Leprotti from 1725, Bianchi could not accept, nor understand, Newton's planetary attractions. To him, Descartes system of vortices, although defective in some points, was the best suited to explain natural phenomena, unlike the most obscure and defective hypothesis of Newton. Either of her own accord, or influenced by Bianchi, Bentivoglio Davia did not care also for Newton's doctrine of attraction, in any context. In the 1724 poem already mentioned, Zanotti referred to her as a Cartesian; and in a letter from 1726 in which she compared Lucretius with Descartes, Bentivoglio Davia stressed the efforts the latter philosopher had made in order to demonstrate the divine essence: as far as she was concerned, a Cartesian could never be accused of atheism.[12]

It is quite possible also that the marchioness was familiar with Descartes'*Principles of Philosophy*, a book which, as seen in chapter one, contained very few mathematical formulations, and which presented in a summary way the Cartesian concept of light. However, her questions addressed to Bianchi in 1732 and 1733 on the phenomenon of light, and Bianchi's answer to these questions, raises doubts as to how familiar she truly

was with the different philosophers' concept of light. Bentivoglio Davia appeared to have had no knowledge of--or at least had forgotten--the Cartesian, Fermatian, and Newtonian explanations for refraction, Snel's sine law of refraction, or even Aristotle's definition of what was light; these explanations were provided by Bianchi in 1732 and 1733. Therefore, it could be said that, if the marchioness might perhaps have skimmed over Descartes' *Principles of Philosophy*, available in the Davia library, she certainly appeared ignorant of Descartes'*Dioptrics*, where Snel's law was published for the first time, and the Cartesian explanation for refraction appeared, and of Newton's *Opticks*, where again both the law, and the Newtonian concept of refraction were explained.[13]

Ultimately, Bianchi was dissatisfied with both the Cartesian and Newtonian explanations as to why when light moved from a lighter to a denser medium its rays approached the perpendicular; but as far as he was concerned, these explanations did not matter. What mattered was to know what was refraction and its law. This approach was good enough to Bentivoglio Davia, who could only add that she had never been really satisfied with Descartes concept of light as pressure, or Newton's one of light as a corpuscule. Thus, it appears that Bentivoglio Davia was a Cartesian in so far as Bianchi was a Cartesian, and no further. This complete confidence on her part of Bianchi's opinions is apparent in her lack of constructive criticism of any of his works, which, in truth, might have been motivated by politeness, rather than by a genuine belief in their value. But her faith in her ex-teacher is never more evident than in the fact that Bentivoglio Davia was willing to abide by Bianchi's medical advices regarding her health, above those of all other physicians, who unlike him had examined her, and therefore were more aware of her true conditions than he was.[14]

It can not be denied that the marchioness always turned to Bianchi when an explanation of a new, or unusual phenomenon was required, even when this phenomenon was beyond his area of specialization, and/or there were others in Bologna more qualified to answer it. For instance, in 1750, Bentivoglio Davia asked Bianchi to explain the sparks and fire which were detected when socks worn together were separated.[15] It appears that Bianchi's only work which made passing reference to bodies electrified by rubbing was the one discussing the aurora borealis, published in 1741. The explanation he provided was not original, but was taken in large part from the *Philosophical Transactions*.

In Bologna, Giuseppe Veratti, in possession of an electrical machine, had published a work on the effectiveness of electric therapy, which also dealt with the physical properties of electricity. His wife, Laura Bassi, in a dissertation presented to the Academy of Sciences, made reference to the fact that pointed objects attracted electricity, a conclusion Bassi had arrived at, after investigating the physical propertied of electricity together with her husband. Either Veratti, or Bassi would have been more suitable candidates to ask questions on electricity by 1750 than Bianchi, particularly in view of the fact that Bentivoglio Davia was acquainted with the couple.[16] But it would have been unthinkable, and tantamount to admitting defeat for the marchioness to ask explanations in matters dealing with natural philosophy from Laura Bassi. To understand why Bentivoglio Davia could not have asked Bassi for an explanation of the electrified socks, one has to be aware of the former's reaction to the town's official recognition of the latter's learning.

Even before her return to Bologna, Bentivoglio Davia appeared to have been acknowledged as a learned lady by men like Francesco Maria Zanotti, the Academy of Sciences of Bologna secretary. Her lessons in mathematics with Zanotti, and her visit to the Institute of Sciences to hear dissertations by doctors G.B. Beccari and Giuseppe Monti re-enforced this image; as did the fact that, apparently, she set up some kind of informal literary salon amongst friends, where Bianchi's works in literature, medicine, or natural philosophy would be discussed.[17]

But Bentivoglio Davia's position as a learned lady in Bologna was decidedly downgraded, when the government officially recognized Laura Bassi as truly learned by bestowing on her a degree in philosophy, a position of lecturer on the subject at the university, and a membership at the academy of sciences, after the latter had successfully , and publicly, defended two sets of theses to achieve these awards. Matters were made worse by the fact that Gaetano Tacconi, Bassi's teacher, had been dismissive of Bentivoglio Davia's philosophical studies under Bianchi, whom he had reasons to dislike, after the latter had accused him in print of being a beginner, and a thief, over an anatomical dispute.[18]

With the sole exception of Leprotti, as expected, the Bentivoglio Davia camp reacted negatively to Bassi's achievements: Cardinal Davia called them unnecessary displays of public vanity; Bianchi was contemptuous of Bassi's theses, and Bentivoglio Davia referred to Bassi's degree as ridiculous. Furthermore, she added that as Bassi's teacher had given women permission to speak, she now could also speak of her studies, whereas before she had kept silent.[19] It appears that the marchioness followed through with her intent because the greatest activity of her *conversazioni* can be traced to 1732 and after.

For instance, Bentivoglio Davia's interest on the phenomenon of light dated from June 1732 to July 1733, after Bassi had demonstrated in her defence of her theses knowledge, and preference for Newton's theory of light and colours; and had investigated with others several of Newton's experiments described in his *Opticks*. Apparently, Bentivoglio Davia had shown no interest in the phenomenon of light in 1727-1728, when Francesco Algarotti had successfully repeated, for the first time in Italy, several of Newton's optical experiments at the Institute; experiments which were to garner him considerable fame.[20] Her resentment towards Bassi might have been made worse by the fact that Bianchi, who was initially hostile, later actively sought Bassi's correspondence and friendship; and his contempt for Bassi's first set of thesis turned into praise of the ability she demonstrated in public disputations in anatomy.[21]

Even Bentivoglio Davia's request to Bianchi of a certificate of studies in 1736 has to be understood in the context of her rivalry with Bassi. The contents of the certificate, already mentioned, seemed to indicate that Bentivoglio Davia had followed, under Bianchi, the equivalent of a course which would have led to an university degree in philosophy. The theses Bassi defended in order to receive her degree were in logic, physics, metaphysics, and on the nature of the mind, or soul. In general terms, her theses were not dissimilar to what Bentivoglio Davia was supposed to have studied. But, as seen, there are some doubts as to how much geometry and physics she could have studied under Bianchi. A similar doubt could also be cast on how deeply had she really studied the other subjects mentioned in the certificate. Such doubts would not arise, if Bentivoglio Davia had not tried so hard to enhance her reputation as a learned lady in Bologna only after Bassi's degree, and after the works in mathematics, and mechanics of

another lady, Faustina Pignatelli--also a member of the academy of sciences since 1732--were read at the academy in 1732 and 1736, respectively.

Apparently, the certificate did not achieve the desired results, particularly if its true intent was to make her a member of the academy of sciences, like the other two ladies. Her failure to be taken seriously as a learned lady by those who might have promoted her admittance to the academy of sciences is illustrative of the inherent unfairness of a system, which did not really discourage higher education for women, but promoted it in an haphazard way. Depending on the families,and/or instructors, some women would receive an education at par with men, whereas others would receive only a simplified version of what men studied. The marchioness might have thought herself a learned lady, and to a great extent she was, if compared with most women of the bourgeoisie, and aristocracy; but, ultimately, she was not as learned as the Italian women who were made, or would be made, members of any public scientific academy.[23] Under these circumstances, it becomes clear that Bentivoglio Davia could have never asked Bassi for explanations on electrical phenomena, for it would be equivalent to admitting her inferiority in philosophical matters to the other. Such a system was not conducive to solidarity amongst learned women.

Bentivoglio Davia was more successful in acting as a patron to Giovanni Bianchi, particularly early in his career; and in turn, he would provide her with scientific material of his own production, which, as they were published, could be used by the marchioness to enliven her *conversazioni.* While in Rimini, Bentivoglio Davia's role as a patron was straight forward enough: she chose him as hers and her children's physician. To a recently qualified young doctor, it was a prestigious position to be the physician of the

niece and nephews of the Archbishop of Rimini. But Bentivoglio Davia was also to assist Bianchi after Cardinal Davia had left Rimini for Rome, and the new ecclesiastical authorities in town, accused the physician of performing an autopsy without Rome's permission, and then of taking home one of the dissected body parts (a cranial bone). Being familiar with the rules, Bentivoglio Davia interceded on his behalf. She pointed out that a bishop had the power to allow dissections, once the relatives had given permission to perform them. She then stressed that her uncle had allowed dissections many times. Her clarification of the rules seemed to have resolved the controversy in Bianchi's favour. With such effective patrons, is no wonder that the physician was quite distressed when Davia's departure from Rimini was compounded by that of his niece in 1726. But the marchioness would continue to be useful to Bianchi even after she left Rimini .[24]

In 1727, Bianchi asked the marchioness to intercede with her husband, and other Bologna senators of her acquaintance so that a surgeon who specialized in lithotomy--a surgical procedure to remove bladder stones--and whom both Bianchi and Bentivoglio Davia knew, and esteemed, Pier Paolo Lapi, might accede to a surgical post in town which was in the power of the senators to bestow; she promptly obliged. That same year the physician asked Bentivoglio Davia to intercede with her uncle-in-law so that he might provide him with the maps of the Rimini diocese done at the Cardinal's request while he was the town's bishop. Bianchi needed to make a study of the ancient course of the Rubicone. There were other similar requests from Bianchi to Bentivoglio Davia, particularly in the earlier years of her return to Bologna.[25] These demands decreased with time, as Bianchi's reputation as a physician and naturalist increased, and made him

less dependent on the patronage of the Davias. By the same token, the role Bentivoglio Davia had in publicizing his scientific productions through her *conversazioni* soon after her arrival at Bologna, was to lose its importance as Bianchi's scientific correspondence, and publications increased and diversified. As time passed, Bentivoglio Davia--not belonging to any scientific institutions, even marginally--was to become far more dependent on Bianchi to keep informed on scientific matters, than he would be dependent on her publicizing any of his scientific productions.[26] Nevertheless, friendship, and affection--however less intense--demanded that Bianchi keep Bentivoglio Davia informed on his latest works.

Bianchi sent the marchioness short stories in the style of Boccaccio, which were never published, and were solely meant for her and her friends' entertainment. He sent her his work on the aurora borealis, and of course, as already discussed, explanations on physical phenomena at her request.[27] But the bulk of the material Bianchi sent her were publications which dealt with his specializations in natural history and anatomy. Such publications would require no particular mathematical preparation on the part of Bentivoglio and her group, were not hard to understand, and remained popular subjects amongst people with little scientific training. As discussed in chapter two, natural history had been popular since the fifteenth-century amongst the educated elite; its popularity was to increase throughout the eighteenth-century. Public anatomy lessons were an annual occurrence at Bologna and were attended by the curious and interested.[28] In 1739, Bianchi was to send her his most important work in natural history, *De conchis minus notis liber* (Venice 1739), which contained a description of little known species of shells from the sea around Rimini, such as *foraminifera* hitherto unknown.[29]

As a physician and anatomist who believed in his own expertise, and loved controversy, Bianchi never shied away from polemics in his published and unpublished monographs. Such a style might not have won him many friends amongst the physicians he attacked, and their supporters; but they could be entertaining reading in a salon setting, particularly when the salon would be populated by his friends. Bianchi was apparently aware of this, and therefore was faithful in sending to Bentivoglo Davia works in which he fostered controversy, such as his letter to Pozzi, or in 1731 his *Istoria del signor dottor Giambattista Mazzacurati intorno l' infermità, morte e sezione del fu nobile giovanetto Giulio Galli*, and in 1744 his *Breve storia della vita di Catterina Vizzani romana.* These works stressed his abilities, as well as the incompetence of others, such as Gaetano Tacconi, Laura Bassi's teacher, as anatomists of the liver.[30] In 1749 and 1753, Bianchi sent Bentivoglio Davia two other works in which he again attacked specific doctors for respectively the remedies used in one case, and the diet recommended in the other.[31]

From the activities which were carried out at her uncle's academy in Rimini, and from the material she received from Bianchi, one might say that the marchioness was far more knowledgeable in anatomy than in physics, or mathematics. Bentivoglio Davia's knowledge of anatomy was clearly demonstrated in Bianchi's letters to her, in which he explained dissections' findings. Bianchi assumed Bentivoglio Davia knew exactly to which anatomical part he referred. Lest one might think, however, that Bentivoglio Davia's *conversazioni* dealt exclusively with intellectual matters, one should be aware that they could easily turn into frivolous exercises, as could, one suspects, many other such gatherings. For instance, Bianchi's *Breve storia della vita di Catterina Vizzani romana*, which discussed the life and death, and then the physician's dissection of a

woman who had had lesbian tendencies during her lifetime, had been sent to Bentivoglio Davia and her group not so much to improve their knowledge of human anatomy, but in order to amuse them.[32]

In spite of descending from one of the oldest aristocratic families in Italy, Bentivoglio Davia had limited income of her own, with which she could dispense her patronage. Most of that patronage seemed to have been directed towards Bianchi, for whom she had a special affection, and perhaps towards a few other learned men, of whom little is known. Her friendship with Francesco Maria Zanotti seemed to have brought her few benefits, outside of mathematics lessons, and appeared to have had little effect on the natural philosopher's career.[33]

There was another noblewoman, Clelia Grillo Borromeo (1684-1777), who like Bentivoglio Davia, was the descendent of an old Italian aristocratic family, and was learned in several languages, natural philosophy, and mathematics. Like the marchioness, and in spite of her supposed learning, Borromeo failed to publish anything in science. But, unlike Davia, Borromeo had enough income to act as patron to several natural philosophers, and at the same time, draw considerable benefit to herself. If she could not be member of any public academy of sciences, Clelia Borromeo could found her own, give it a set of regulations, provide it with various instruments, attract natural philosophers by financial incentives, and her own prestige, and finally be its head, and thus indulge in her own experimentation, very much as the Prince of Tarsia was to do several years later in Naples. Borromeo's initial intent had been to found a publicly-funded experimental academy of sciences in Milan with government support, modelled after the Bologna Academy of Sciences, founded by Prince Ferdinando Marsigli, and

then place herself as its head. It was a considerable ambition for a woman to have in the first half of the eighteenth-century. This ambition can be attributed in part to her own character, her social position, her own learning, and in part, to the fact that she believed to have had precedents.[34]

II. *Clelia Grillo Borromeo and the Foundation of the Academy Clelia*

Clelia Grillo was born in Genoa to one of the richest, and noblest families of the town, that of the Marquises of Chiarafonte and Carpeneto, and Dukes of Mandragone. Very little is known of her education, and of her teachers. Up to the age of twenty, she was supposed to have been a boarder at a convent. A year later, in 1705, the young woman was already known as being very erudite. She is supposed to have known Italian, Latin, French. English, German, Spanish, and Arabic, and subjects like rhetoric, history, geography. philosophy, geometry, astronomy, arithmetics, and algebra; since nothing is known of her teachers, it might be assumed that she was in part self taught, and at the same time, had received a considerable education in the convent. As seen in chapter three, other women were supposed to have received a considerable education in a convent, which seems to indicate that there were exceptions to the assumption that convent education was limited.[35] Even allowing for exaggerations on the part of some of her protégés, other men who had met her , such as Montesquieu, De Brosses, Guido Grandi, and Antonio Vallisneri seemed generally impressed by her learning.[36] But Borromeo published nothing from which we can measure with some degree of accuracy the extent of her scientific knowledge. We can only evaluate it by means of her correspondence, and the accounts of her associates.

In 1707, Clelia Grillo was given in marriage to Count Giovanni Benedetto Borromeo, who belonged to one of the two most important families of Milan. Her and her husband's family wealth and prestige, as well as her education made it easy for her to patronize science. It is not known when Borromeo became interested in the sciences, but this interest was already there with certainty by 1718, when during a visit to Padua, the countess arrived at 2 o' clock in the morning at the naturalist, and physician, Antonio Vallisneri's house to inform him that she had read all of his works, had been suitably impressed, and could not leave the town without meeting him. The following year, Vallisneri spent several months as her guest in Milan, where they both indulged in experiments in medicine, and natural history.[37]

Vallisneri, who in 1718, had already been professor of practical, and theoretical medicine at the University of Padua, had studied, as discussed in chapter one, medicine for a time at the University of Bologna under Marcello Malpighi. In the years preceding his meeting with Borromeo, Vallisneri had already published his " Dialogues on the curious origin of many insects " (1696 and 1700), in which he disproved spontaneous generation, like Francesco Redi before him.[38] Other works on natural philosophy and medicine were to follow, such as *New Observations and Experiments on the Ovaries Discovered in the Round Worms of Men and Cattle with Various Letters Pertaining to Medical and Natural History* (1713), *Academic Lesson on the Origin of Fountains* (1715), and *New Observations on the Verminous and Epidemic Constitution which Affected Horses in the Mantovano* (1715), whereby Vallisneri studied the effects of short worms on horses, described the manner in which they were formed, and claimed that epidemics in cattle were also caused by worms. In addition, Vallisneri collaborated

also with Italian journals such as *Galleria di Minerva,* and the *Giornale de' letterati d' Italia*; he had co-founded the latter with Apostolo Zeno and Scipione Maffei.[39]

In 1721, after his stay in Milan as the countess' guest, Vallisneri was to dedicate his most important work in minerology to her, *On the Marine Bodies Found on Top of Mountains, their Origin, and the State of the World before, during, and after the Universal Deluge*, in which, the naturalist, in his attempt to explain why marine fossils were found on top of mountains, came to reject the history, and truth of the Biblical Universal Deluge.[40] In his dedication to Borromeo, Vallisneri stated that it was perhaps unusual to offer a work full of theory and complicated questions to the gentle sex, to whom should only be addressed works full of gentle, easy, soft, loving, and caring subjects. But she was so much above other women in heroic and masculine virtues, and not only equal, but greatly superior to men trained in the sciences, that any scrupples on his part were unnecessary. On stressing Borromeo's exceptionality, the naturalist had followed in the footsteps of other Italian learned men when addressing any of their works to women of learning.[41]

Vallisneri's books did not require specialized skills, since they were neither written in Latin, nor mathematical. However, Borromeo received, and supposedly, read works which required more advanced knowledge. The mathematician Guido Grandi (1671-1742), professor of mathematics at the University of Pisa, sent the countess several of his works, dedicating, like Vallisneri, one of them exclusively to her.[42] Perhaps after having heard of Borromeo's generous gifts to natural philosophers who were willing to indulge her scientific interests, the mathematician dedicated to the countess his *Flores Geometrici ex Rhodonearum et Cloeliarum curvarum* (1728), whereby, amongst other things, a

series of rose-petal curves, the *Cloeliae*, belonging to the solid surface were geometrically described, and identified after her. To appreciate the work, Borromeo needed a knowledge of solid geometry and spherical trigonometry.[43] Apparently, Borromeo's knowledge in geometry went beyond the thirteen books of Euclid's *Elements,* for she was familiar with Grandi's *Compendium of Apollonius' Conic Sections* (Florence, 1722), which was meant as a follow up work to the *Elements* to students of geometry.[44] Grandi was also the author of two works which dealt with infinitesimal calculus, such as the *Quadratura circuli et huperbolae* (1703) and *De infinitis infinitorum et infinite parvorum ordinibus* (1710). Borromeo might have perused these works, as she did many others. However, the countess, apparently, had no understanding of infinitesimal calculus, since she admitted readily to Grandi that Fontanelle's *Elemens de la geometrie de l' infini* (1727) would have been beyond her intellectual reach. If the librarian of the Ambrosiana Library--founded by the Borromeo family--is to be believed, Borromeo did have, notwithstanding, a knowledge of algebra.[45]

In spite of an interest and knowledge of the sciences which, as seen above, predated her meeting in 1718 with Antonio Vallisneri, apparently Borromeo only began to think of founding a scientific academy, circa 1720, after the natural philosopher had spent several months as her guest in Milan, and began acting as her consultant in the project. Borromeo's initial plan was to found an academy in the experimental sciences, mathematics, and natural history in Milan with funds from the Austrian government--the rulers of the Duchy of Milan-- modelled after the publicly-funded Academy of Sciences of Bologna. This latter academy had been founded in 1711 through the efforts of General Luigi Ferdinando Marsili, a Bolognese aristocrat at the service of the papacy, and was

funded by the papal government. Having plenty of confidence in both her scientific knowledge, and ability, as she clearly illustrated in her letters to Vallisneri, Borromeo thought proper and suitable to be the head of such an academy. She believed such an academy would not only bring glory to herself and the state, but also be advantageous to the arts and sciences in Milan. Moreover, Borromeo stated that she knew of no one more suited to direct such an academy, if one considered her talent for studying, and for political and economic leadership, as well as her ability and erudiction. Such a position of leadership in a public academy could be considered a prize to her studious inclinations; it would also encourage the same desire to study in others.[46] Modesty was not one of Borromeo's characteristics!

She was perfectly aware that giving such a position to a woman was not customary. The emperor would consider it strange, and her Milanese opponents would view it as ridiculous; therefore Borromeo used precedents to back her case. She referred to the fact that Venice conceded a public lectureship to a woman, she could not name (Elena Cornaro Piscopia, or Cassandra Fedele ?). However it was her own friend, Giacinto Gimma, who would provide her with the best precedent by referring to the Academy Corregiana founded and headed by Veronica Gambara in the early 1500s. Veronica Gambara was the wife of the Lord of Correggio, and thus had the power to initiate such an academy. Although belonging to one of the two most important Italian families of Milan, Borromeo held no such a position; political power in eighteenth century Milan rested with the Austrians.[47]

Borromeo and Vallisneri continued in their quest to get public funding for the Clelia de' Vigilanti Academy--as it became known--well into 1729. For the first few years,

their mediators in Vienna were Savello and Apostolo Zeno; the latter had been Vallisneri's partner in the *Giornale de' letterati*, before departing for Austria. Borromeo's desire was to get sufficient money to get the academy started, and equipped with materials. It is not clear from her surviving letters, whether she intended also to get remuneration for the academy's members. It was her belief, however, that, once the academy became established, additional funds could be provided from the sale of books published by its members, of instruments and other equipment produced therein. While waiting for imperial funds, Borromeo asked Vallisneri to provide the academy with regulations, as well as with suggestions for experiments.[48] Such an action from the countess shows that, for all the bragging on her part on the scientific knowledge she was supposed to have, she lacked the confidence, or the experience, to write the regulations herself, and suggest, at least some experiments. The situation illlustrates also that not only men limited the roles Italian women played in the sciences. Often enough, the women themselves limited themselves.

The surviving regulations illustrate that the plans for the academy's operations were ambitious indeed. The *Clelia* was to be an academy, which would publish works by its members solely to be based on experimentation, observation, and careful study. To ensure these works were up to date and of sufficient quality, and thus avoid embarassment to the academy, the material had to be submitted to the judgement of the society's members. All sciences, such as mathematics, mechanics, physics, botanics, medicine, anatomy, chemistry, or history were to be given equal weight within the academy. Works of poetry, rhetoric, and religion were to be excluded. The members were to stick to their own fields of expertise to ensure quality. Publications could be in

Italian, Latin, or any other language; but Italian was to be the preferred language to ensure the accessibility of the works to as many people as possible. Correspondence with foreign philosophers, and articles of interest from journals, or academic acts were also to be communicated to other members of the society.[49]

In spite of regulations which supposedly gave weight to all the sciences, Vallisneri's interests were to dominate: four of the twelve regulations dealt with the study of natural history. The study of rare animals, their anatomy, nature, and habits were to be undertaken. Particular attention was to be given to insects, which, as seen, was one of Vallisneri's fields expertise; neither were plants and their medicinal properties to be neglected. In fact, all the three kingdoms of nature were to be considered. Some members were to undertake nature trips to the surrounding region, as well as to other regions in Italy, and Europe in order to study these regions' structures, types of earth, the origins of their fountains, potential mines, fossils, and plants. Trips were also to be undertaken to Asia, Africa, and the Americas to study and observe their nature, arts, and the customs of their people. The final intent was to communicate the findings, and send specimens to the academy.[50]

In spite of Borromeo's generous remuneration to those who mediated on her behalf and supported her in her effort to found a public academy, and , what appears to have been the backing of a minister, the academy does not seem to have received public funding. The Clelia remained a private academy operating out of Borromeo's house, and had to limit its scope, because it did not have the means to carry out the ambitious program outlined in the regulations. Borromeo and her academy were to encounter other set backs, such as Vallisneri's death in 1730, and when her attempts to get a licence for

the scientific books in the *Index librorum prohibitorum* failed. Vallisneri's death left the academy without a brilliant experimentalist. The Clelia had, of course, other very important members, who like Vallisneri did not reside in Milan, and only came on occasion, such Guido Grandi, Girolamo Saccheri, Tommaso Ceva, and Giovanni Crivelli. However, these men were essentially mathematicians, and therefore, one assumes, not as experimentally minded as Vallisneri had been.[51]

Furthermore, the academy must have been interrupted, if it did not come to an end in 1746, when her support for the Spanish led to her exile to Bergamo, and confiscation of her possessions. While at Bergamo, Borromeo set up a salon attended by Count Pietro Calepio, a relation by marriage of Bentivoglio Davia's sister, and by Marco Tomini Forresti, who dedicated to her several poems which dealt with scientific subjects. Poetry was one subject not allowed in her Milan academy. Most probably, her reduced income forced her to reduce her expectations, and have a salon not dissimilar to the one Bentivoglio Davia ran in Bologna.[52]

It is impossible to know how long the academy operated. While Vallisneri was alive, it showed some activity, much of it related to natural history and medicine, which only serves to re-enforce Vallisneri's importance to the academy. Although the naturalist lived in Padua, there are records of his visits to Milan, when experiments would then take place. But, there are also records of activity in his absence, most probably, instigated by his suggestions. In one of her letters, Borromeo made mention of a study of a woman who would not eat. But, most importantly, she mentioned also her experiments to get a female mule to conceive, at first by mating her with a horse, and then attempting it with

an ass. The experiments, which appears to have succeeded at least once, were also viewed as a extravagant fancy by her acquaintances around town.[53]

Regardless of what her acquaintances thought, Borromeo was prepared to move ahead with Vallisneri's guidance, and supervision. Thus, Borromeo and some of the academy's members were responsible for carrying out a series of dissections, microscopical observations and experiments on vipers which were extensions of Francesco Redi's own experiments on the animals. According to one of these members, the oblate G.A.Sassi, Boromeo and members examined where the seat of poison rested in vipers, agreeing with Redi's findings on the subject. They also determined how such a poison was introduced into their victims. Furthermore, they examined how long an animal would survive after the viper's poison was injected, how effective would an antidote be, how long would the poison last in the snakes' heads, after these had been severed from their bodies, and other similar experiments.[54]

In addition to the usual exchange of works between Vallisneri and Borromeo, she also appears to have acted as intermediary, on occasion, in his correspondence with the Swiss naturalist Bourguet. However, Borromeo appeared very critical of the Swiss'work. Once, she did not even bother sending one of his papers to Vallisneri, because she felt he could not possibly have been interested in it; and one suspects she was right. Bourguet believed in the Biblical Deluge as a natural explanation for geological changes. Vallisneri did not share this opinion, and probably, neither did Borromeo. But we should not assume that because the countess had progressive views in natural history, she had such views elsewhere. For instance, Borromeo was an admirer of the works of another member of her academy, the Venetian natural philosopher Giovanni Crivelli. His

Elements of Physics (1731) did contain mention of many of the new philosophical ideas from Newton, Keill, Leibniz, Bernoulli, 's Gravesende, and Vallisneri, but, as Ferrone points out, it essentially reinterpreted modern science within the context of a renewed Aristotelianism.[56] Her admiration for such a work, leads one to wonder if Borromeo really cared, and supported a science based on experimentation, observation, and mathematical demonstrations, as the regulations of her academy stressed, or simply cared for those philosophers willing to indulge her in the creation of an academy.

For all her wealth, social standing, and even considerable learning, Borromeo was perfectly aware that she was in a position of weakness in relation to natural philosophers like Vallisneri, Crivelli, Saccheri, and Grandi. In the exchange between female patron, and natural philosophers, it appears that the former was far more in need of the latter, than the other way around, particularly, when the philosopher had become established. Both Bentivoglio Davia, and Borromeo had to contend with this fact; a woman's patronage, particularly in the shape of remuneration, served to attract established natural philosophers with limited incomes, but it had its limitations; these men's careers came first. The differences that existed between Bentivoglio Davia's form of patronage, and that of Clelia Borromeo, were due in part to the fact that Borromeo might have been more interested in science than Bentivoglio Davia. After all, Borromeo was willing to found an academy and equip it with instruments and materials in order that she might be part of a group of experimentalists, and carry out experiments in their company. Bentivoglio Davia witnessed dissections when in Rimini; but there are no indications that she extended her scientific interests to the level of buying equipment, and carrying out experiments. But, ultimately, what separated Borromeo's form of patronage from that of

Bentivoglio Davia was the wealth the former had at her disposal as compared to the latter. Borromeo's wealth allowed her to engage in a form of patronage which was similar to the one carried out by Ferdinando Vincenzo Spinelli, Prince of Tarsia, in Naples. Interested in the experimental sciences, the Prince of Tarsia founded an experimental academy in his own home in 1747, and equipped with books, and the latest scientific apparati, which he then put at the disposal of the academy's members--usually men on whom he had bestowed his patronage.[57]

For all the flattery Vallisneri lavished on Borromeo, his attitude towards her, and women in general remained ambiguous. In his introduction to a debate carried out at Padua's Academy of Ricovrati on whether women should be admitted to the studies of the sciences and the arts, the naturalist believed, appropriately, that, at a time like theirs, when old philosophies were being constantly questioned, they should also question the custom that kept women from attending universities, and from studying science and the arts. Still, as seen, in his dedication of *De' corpi marini* to Borromeo, Vallisneri seemed to believe that only an exceptional woman, with masculine virtue, could appreciate his work. Thus, it appears that the extension of learning for all women was not really in his agenda. As far as his attitude towards Borromeo is concerned, one has a glimpse of it in a letter the naturalist wrote to a friend, in which he described her writings as confused; and to give him credit, perhaps they were, which could explain why she never attempted to publish anything. But, it begs the question: if Borromeo had not had money and a social position, would Vallisneri have taken her into consideration?[58]

As shall be discussed later, there were some men who would be less ambiguous as to the role women could play in academic life. But some of the blame should also fall on

Bentivoglio Davia, and Borromeo, who did not quite understand, early in the eighteenth-century, what was required to be taken seriously scientifically, at least by those men who were predisposed to have women play other roles in science, besides that of patron. To be an effective natural philosopher, a person needed a systematic education in the sciences of interest. Men were much more likely to receive such an education, since they were allowed to frequent colleges and universities Women had not these advantages. Therefore, they either engaged in a serious course of studies on their own, much like Laura Cereta had done in the past, or they, or their families engaged teachers who would provide them with such an education, like Margherita Sarrocchi had done. Women with wealth, and a social position could easily engage as teachers, natural philosophers needing to establish themselves. One woman, Faustina Pignatelli seemed to have had clearer ideas to what was required to become an effective patron, as well as a recognized natural philosopher.

III. *Faustina Pignatelli, Princess of Colobrano, Patron and Natural Philosopher*

Faustina Pignatelli was born in the Kingdom of Naples into the family of the dukes of Tolve around 1710. She came into sole possession of the title, and thus one assumes, of all the properties associated with it, prior to 1732. Between 1732 and 1734 she was to marry Francesco Carafa, Prince of Colobrano.[59] Nothing is known of her early education, except that in 1730, she turned away from studies in the humanities to dedicate herself to philosophy and mathematics. Her sole teacher in these latter subjects appears to have been Nicola de Martino (1701-1769), the *de facto* teacher of mathematics at the University of Naples since 1721. A. Ariani was the official holder of the chair of

mathematics at the university. Thus, to teach a young woman from the Neapolitan aristocracy could only help someone like De Martino, who for all his talents, was not yet officially established in Naples' academic life.[60]

De Martino was the author of several books in mechanics and mathematics associated with his teaching at the university, and elsewhere. The most relevant works to Pignatelli's education were, probably, *Elementa statices* (1727), *Elementa sectionum conicarum* (1734), and *Algebrae geometria promotae elementa* (1737). The last two works were written, according to De Martino, for the purpose of instructing Faustina Pignatelli, and were eventually published with her encouragement. According to Nastasi, De Martino's *Elementa statices* used as models the *Phoronomia* (1716) of Jacob Hermann and the *Nouvelle mécanique* (1725) of Varignon, and covered all the recent discoveries in mechanics. The book contained a synthesis of the essential dynamic concepts of Newton's *Principia mathematica*; it dealt with celestial mechanics, the problems of equilibrium, and the laws of motion. Furthermore, the differential methods used in the recent works in mechanics were also given extensive coverage in the book, which in itself was a rarity for Neapolitan mathematics. Although the book was published before Pignatelli became De Martino's student, no doubts the *Elementa statices* was essential reading on her part, if one considers her interest in, and later contributions to, the debate on live forces.[61]

De Martino's *Elementa sectionum conicarum* dealt geometrically, for instance, with conic sections' descriptions in the plane, the tangents and secants of the conic sections, their foci, their geometric loci, and the construction of problems of solids. Like Grandi's *Conic Sections*, sent to Borromeo, De Martino's book was meant as a follow up to

Euclid's *Elements*, a textbook the Neapolitan mathematician had already published in 1729.[62] His *Algebrae geometria promotae elementa*, also designed as a textbook for Pignatelli, dealt with elementary algebra in its first volume. The second volume discussed the general theory of equations, such as the resolution of problems by means of analysis. Its third volume dealt wih the theory of geometric loci, and with the geometrical representation of the roots of equations.[63] The fact that Pignatelli had studied the *Elementa sectionum conicarum* and *Algebrae geometria promotae* indicate that she was learned enough in both geometry and finite analysis, to be able to understand the mechanics, and the differential calculus present in De Martino's *Elementa statice.*

Nicola De Martino was to instill his interest in mathematics, and mechanics to his two students, Pignatelli and his younger brother, Pietro de Martino. In 1732, Celestino Galiani, intent on reforming astronomy at the University of Naples, sent Pietro de Martino, to Bologna to study the subject under Eustachio Manfredi. In July 1732, De Martino became member of the Academy of Sciences of Bologna, whose members had made Laura Bassi its first woman member in March 1732. Without question, De Martino was instrumental in introducing Pignatelli to his fellow members, for on November 20, 1732 she became the second woman member of the Bologna Academy of Sciences. Furthermore, she appears to have been the first noblewoman to become a member of a publicly-funded academy. Elena Cornaro Piscopia had been made a member of the Academy of Ricovrati, associated with the University of Padua, but this latter was not a publicly-funded academy of sciences, as the Bologna academy was then.[64]

Pignatelli's abilities must have come to the attention of important academy members like Francesco Maria Zanotti and the Manfredi brothers, when Pietro de Martino had

proposed to solve a reverse problem on annuity submitted by Eustachio Manfredi. The problem was reproposed by De Martino to Pignatelli by correspondence. What followed was a rapid exchange of various letters between the two parties to discuss the problem and its solutions. The Academy's members must have been aware of the contents of Pignatelli's letters, and remained sufficiently impressed to make her a member a month before De Martino actually presented a summary of these letters, and his and her solutions to an assembly of the academy.[65]

De Martino's dissertation containing Pignatelli's solution was never published in the *Commentarii* of the Academy of Sciences of Bologna. But Pignatelli had better luck when she sent a short work to a friend at Cassel, Baron Blance, in which she exposed the sophism of Leibniz's first demonstration to determine the quantity of motive force. Blance had the work published in Leipzig's *Nova Acta Eruditorum* of 1734, together with three other mathematical problems. One assumes the first three problems to be hers also, since they are referred as " Mathematical Problems of an Anonymous Neapolitan "[woman], or " Anonymae Neapolitanae problemata mathematica ". However, based on Pignatelli's letter to the secretary of the Academy of Sciences of Bologna, Francesco Maria Zanotti, one cannot be as sure of her ownership of the first three problems, as one is of the fourth.[66] Whether Pignatelli published one or four problems in a foreign journal, the fact remains that by that publication, she had achieved a first, as far as Italian women were concerned.

Like Bentivoglio Davia and Borromeo, Pignatelli had the social standing and wealth to act as a patron. As already discussed, she encouraged Nicola de Martino to publish his *Elements of Conic Sections*, and his *Elements of Algebra.* Pignatelli co-operated,

extensively, also in the attempts by those at the university to build an observatory in Naples. Most importantly, she appeared ready to assist her fellow members at Bologna's Academy of Sciences. Pignatelli welcomed the academy's secretary, Francesco Maria Zanotti to Naples in 1750. Zanotti was received in her home, introduced to many of the Neapolitan learned through her efforts, and taken, again, by her on a tour of the most important Neapolitan sites. In 1769, the Princess assisted again another secretary of the same academy, Sebastiano Canterzani, when he desired his name and scientific qualifications be known to Marquis Tanucci, an acquaintance of Pignatelli staying in Naples, who controlled university appointments at Pavia.[67] The *Commentarii* of the Bologna Academy of Sciences contained a note by Sebastiano Canterzani, the academy's secretary, on Pignatelli's donation to the institute of a sulfurous inflorescence encrusted with precious stones from Pozzuoli, where she had a villa.[68]

Like Bentivoglio Davia, and Borromeo, Pignatelli had her own salon, which might have been established sometime in the 1730s, but increased in importance after the Naples Academy of Sciences, associated with the university, founded by Galiani in 1732, came to an end in 1744. In his book, *Delle forze de' corpi che si chiamano vive* (Bologna, 1752), Zanotti has left us the best record of this salon during his visit to Naples in 1750. Pignatelli's group was not experiment-oriented as Borromeo's, or the other group associated with Pignatelli's Neapolitan competitor--Maria Angela Ardinghelli--the Prince of Tarsia Academy. As Nastasi and Brigaglia stressed in several articles, the Pignatelli group, consisting of Nicola de Martino, Francesco Serao, Marquis of Campo Hermoso, Count de la Cueva, Francesco Sabatelli and Pietro de Martino, until he died in 1746, had decidedly mathematical physics inclinations, and thus were more prone to

thought experiments than real ones. The princess' salon appeared to have been still active in 1762, and may have survived until Nicola de Martino's death in 1769. Being less ambitious than Borromeo's academy, Pignatelli's salon was to have a longer life. For the same reasons, it also appears to have been more successful than the Prince of Tarsia Academy, where enthusiasm for experimentation was initially very strong, but was to lose momentum rather quickly.[69]

With a mathematical education at par with members of her salon, such as the De Martino brothers, and Francesco Serao, the princess remained essentially interested in mathematics and mechanics. The fact that her mathematical skills were recognized by members of the Academy of Sciences of Bologna, who made her one of its members, must have encouraged her to continue in her scientific studies, and research. At the same time, her membership to a publicly-funded academy allowed natural philosophers in general to recognize her as a woman whose scientific knowledge was not superficial. Undoubtedly, her membership to a scientific academy facilitated the publication in 1734 of her problems in mathematics, and mechaniscs in a foreign journal, the *Nova Acta Eruditorum*. Barred from a university position, and member of an academy which was far from Naples, her salon, and its members provided Pignatelli with a forum in which to discuss her scientific ideas, and learn that of others. From what it can be gathered from Pignatelli's contribution to the dissertation Pietro De Martino presented to the Bologna Academy in 1732, her publications in the 1734 *Nova Acta Eruditorum*, her letters to the Bologna Academy's secretary, F.M. Zanotti, and this latter's publications, Pignatelli's scientific research centered around mathematics, and the debate on live forces, a topic

which interested many natural philosophers in Italy and abroad in the first half of the eighteenth century.

As referred above, Pignatelli's first recorded scientific work was in the field of applied mathematics: in Pietro de Martino's 1732 dissertation, presented to the Academy of Sciences of Bologna, Pignatelli solved a reverse problem on annuity by recognizing it to be a case of geometric progression; she not only provided the progression, but solved it by means of logarithms. Of the four problems published in Leipzig's *Nova Acta Eruditorum* of 1734 as " Anonymae Napoletanae problemata mathematica ", which, as mentioned above, may be attributed to her, problems one and three were geometrical in nature, and were explained by means of synthetic geometry. The second problem, which also made use of synthetic geometry, had applications either in mechanics, or optics, and it was connected to the theorem James Bradley used to explain aberration of starlight. The discovery of this aberration was the first proof Copernicans had of the annual rotation of the earth. Pignatelli's own teacher was not fully convinced of Bradley's mathematical demonstrations to prove light aberration, and thus, the earth's motion. A dispute arose in the then active Naples Academy of Sciences between Nicola de Martino and Mario Lama, who, unlike Martino, was convinced of Bradley's findings.[70]

In the scholium, Pignatelli mentioned the fact that many doubted Bradley's theorem; but, as far as she was concerned, the solution of the problem, as demonstrated by Bradley, offered sufficient proof of its validity, since it would be certain that the star considered would be observed from the same position. Thus, it appears that Pignatelli was ready to contradict her teacher, and accept Bradley's proof of star aberration, and consequently, of the earth's rotation. Of course, she had two advantages over De

Martino: firstly, as a powerful Southern Italian aristocrat, the princess was accustomed, like her peers, to give orders and be able to express herself freely. De Martino could not have enjoyed such a freedom, for he was dependent on the patronage of the crown, and of those controlling the university for his living. Secondly, Pignatelli was writing for a German periodical, which was not subject to the Roman Inquisition, as periodicals in many Italian states were.[71]

The article in the *Nova Acta Eruditorum* also contained problem four, to which Pignatelli admitted autorship in her 1736 letter to Francesco Maria Zanotti. It was her first recorded foray in the debate on live forces. From 1734 onwards, she would make contact not only with other members of the Academy of Sciences of Bologna interested in the subject, but with the Secretary of the Paris Academy of Sciences, Jean-Jacques Dortous de Mairan, and with Mme. du Châtelet, and with Baron Blance. In his 1741 publication on live forces, Pietro de Martino wrote on the contents of the letters exchanged that same year between Mairan and Du Châtelet themselves; and, in turn, the princess provided them to De Martino.[72]

As discussed in chapter one, the *vis viva* (live force) debate arose from what was the "true" measure of force. To the Cartesians and Newtonians the "true" measure of force was the change of motion over time, and it was measured as the product of the mass and the velocity (mv); in this case, the total quantity of motion was conserved. To the Leibnizians, the "true " measure of force was the live force, which was the product of the mass and the square of the velocity (mv^2). To the Leibnizians, it was the *vis viva* which was conserved. In this case, space was the basis for the measure of force.[73]

The surviving records show that Pignatelli's position vis-a-vis the debate on live forces did not remain constant throughout. In problem IV found in *Nova Acta Eruditorum* of 1734, the princess was decidedly anti-Leibnizian. There, she was intent in exposing the paralogism of Leibniz's demonstration, which defined force as the product of the mass and the square of the velocity. To her, force had to be defined as the product of the mass and the velocity, when the effect of the force was not considered in its entirity, but per unit of time.[74]

In 1736, Pignatelli had shifted her position, somewhat, vis-a-vis the live forces debate. In her 1736 letter to Zanotti, the princess stated that Baron Blance had suggested that she accept Leibniz's manner to measure force, at least as an hypothesis. To which she answered that the Leibnizian measure of force was admissible, but that the Cartesian measure of force was the true one, since the former had been derived from the latter. Blance had demanded a proof to her extravagant answer, which Pignatelli, obligingly, provided. She sent also a copy of this proof to Zanotti, attached to her 1736 letter, with the hope it would please him and the institute.[75] The dissertation has not been traced, or published in the *Commentarii*. However, in 1745, when Zanotti finally published, in the *Commentarii* the different opinions of the various members of the Bologna Academy of Sciences on the debate, he referred briefly to her own findings on the subject as he had received them in 1736. According to Zanotti, Pignatelli had seen the whole controversy as nominal. By means of hypothesis and demonstrations she had demonstrated that if the Cartesians and Leibnizians agreed on the meaning of a few names, the remaining question could be reduced to nothing.[76]

As Iltis points out, Jean d' Alembert, John T. Desaguliers, Ruggero Boscovich and Thomas Reid, writing in the 1740s, admitted the validity of both measures of force. In 1743, D' Alembert called the controversy a dispute over words. It seems that Pignatelli had arrived at that conclusion a few years earlier, although the publication of her point of view appeared only in 1745. Thus, in 1736, Pignatelli had come to accept that both measures of force were admissible, but, like Boscovich would do in 1745, still believed the quantity of motion to be the true measure of force.[77]

Pignatelli was not the only one in Naples at the time to think the whole controversy to be nominal. Her own teacher, Nicola de Martino, believed that also at the time, as recorded in Pietro de Martino's *De corporum quae moventur viribus earunque aestimandum ratione* (1741). Thus by 1741, and most likely earlier--if one considers delays in publication--teacher and student (Nicola and Pignatelli) shared the same opinion over the controversy. It is difficult to know who convinced who on the matter. It is also possible that teacher and student arrived independently at the same conclusion. In view of the continuous respect Pignatelli showed her teacher, and the fact that they came to share the same views on live forces, at approximately the same time, one has to question Voltaire's statement as to her intellectual independence from De Martino, at least, and particularly, on live forces.[78]

Pignatelli's stance on the *vis viva* controversy was also mentioned in Francesco Maria Zanotti's *Della forza de' corpi che chiamano viva* (Bologna, 1752), a work which, supposedly, recorded the discussions that took place at the princess' salon during the author's visit to Naples in 1750. The book, written in the form of dialogues, centred on the debate brought about by the recent publication of Vincenzo Riccati's *Dialogo dove*

ne' congressi di due giornate delle forze vive e dell' azione delle forze morte si tien discorso (Bologna, 1749), which the princess had not yet read, and wanted discussed by the group in her salon. Zanotti's book illustrated the author, the holder of the Cartesian-Newtonian position, being pitched against a solid group of Neapolitans intent on defending Riccati's Leibnizian point of view. Amongst this group of Neapolitan supporters of the Leibnizian definition of force was Faustina Pignatelli. This represents quite a shift of position for Pignatelli, who in 1734 was convinced of the Newtonian-Cartesian definition of force.[79]

However, the Leibnizian position of the Neapolitans, including Pignatelli's, has to be accepted with caution, because the book, written in the form of dialogue, intended to emphasize opposing points of view, rather than nuanced differences. As Kolky stresses, as a literary form, the dialogue allowed the writer not only to present the arguments for both sides, but also to manipulate them in favour of one side. There was a ludic aspect tradionally associated with the format, which warned the reader not to take everything that was said literally, or as an accurate representation of the real world. Furthermore, dialogues, scientific or otherwise, were usually associated with the Italian court culture of the late Renaissance and Baroque periods; they were designed to instruct while they entertained.[80]

Zanotti's work, published in 1752, was not actually written for a court setting; but was certainly designed for a salon, like the one held by Pignatelli in Naples, or the various salons around Bologna, such as those of Bentivoglio Davia, or Elisabetta Ratta, which Zanotti attended. Moreover, in the book Zanotti represents Pignatelli as someone needing instruction on the topic being discussed--live forces--from the men attending her

salon.[81] This is hardly a realistic portrayal of a woman who was as learned in mathematics as Zanotti himself, and who had given proof of her skills in mathematics and mechanics to Academy of Sciences of Bologna, and by her publications in the *Nova Acta Eruditorum*. Pignatelli might not have read Riccati's book discussed by Zanotti in his work, but she needed no instruction from men on what had been said on live force years earlier. If one considers all the problems mentioned above, either with the literary form of the book, and the portrayal of the princess herself, one has to ask how accurate was Pignatelli's defection from the Cartesian-Newtonian camp into the Leibnizian one, indicated clearly in the book.

In the book, Zanotti criticized Vincenzio Riccati' use of *vis viva* as a "true " measure of force in cases of gravity, elasticity--represented by Bernoulli's series of elastic springs--and the parallelogram of forces. In spite of Zanotti's arguments in favour of the Newtonian-Cartesian definition of force, and the validity of its application to the cases used as examples by Riccati, Pignatelli was not convinced by Zanotti's arguments. According to Zanotti, she remained faithful to Leibnizian principles, and believed that Leibniz's *vis-viva* was valid as a measurement of force in cases of gravity, in Bernoulli's series of elastic springs, and even in Riccati's own application of it in the parallelogram of forces.[82] This was quite a conversion for someone who in 1734 was intent on demonstrating the sophism of the Leibnizian demonstration, and who in 1736, had stated that the Leibnizian definition of force was admissible, but that the Cartesian one was the real one. If Zanotti was being accurate in his portrayal, by 1750 Pignatelli had come to accept the *vis-viva* as the "true" measure of force. Whereas the quantity of motion could still be calculated, but it no longer defined force as it had in 1736.

One suspects that Pignatelli's conversion, if it took place, might have been brought about by the experiments carried out by her friend Pietro de Martino around 1740. De Martino had carried out similar experiments to those found in Giovanni Poleni 's *De castellis* (1718). These experiments were designed to demonstrate that force had to be measured according to Leibnizian definitions. In his experiments, P. de Martino had obtained the same results as Poleni, but as a convinced Newtonian, he simply did not accept them. But perhaps they were enough to convince Pignatelli, who had been shifting position in the debate from 1734 to 1736. After all, similar experiments were enough to convince William 's Gravesande, a Newtonian, to the Leibnizian cause.[83]

Again, if Zanotti was being accurate, Pignatelli might have been ready to accept Leibniz's *vis-viva*, as definition of force, but she was not ready, unlike Mme. du Châtelet, to accept his metaphysics, or for that matter, any metaphysics. According to Zanotti, the princess described metaphysicists as obscure, and ready to lose time in useless questions, such as the hidden virtues which instigated movements in bodies. By the same principle, Pignatelli rejected also the Newtonian force of attraction, which had been introduced, according to her, solely because it was needed as an explanatory tool. As far as the princess was concerned, the Newtonians led the way when it came to philosophical obscurities, for they had not only a variety of attractive forces, but several of these forces were also repulsive. Pignatelli, attracted, as her Neapolitan counterparts, to Maupertuis' principle of minimal action--whereby only the simplest laws of motion, requiring the least effort, and least action, were acknowledged by God--appeared to have believed the Newtonians' forces of attraction and repulsion too obscure and complex to fit such a simple Maupertuisian world.[84]

As a woman, and an aristocrat Pignatelli certainly broke new ground in Italy as far as scientific publications, and membership to a public academy of sciences were concerned; nevertheless, her activities peaked at an early age. She published nothing after 1734. Her attempts to have her own dissertation published in the Bologna *Commentarii* failed. She was only to receive a brief mention of her position on live forces in the journal, written by Zanotti himself. He was to offer more space to, supposedly, Pignatelli's alleged position in the debate on live forces in his book on the subject. But even there, one suspects that her part in the debate was much curtailed by what Zanotti believed should have been the role of a woman patron. Had she lived in Bologna, Pignatelli might have been a more active participant of the Bologna Academy of Sciences. But Pignatelli lived in Naples, where, she does not appear to have been made a member of the Naples Academy of Sciences founded by Galiani, while it existed.[85] There, in spite of her learning, she remained in the margins of academic life. If she wanted to participate in learned discussions, she had to use her social prestige and patronage to attract learned men to her salon. In this, Pignatelli was very similar to the women patrons who preceded her, and contemporaries like Bentivoglio Davia and Borromeo. Of course, Pignatelli might have been responsible for initiating the debate on live forces in Naples; after all she appears to have been the first in her salon group to publish on the subject. She was also the one to correspond with French natural philosophers, like De Mairan, and Mme. du Châtelet on the topic. Such activities on Pignatelli's part would make her more of a leader of the group of natural philosophers who attended her assemblies than Bentivoglio Davia and Borromeo ever were of theirs.

IV. *Women and Patronage in Late Eighteenth Century Italy*

Women with wealth and social standing continued to act as patrons, and engage in *conversazioni* past the end of the eighteenth-century. Furthermore, scientific subjects continued to be discussed in these gatherings. But, surviving records seem to indicate that sciences discussed therein experienced some changes, reflecting the scientific interests of a new generation of women patrons. The new generation of women patrons appeared to have been increasingly interested in natural history in its three branches: botany, minerology and zoology, as well as, but not to the same extent, in the new Lavoisierian chemistry, and in meteorology. The popularity of the movement to classify the three kingdoms of nature sparked off by Linnaeus' system of classification, and the publicity Lavoisierian chemistry received in Italian periodicals might explain the interest women patrons of the new generation had in these subjects. But, as discussed in chapter one, natural history had been an active field of research in Italy since the sixteenth century, and women patrons of the past, such as Isabella d' Este and Caterina Sforza, and of the early eighteenth century, such as Bentivoglio Davia and Borromeo, had been interested in the subject. However, patrons like Borromeo, Bentivoglio Davia, and of course, Pignatelli had been also interested in mathematics and Cartesian, Newtonian and Leibnizian natural philosophy, and may have continued to be interested in these subjects, particularly in Pignatelli's case, until their deaths in the second half of the eighteenth century. The controversy that existed in the first half of the eighteenth century regarding the validity of different philosophies, would eventually die down by the second half of the eighteenth century with the winning out in Italy of Newtonian natural philosophy. The highly complex, mathematically advanced celestial mechanics

of Lagrange, Laplace, and then Gauss did not make suitable topics of conversation; besides they lacked the controversy associated with the early philosophies. In fact, surviving records indicate that the new generation of women patrons who ran salons rarely referred to mathematics and physics in their gatherings.[86]

That is not to say that elite women did not learn mathematics, or physics in the second half of the eighteenth century. One suspects there might have been more women learning these subjects during that period than ever before. By then, a father like Pietro Verri of Milan, and the fathers of aristocratic girls boarding in Neapolitan convents, came to realize that young women were likely to be out in society, and consequently needed a veneer of culture which included the sciences. One also suspects that the mathematics and physics these women would likely learn would be very elementary, and totally inadequate to understand new developments in these subjects. One simply cannot find in the records an elite young women with the knowledge in mathematics and mechanics of a Faustina Pignatelli by the end of the century. The mathematics learned by women of the elite would be, one suspects, at the level of the mathematics learned by the Brescian poet Diamante Medaglia Faini (1724-1770). Medaglia Faini prescribed physics and, particularly, mathematics as essential subjects of study for women, in an oration she presented in the 1760s to the Academy of the Unanimi of Salò, of which she was a member. To Faini, the most sublime science was mathematics. Women who undertook its study would not fall into fallacious reasonings, to which they were prone to a greater extent than men.[87]

Having become tired of writing sonnets to physicians, lawyers, new brides and nuns, Medaglia Faini decided to follow her own advice and undertake a course in mathematics

when she was already forty years old. The poet spent three months in 1764, being tutored in mathematics by the mathematician Giambattista Suardi at his own residence. What she learned during these three months is open to speculation, but her poetry seems to indicate, a little Euclidean geometry, since, it is fair to assume that to learn Euclid's *Elements* properly required more than a three-months' application. To learn finite and infinite analyses, tools needed for understanding the new celestial mechanics, would require even longer time. The study of mathematics had advanced considerably from Euclid's *Elements* by the second half of the eighteenth century, as did the study of mechanics, optics and astronomy.[88] Thus, Medaglia Faini's astronomical observations, indicated in her poetry, probably never went beyond those undertaken by a low grade amateur. To practice astronomy at the level of professional astronomers required by the second half of the eighteenth century, expensive equipment--usually found only in public observatories--and an extensive knowledge of theory--usually acquired at universities--institutions which were, on the whole, closed to women.[89]

More elite women might have been introduced to elementary mathematics and physics than ever before, but fashion determined to a great extent which scientific topics women would be interested in, discuss at their gatherings, and the natural philosophers they would invited to them. For instance, from 1770 to 1790 meteorology (weather observation and climatology) was " zealously pursued throughout almost the whole of Europe ". European agricultural, patriotic, and economic societies sponsored meteorological observations and research. In the 1780s Giuseppe Toaldo, professor of astronomy at the University of Padua, and principal meteorologist of the Venetian Republic, was able to form a network of observers from different Northern Italian towns,

who provided him with local meteorological data. Two women from the Venetian aristocracy volunteered to provide Toaldo with data for the towns of Schio and Sacile in 1784. Had not meteorology been so popular at the time, the women might not have thought of volunteering for such an activity.[90] The publicity Lavoisierian chemistry received in periodicals would make chemistry a fashionable topic of conversation. For instance. Giuseppe Compagnoni published his *Chemistry for Ladies* in 1805 because chemistry, as expounded by Lavoisier and his followers, had become fashionable; and he had been asked by Madame Stuardi Richelmi, lady of Robasumé, and by Countess Marianna Gnudi Rossi, to whom the book was dedicated, and of whom we have no information, to explain its mysteries to them.

The first volume of the work dealt with many of the concepts found in Antoine Lavoisier's *Elements of Chemistry*. Compagnoni explained caloric, how it entered in the formation of gases, and which were the different known gases. Also he explained combustion, how flogiston had been rejected, hydrogen and oxygen, how these two elements combined to form water and how the latter, once thought an element, decomposed into hydrogen and oxygen. Compagnoni described how oxygen was the acidifying principle of a body, how all acids were composed of oxygen, and how to express the degrees of acidity; he then enumerated the acids which characterized Lavoisierian chemistry. Alkalies and their properties, salts and their composition and diversity, as well as what constituted simple substances were also discussed. The last chapters of the first volume were used to explain the different substances and immediate materials which composed the three kingdoms of nature: mineral, vegetable and animal.[91]

A woman--or man, for that matter--with no knowledge in chemistry, after reading Compagnoni's first volume, could no longer be considered ignorant on the subject. If the topic came up in a *conversazione*, the *salonnière*, having read the book, needed not to keep silent, and, most importantly, would have avoided asking questions on the matter which might have displayed her ignorance. At no time did the author intend his work to be used as a manual for chemical research. Banished from the work were the quantifications and precise measurements so essential to Lavoisier's chemistry. Compagnoni did refer to some equipment used in chemistry, such as eudiometers, and gasometers, but he did not bother to describe, or provide designs for the apparati essential to chemical research. Compagnoni's *Chemistry for Ladies* was not designed for the serious pursuit of that science, any more than its precedent, Algarotti's *Newtonianism for Ladies*, had been designed for the serious pursuit of Newtonian physics. Women, who wanted to study Lavoisier's chemistry seriously, had at their disposal Vincenzo Dandolo's translation of Lavoisier's *Elements of Chemistry*, as well as other works on the subject.[92]

Chemistry might have been fashionable, according to Compagnoni, but, it appears that Italian elite women who took up the subject with any degree of commitment were very few indeed. The two women, Margarita Trippi, and Sabina Baldoncelli, who were to receive degrees and licences to practice pharmacy from the University of Bologna in 1796 and 1807-1808 respectively, were examined on their theoretical and practical chemical knowledge--Lavoisierian or otherwise--in order to get their degrees and licences. They would continue to practice chemistry in the pharmacy which they ran. The recently graduated physician Maria dalle Donne displayed a knowledge of

Lavoisier's nomenclature, as well as of the role oxygen played in respiration in the theses in *Anatomy and Physiology*, and in *Universal Medicine* she published in 1800 in order to get her licence to practice.[93]

As a member of Bologna's Academy of Sciences, Dalle Donne presented two dissertations with chemical topics to the academy. One such dissertation presented on March 4, 1802 dealt with combustion which took place in vacuum. The other presented on April 6, 1803 dealt with the use of albumen found in the Porretta spa. Maria dalle Donne was also a member of the Benedettina Academy within the academy of sciences, as such, she was entitled to use the laboratories and materials within, and also claim expenses for experiments carried out.[94] The physician was working in an institutional setting; most women had no such advantages, and thus could not, or wished not, to buy all the material and equipment required to pursue their interest in chemistry. For these women, Compagnoni's book would have done very well indeed.

Chemistry might have been popular and women, such as Gnudi, might have been willing to act as patrons to men popularizing the subject, like Compagnoni; but not unlike astronomy, chemistry was a subject practiced by professional women in institutional settings. Natural history was still relatively free of institutional settings at the end of eighteenth century, and it would continue be so into the nineteenth century, since the field trip to study and collect specimens was an important aspect of research in the subject. Natural history had been popular in the past. Women in the sixteenth century were familiar with Pliny's *Natural History*. Laura Cereta had engaged in her own nature trip; some women visited natural history museums and botanical gardens, some like Isabella d' Este had their own collection of natural wonders. They were familiar with many

plants, and their medicinal properties; and someone, like Borromeo, even carried experiments on animals in her own academy. But it seems that one had to wait until the second half of the eighteenth-century for Italian women to engage in field trips in significant numbers in order to observe and collect specimens in natural history. In fact, the field trip had become so popular, that naturalists, like Alberto Fortis, complained that too many men and women were engaged in collecting specimens with little preparation, or knowledge, as to what they were really collecting.[95]

Some of these women's interest in natural history is reflected in the correpondence of the naturalist Lazzaro Spallanzani. The naturalist visited these women's estates, attended their salons, lent them books, taught them natural history, all in exchange of the patronage their wealth and social position could bestow on him. One of the ladies he instructed, and who acted as his patron was Isabella Teotochi. The countess Isabella Teotochi Marin, then Albrizzi (1760-1836) was an established biographical writer, who held a salon in Venice in the 1790s, attended by Lazzaro Spallanzani. A friend of the naturalist, Teotochi seemed to prefer natural history to any other scientific subject. There was interest on her part on Spallanzani's study of the behaviour of eels, their economic importance in the area, as well as on his coming publications of his trips to the *Two Sicilies and Some Parts of the Apenines* (1792-1796) to study the natural history of the region. While at Paris for a five months period, the countess became friends with other important naturalists, such as Georges Cuvier, and Alexander von Humboldt.[96]

In several letters to the Swiss naturalist Charles Bonnet, Spallanzani sang the praises of Marchioness Sassi of Modena. She had availed herself of all of Bonnet's works, studied, and discussed these works with Spallanzani in her salon, and was particularly

taken by Bonnet's *Contemplation*. After gathering butterflies in a field trip, Sassi had discovered that their eyes shone like a *phosphore*, when the butterflies were transported from a room lit by candlelight to one, which was dark. Spallanzani had the opportunity to observe this phenomenon with the marchioness, while visiting her at her country villa. To the naturalist, this effect could shed light on the nature of the butterflies' eyes.[97]

Another of his students, Chiarina Segré of Scandiano, described to him all she had observed in one of her field trips. Segré was particularly fascinated by the productions of the animal kingdom, a fascination also shared by Spallanzani, and the students who attended his course in natural history, dedicated to the animal kingdom, at the University of Pavia. The naturalist regretted that Segré could not attend the course; but he explained to her what he intended to teach, so that she could follow a similar course of study at home. To enable her to do so, he had given her access to all the books in his personal library. Spallanzani's understanding of women's desire to study and participate in the sciences might have been motivated not only by the patronage these women could offer, but also by the fact that his own teacher in experimental physics at the University of Bologna had been a woman, his cousin, Laura Bassi. He credited Laura Bassi for instilling in him love for all sciences.[98]

Teotochi, Sassi and Segré might have been very learned in natural history, but we cannot determine the extent of their learning because, following in the footsteps of women patrons such as Borromeo and Bentivoglio Davia, they published nothing in their scientific subject of interest. Furthermore we cannot say with certainty, excepting perhaps in Segré's case, whether they followed any systematic course of study in natural history, like Pignatelli had done in mathematics and mechanics in the 1730s. One woman

patron of the late 1700s and early 1800s, Marchioness Clelia Durazzo Grimaldi (1760-1837) would achieve the same level of expertise in one of the branches of natural history, botany, as Pignatelli had achieved in hers. Since Durazzo Grimaldi's field of expertise was botany, she will be discussed as a botanist in a later chapter. For now it suffices to say that in 1797 Durazzo Grimaldi began a serious course of botanical studies under the supervision of Diego Pascal, professor of botany at the University of Parma, which was to last several years. Belonging to the richest family in Genoa, the marchioness had been able to use her wealth to found her own botanical garden at her residence in Pegli in 1794. As it developed, Durazzo Grimaldi's botanical garden contained many rare species which she could then supply to professors at various universities for the purpose of study, and/or to enrich the universities botanical gardens. To inform experts of the plants she cultivated, Durazzo Grimaldi published a catalogue on an annual basis which listed the plants in the Linnean binomial nomenclature. Her library, which at her death contained over 500 books in botany, and related fields, served as a centre of consultation for botanists who visited the area.[99]

Although we know that botanists on an individual basis visited Durazzo Grimaldi's botanical garden and library, there are no indications that she ran a salon where botany was discussed. Salons continued to exist after the collapse of the Napoleonic regime in Italy in 1815, but they appear to have been mostly political and literary in nature. There is no evidence that scientific subjects were discussed in them. Women of wealth and social position continued to act as patrons through these salons, but their patronage appears to have been directed towards men who promoted the unification of Italy, and the arts.[100] Thus one has to conclude that the peak of scientific patronage for women

occurred during the eighteenth century, with a few women, such as Durazzo Grimaldi, and Teotochi, continuing to be patrons in science in the early nineteenth century, as a few had been in the sixteenth and seventeenth centuries. This pattern seems to indicate that the number of women patrons in science increased with the popularity of the sciences in the eighteenth century, to wane in the nineteenth century, when most of the Italian elite was focused on the unification of Italy.

Women patrons were particularly susceptible to scientific fashions. In the first half of the eighteenth century the controversy associated with various aspects of Cartesian, Newtonian, and Leibnizian philosophies, at variance with each other, made physics an interesting topic of conversation in the salons organized by women patrons. The study of mathematics facilitated an understanding of the different philosophies. Although more elite women, born in the second half of the eighteenth century, were probably introduced to some low level study of mathematics and physics at the request of fathers, these subjects waned as topics of conversations in the salons of the period. This decline was brought about in part by the end of the controversy, with the victory of Newtonian natural philosophy over the other philosophies, as well as by the increased specialization which was needed in order to understand mathematics and physics.

The publicity associated with Lavoisierian chemistry, and the popularity of meteorology in the late 1700s drew the attention of a few elite women who assisted men involved in these fields. But both chemistry and meteorology required the acquisition and operation of equipment, material, and instruments, as well as considerable measurements, therefore needed a greater level of commitment on the part of women patrons. Natural history suffered less of such constrictions, and did not require

specialization in mathematics, therefore it remained popular throughout the century, growing in popularity as the century wore on. Earlier in the century, Clelia Borromeo wanted to encourage several sciences in her academy, but Borromeo's own interests favoured natural history over other subjects, as it was reflected in the academy's regulations and activities. In later decades, it was the nature trip which attracted many of the ladies and gentlemen of the elite. They not only observed nature's specimens, but also collected, and attempted to classify them.

To act as a patron in science a woman had to be knowledgeable in the scientific topics which interested her. Borromeo had read all of Vallisneri's works before she began to act as his patron. How extensive was that knowledge is far more difficult to ascertain, since most women patrons did not publish scientific works, and many lacked a systematic education on the topic of interest. There were a few notable exceptions: Pignatelli and Durazzo Grimaldi had been taught thoroughly, over a course of several years, the sciences which interested them. Instructed properly, both were able to contribute to their fields of expertise. Pignatelli was to publish the results of her research in a prestigious foreign journal, and her expertise was recognized with a membership to a public scientific academy. Pignatelli might have also been responsible for bringing the debate on live forces to the fore in Naples, and the activities of Neapolitans on the topic to the attention of members of the Paris Academy of Sciences.

Women acted as patrons in science because patronage had the advantage not only of benefiting the recipient, but also the donor: women, who acted as patrons, were more likely to get the natural philosophers they assisted to teach them subjects which were only available in universities they could not attend. They could bring to their salons the

debates which took place in scientific academies, from which they were usually excluded. They could also take part in scientific activities which would take place in institutions to which they could not belong. Furthermore, in places, such as Milan, and Naples, where public scientific academies did not become established until later in the century, a woman's academy (Borromeo's), or a salon (Pignatelli's) could also be the only forum in which male natural philosophers could expound their ideas.

[1]Schiebinger, *The Mind Has No Sex...*, pp. 31-32, 36, 65.

[2]Quondam, p.35 (Gambara); Franchini, pp. 86-90; Brown, pp. 325-53 (Isabella d' Este) B.U.B. *Aldrovandi* ms. 35, XII, pp. 203v-204r (Sforza); Baldini, Napoletani, pp. 12-69, 135-136,141-42 (Sarrocchi).

[3]Thorndike, *History of Magic*, Vol. VIII, pp. 346-47 (Mancini); Bacchini, pp. 143-44 (Piscopia).

[4]Doria, *Raggionamenti*, " Prefazione and p. 424; see Spallanzani's letter to Bonnet no. 62 of April 17, 1766 in Lazzaro Spallanzani, *Epistolario*, B. Biagi ed., (Florence: Sansoni, 1959), Vol. I, p. 87; for Francesca Capodilista see Ciancio, pp. 25-27; Des Brosses in trip across Italy visited several of these salons see Charles de Brosses, *Le Président de Brosses en Italie. Lettres familières écrites d' Italie en 1739 & 1740 par Charles de Brosses*, Tome I, (Paris: Les oeuvres représentatives, 1929), pp. 90-91, 288, , 330, 178-179; for Elisabetta Ratta see Francesco Maria Zanotti's letter to Ratta from June 16, 1724 in F. M. Zanotti, *Opere scelte*, (Milan: Società tipografica de' classici italiani, 1818), Vol. I, pp. 584-85; Luigi Neri, " Mechanica ", *Anatomie Accademiche*, Vol. II: *enciclopedia scientifica*, p. 173..

[5]Laura Bentivoglio was born on August 12, 1689, see A.A.B.: *Libro dei Battezzati*, anno 1689, p. 200 v; for her death see B.U.B.: ms. 4207: Montefani, Caprara, *Delle famiglie bolognesi*, Vol. XXIX, p. 169 v; her death occurred on June 5, 1766. She married Francesco Davia in 1708; for the Bentivoglio family see Littre, " Bentivoglio di Bologna ; in *Famiglie celebri italiane*, no. 4, disp. 42-53, (Milan: Guisti, 1834), pp. 2, 46; Gabriele Bonazzi, *Bologna nella storia*, (Bologna: Zanichelli, 1989), pp. 75-114; for the gossip associated with her marriage and her husband's character see B.U.B.: Mss. 770: Ghiselli, Vol. LXX, (1707), pp. 255-62; Vol. LXXII, (1708), pp. 377, 575-77; Montefani Caprara, pp. 169v-171v; for her attempted divorce see B.C.A.B.: Ms. B. 43: *Miscellanea di cose spettanti a Bologna*, 32f, 165r and v; for Cardinal Davia see G.P.

Brizzi, " Davia, Giovanni Antonio ", *D.B.I.*, vol. 33, pp. 127-30. Pope Benedict XIV was to say of Bentivoglio Davia's husband at the time of the latter's death: " We are sorry to hear of the death of your husband, I hope he is in heaven. Whoever had to deal with him, had the occasion to endure him, and therefore has more reasons to pity you, respectable lady who had to live with him for 45 years". Bentivoglio Davia was to return to her husband in 1726 at her sons' request, see Alfredo Testoni, *Il Cardinale Lambertini. Commedia storica in cinque atti, con note. Introduzione di Luigi dal Pane,* (Bologna: Capelli, 1975), pp. 158-59, 179-80.

[6]Cardinal Davia was involved with Bolognese academies such as the Tracia Academy, before he founded the Rimini Academy, see Marta Cavazza, " Accademie scientifiche a Bologna. Dal " Coro anatomico " agli Inquieti (1650-1714), *Quaderni storici*, no. 48, (1981), p. 885; Mauro de Zan, " La messa all' Indice del *Newtonianismo per dame* di Francesco Algarotti "in *Scienza e letteratura nella cultura italiana del settecento*, p. 139 and n.; for the foundation of the Rimini academy see " Joannes Blancus, seu Janus Plancus Auctore Anonimo " in *Memorabilia Italorum eruditione praestatium quibus vertens saeculum*, Jo. Lami ed. (Florence: Centauri, 1742); the author of the biography was Giovanni Bianchi see A. Fabi, " Bianchi, Giovanni ", *D.B.I.*, Vol. 10, p. 106; Brizzi, p. 129; Ferrone, pp. 82, 103. For Bentivoglio Davia's lessons in natural philosophy see " Joannes Blancus seu Janus Plancus Auctore Anonimo ", p. 362; Simonis Cosmopolitae, *Epistola Apologetica pro Jano Planco ad anonymum Bononiensem*, (Rimini: Albertini, 1745), p. XXI; see also Bentivoglio Davia's letters to Bianchi , Bologna October 12, 1736 and October 27, 1736 in B.G.R.: Fondo: *Gambetti*, Posizione : Davia Bentivoglio Laura, *Lettere a Giovanni Bianchi*; for her possible presence in the Rimini academy see letters of Cardinal Davia to Eustachio Manfredi no. 6662: Rimini, December 1722, no. 6664: Rimini, December 22, 1722 and no. 6667: Rimini January 2, 1723 in B.C.A.B.: *Collez. autogr.*, XXIII, nn. 6546-6778: *Lettere del Cardinale Giovanni Antonio Davia ad Eustachio Manfredi.*

[7]For her knowledge of German see B.U.B.: Ms. 770: Ghiselli, Vol. LXX, (1707), p. 257; Bianchi sent her some of his works in Latin, which she appeared to have read and understood see her letters to Bianchi of August 15, 1739, October 13, 1745, October 30, 1745, December 15, 1745, January 31, 1750 in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura organized chronologically; Fabi, pp. 105-06. Cardinal Davia's library, and that of the Davia family contained many books in Latin and French which would be accessible to Bentivoglio Davia. She also referred to reading the Philosophical Transactions; the Cardinal had volumes from 1665-1669 in Latin, published in Amsterdam, see O. P. D. B. B.: *Archivio della famiglia Davia:* Inventario della Biblioteca Davia fatto l' anno 1741, 163; the family also had four volumes of the Transactions published in Paris by Bremond dating from the 1730s and the 1740s; the latter volumes were most likely consulted by Bentivoglio Davia see O.P.D.B.B.: *Archivio della famiglia Davia :* 1769 Davia Index Librorum Bibliotheca Deviana seu Index librorum: Bremond Transactions philosophiques...; see her letters to Bianchi of January 24, 1750, March 21, 1733 in B.G.R.: Fondo : *Gambetti*, Posizione: Davia Bentivoglio Laura. I would like to thank prof. Paula Findlen for pointing out the Archivio Davia to me.

[8]Eustachio Manfredi's brother Eraclito completed the solid geometry section of the work, left unfinished by Eustachio at the time of his death see Eustacho Manfredi, *Elementi della geometria plana e solida e della trigonometria,* (Bologna : Lelio della Volpe, 1755); for Leprotti's support of Newtonian philosophy in Ferrone, pp. 332, 450n; for Manfredi's and Newton's works in the Davia library see O.P.D.B.B.: *Archivio della famiglia Davia:* Inventario della Biblioteca Davia (1741) and Index Librorum Bibliotheca Deviana (1769); the 1769 index is arranged in alphabetical order, the 1741 version is not; for her study in mathematics see her letter to Bianchi of January 11, 1726 in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura; in it Bentivoglio Davia referred to learning primary operations of algebra from Zanotti; thus she was very far from knowing finite analysis.

[9]See Bianchi's letters to Leprotti of December 11, 1717, March 14, 1718, December 14, 1718, March 27, 1720, February 29, 1720 in B.G.R.: Ms. 962: *Lettere autografe del Dott. Giovanni Bianchi a Leprotti dal 1717 al 1732*; see Fabi, p. 109; for his borrowed (from the Philosophical Transactions) and descriptive work on the aurora borealis see " Lettera prima dell' abate Giovenedi di S. Vito Diocesi di Rimino al dott. Bianchi. Lettera seconda del sudetto al medesimo, lettera terza dell' Abbate Pesci di Rimino ad un suo amico. Breve spiegazione dell' Aurora Boreale ", *Raccolta di opuscoli scientifici e filologici*, XXVI, (1741), pp. 187-203; in spite of the names, the article is his own, see Fabi, p. 109.

[10] See " 20 ottobre 1736. Attestazione di Giovanni Bianchi per Laura Davia Bentivoglio " in A.S.B.: *Archivio Bentivoglio Manzoli*, serie II, no. 101, fasc. 26; see Bianchi's letters to Leprotti of March 14, 1718, December 14, 1718, March 27, 1720 in B.G.R.: Ms. 962; Bentivoglio Davia's letter to Bianchi of January 11, 1726 in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura; for Zanotti's poem to Bentivoglio Davia see Pier Andrea Budrioli ed., *Rime di poeti illustri viventi,* (Faenza: Maranti, 1724), vol. I, p. 160.

[11]The family library contained many important works in mathematics, which she could have used to improve her knowledge on the subject, including several by Guido Grandi, such as *Instituzioni geometriche* (1741), *Compendio delle sezioni coniche d' Appolonio* (1722), *Elementi geometrici piani e solidi di Euclide* (1720), *De infinitis infinitorum et infinite parvorum* (1710), *Quadratura circuli et hyperbolae* (1710), *Flores geometricae ex Rhodonearum et Cloeriarum curvarum descriptiones* (1728) O.P.D.B.B: *Archivio della famiglia Davia:* inventario della biblioteca Davia (1741); for an assessment of the *Quadratura circuli...* see Livia Giacardi, " Guido Grandi e il calcolo leibniziano. Presentazione di un manoscritto inedito ", *Bollettino della storia delle scienze matematiche*, Vol. XIV, (1994), fasc. 2, pp. 195-238; Moris Kline, *Storia del pensiero matematico*, Vol.I: *Dell' antiquità al settecento*, (Turin: Einaudi, 1996), pp. 452, 519-20; for her letter to Ortes see B.M.C.V.: *Raccolta Cicogna 3195-3196:* Epistolario G.M.Ortes, lettere a lui dirette, B.5: Lettera della Marchesa Davia Co.[sa] Dalmond nata March. Bentivoglio all' Ab. G.M.Ortes di 25 luglio 1744.

[12]See Bianchi's letter to Leprotti of October 23, 1727 in B.G.R.: Ms. 962; Budrioli, p. 160; see Bentivoglio Davia's letter of March 7, 1726 in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura.

[13]See Bentivoglio Davia's letters of June 14, 1732 and June 24 1732, and July 8, 1733 and July 15, 1733 in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura; see Bianchi's corresponding answers of June 17, 1732, July 4, 1733, July 11, 1733 in B.G.R.: Sc.Ms. 967: *Giano Planco. Minute di lettere dal 1728 al 1735*, pp. 339r-342r, 424v-425r, 428v-430r respectively; for the Cartesian concept of light simply put, see Part 3 no. 55, and Part 4, no. 28 of Cartesio, *Opere filosofiche*, 3: *I principi della filosofia*, (Bari : Laterza, 1986), pp. 145, 239-40; Cottingham, pp. 113-20; Isaac Newton, *Opticks*, Book I, Part 1, Axiom IV, Axiom V, Book III, Query 29; for an explanation of refraction by Descartes, Fermat, Newton see Park, pp. 171-84, 197-215; O.P.D.B.B.: *Archivio della famiglia Davia:* Inventario della Biblioteca Davia (1741).

[14]See her letter of June 4, 1732 in B.G.R.: Fondo: *Gambetti*, Posizione: Bentivoglio Davia Laura; his letter to her of June 17, 1732 in B.G.R.: Sc.Ms 967; for her praises to Bianchi see her letters of December, 14, 1726, April 25, 1731, June 24, 1732, February 24, 1733, July 8, 1733, July 15, 1733, July 15, 1739, April 29, 1744, May 10, 1749, January 24, 1750, January 31, 1750, February 10, 1753; for the letters in which she asked Bianchi's advice regarding her health see May 15, 1747, June 24, 1747, September 17, 1760 and October 15, 1760 all in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura. From her letters to Bianchi it is obvious that the marchioness had considerable affection for Bianchi, which no doubts blinded her to his shortcomings, philosophical or otherwise. He seemed to have cared just as much for her, at least in the early years of their acquaintance. Whether their relationship went beyond the platonic in Rimini it is difficult to say; her son Giuseppe appeared to have been suspicious of their relationship, see Bianchi's extremely sentimental letter to her at her departure from Rimini of December 7, 1726, and his reaction to her son's suspicions in B.G.R.: Sc.Ms. 965: *Janno Planco. Minute di lettere di anno incerto e dal 1717 al 1730*, pp. 544v-547r and 52r-53v respectively; see her letter of May 5, 1727 referring to her son's accusations in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura.

[15]See her letters of January 24, 1750 and January 31, 1750 in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura.

[16]For Bianchi's reference to electricity see his " Lettera prima dell' Abate Giovene di San Vito Diocesi di Rimini al Dottor Bianchi...", p. 203; for Veratti's and Bassi's works in electricity see Berti Logan, p. 803, 806-07; for her acquaintance with the couple see her letters to Bianchi of May 23, 1744 and June 24, 1747 in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura.

[17]Budrioli, Vol. I, p. 160; for her study in mathematics, visit to the Institute, and her salon see her letters to Bianchi of January 11, 1726, March 5, 1727, April 30, 1727, April 25, 1731, June 24, 1732 all in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura.

[18]For Bassi's degree and other awards see Berti Logan, pp. 786-87; for Tacconi's dismissal of her studies see her letter to Bianchi of June 24, 1732 in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura; for the dispute between Bianchi and Tacconi see Fabi, p. 105; Paolo Babini, " Anatomica, Medica, Chirurgica " in *Anatomie accademiche*, Vol. II, pp. 66-67 and notes.

[19]Leprotti had been favourably impressed by Bassi while she was still Tacconi's student, see Berti Logan p. 800 and note; for Cardinal Davia's reaction see Leprotti's letter to Bianchi of March 23, 1733 in B.G.R.: Fondo: *Gambetti*, Posizione: Leprotti; for Bentivoglio Davia's reaction see her letters to Bianchi of June 14, 1732 and June 24, 1732 in B.G.R.: Fondo: *Gambetti*, Posizone: Davia Bentivoglio Laura.

[20]See her letters to Bianchi of June 14, 1732, June 24, 1732, July 8, 1733 and July 15, 1733 in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura; Thesis V of De anima of Bassi demonstrated Newtonian influence on light see Berti Logan, p. 790; for Algarotti's experiments see De Zan, pp. 134-36;

[21]For Bianchi's correspondence with Bassi see B.G.R.: Fondo: *Gambetti*, Posizione: Bassi and B.C.A.B.: *Lettere no. 75 di Giovanni Bianchi.* Collez. aut. VIII 2254-2328; in a letter to Leprotti from June 17, 1733, Bianchi stressed how Bassi, assigned to debate doctor Azzoguidi when he lectured on the nature of poisons, and their antidotes, had admirably succeeded in destroying his thesis see B.G.R.: Sc.Ms. 963: *Lettere autografe di Giovanni Bianchi a Mons. Leprotti 1733 al 1745;* see also Berti Logan, p. 794; Azzoguidi was an acquaintance of Bentivoglio Davia and seemed to have taken part in her *conversazioni,* see her letter to Bianchi of January 24, 1750 in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura; see also Bianchi's defence of his autobiography: Cosmopolitae, p. XXXVI.

[22]For Bassi's theses see Berti Logan, p. 790; for Bentivoglio Davia's certificate see A.S.B.: *Archivio Bentivoglio Manzoli*, serie II, no. 101, fasc. 26, 1736 novembre; for Pignatelli's works read at the academy see Dollo, pp. 236-37 and notes; for her membership see Richard L. Rosen, " The Academy of Sciences of the Institute of Bologna, 1690-1804 " (Ph.D. dissertation, Case Western Reserve University, 1971), p. 189; Bentivoglio Davia's letter to Bianchi of October 27, 1736 in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura.

[23]Even Marchioness Elisabetta Ercolani Ratta, whose limited knowledge of Latin did not allow her to follow Bassi's defence of her theses, to which she was present, failed to take seriously Bentivoglio Davia's efforts to pass herself as a learned lady. She seemed to really pity Francesco Zanotti for having to attend Bentivoglio Davia's *conversazione* at Samoggia; see letter no. 2455 of Elisabetta Ratta to Algarotti, no date in B.C.B.G.: *Epistolario Gamba*, XVI-A.3; Bassi herself left no recorded comment of what she thought of Bentivoglio Davia's learning; their relationship improved with time, see Bentivoglio Davia's letter to Bianchi of May 23, 1744 in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura.

[24]For Bentivoglio Davia's role as a patron at Rimini see his " Joannes Blancus, seu Janus Plancus Auctore Anonimo ", pp. 360-61, 364, 369-70; for the whole dissection controversy see Bianchi's letter to Leprotti of October 27, 1726, and to Bentivoglio Davia , no date; and his letter of chagrin to Bentivoglio Davia for losing his patrons of December 7, 1726 all in B.G.R.: Sc. Ms. 965, pp. 514-515, 532-37, 544v-547r respectively.

[25]For the request on Lapi's behalf, and Bianchi's demand of Rimini's map see his letter to the marchioness of May 31, 1727, and the following letter, with no date; for his request that she monitor the reactions of the learned at Bologna when his tract attacking Tacconi's abilities would appear in print, and another demand from 1727, but with no date see B.B.R.: Sc.Ms. 965, pp. 591r-592v, 76r-77v respectively; Fabi, 105, 109.

[26]These requests were less frequent in the following years, see his letter of October 17, 1728 in B.G.R.: Sc.Ms. 967, p. 42v; see another from August 9, 1746 in B.G.R.: Sc.Ms. 970, pp. 33r-v.; and another of November 26, 1735 in B.G.R.: Sc.Ms. 966: *Giano Planco Minute di lettere dal 1731 al 1760,* pp. 19r-v; for Bianchi's correspondence see Fabi, pp. 105-12; for his publications in the *Commentarii* of the Bologna Academy see dissertations 4, 96, 149, 153 in *Anatomie Accademiche*, Vol. I: *I commentari*, pp. 164, 240, 326, 329; for Bentivoglio Davia's role in publicizing his work even in Brescia see her letters to Bianchi of July 15, 1739 and August 15, 1739 in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura.

[27]For a discussion of his short stories in the style of Boccaccio see Maria D. Collina, *Il carteggio letterario di uno scienziato (Janus Plancus)*, (Florence: Olschki, 1957), pp. 138-50; for when he sent his work on the aurora borealis and the short stories see her letters to Bianchi of January 31, 1750, and of October 9, 1722, December 6, 1725, and January 11, 1726 in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura.

[28]Bassi disputed in these public anatomy lessons on an annual basis, see Berti Logan, p. 794; Giovanna Ferrari, " Public Anatomy and the Carnival: The Anatomy Theater of Bologna ", *Past and Present*, 117, (1987), pp. 50-106.

[29]See her letters to Bianchi of July 15, 1739 and August 15, 1739 in B.G.R.: Fondo: *Gambetti*, Posizioni: Davia Bentivoglio Laura; Fabi, pp. 105-06; Giovanni Bianchi, *De conchis minus notis liber cui accessit specimen aestus reciproci maris superi ad littus portumque Arimini*, (Venice: Pasquali, 1739).

[30]For reference to Bianchi's letter to Pozzi on Tacconi and on the dissection of the sudden death case see Bianchi's letter to Bentivoglio Davia no date, one assumes 1726 or 1728 see B.G.R.: Sc.Ms.965, pp. 76r-77v; see also her letter to Bianchi of June 24, 1732; for his attack on Mazzacurati see her letter of April 25, 1731; for her reaction to Catterina Vizzani see her letter to Bianchi of September 30, 1744 all in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura; Giambattista Mazzacurati, *Istoria del Signor Dottor Giambattista Mazzacurati intorno l' infermità, morte e sezione del fu giovanetto Giulio Galli da Pesaro. Osservazioni sovra l' antecedente storia, e sezzione scritte in una*

lettera del signor Pietro Ghigi d' Arimino, (Rimini: Albertini, 1731), particularly pp. 15-20; Fabi, pp. 105, 108; Giovanni Bianchi, *Breve storia della vita di Catterina Vizzani romana che per ot' anni vestì abito da uomo in qualità di servidore la quale dopo varj casi essendo in fine stata uccisa fu trovata Pulcella nella sezzione del suo cadavare*, (Venice: Simone Occhi, 1744), pp. 23-27.

[31]Fabi, pp.107, 108; Bentivoglio Davia's letters to Bianchi of May 10, 1749, October 24, 1750 and February 1, 1753 in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura; Giovanni Bianchi, *Se il vitto pittagorico di soli vegetabili sia giovevole per conservare la sanità e per la cura di alcune malatie*, (Venice: Pasquali, 1752), pp. 3-14, 56, 79.

[32]See Bianchi's letter to the marchioness, no date B.G.R.: Sc.Ms. 965, pp. 76r-77v; his letter to her of March 1733, B.G.R.: Sc.Ms. 967, pp. 391r-v; see Bentivoglio Davia's letter to Bianchi of September 30, 1744 in B.G.R.: Fondo: *Gambetti*, Posizione: Davia Bentivoglio Laura; Fabi, p. 108; Bianchi, *Breve storia*, pp. 23-27.

[33]For her financial situation see Gloria Malavasi, " L'Archivio privato Bentivoglio-Manzoli di Bologna (1327-1759)", *Inventario della Università degli studi di Bologna 1987-1988.* Facoltà di Lettere e Filosofia, Tesi: Archivistica. Corso di Laurea di Lettere Moderne, p. 42; see also B.U.B.: Ms. 770, Vol. LXX (1707), pp. 257-62; Zanotti's position as lecturer and secretary of the Academy of Sciences predates her return to Bologna see Bianchi's letter to Leprotti of December 14, 1718 in B.G.R.: Sc.Ms. 962; Tega ed., *Anatomie Accademiche*, Vol.I, p. 57.

[34]See her letter no. 4 to Antonio Vallisneri dated, Milan, 1725 in A.C.R.: *Raccolta Concordiana, 338 / 50*: Grillo-Borromeo, Cont. Clelia di Milano; G.A. Sassi, " De studiis literariis Mediolanensium antiquis et novis " in Philippi Argelati Bononiensis, *Bibliotheca Scriptorum Mediolanensium seu acta et elogia*, Tomus primus, (Milan: Palatini, 1745), columns LXVIII-LXXII; Giuseppe Antonio Sassi, a member of her academy, and librarian of the Ambrosiana Library (founded by the Borromeo family), published the account in 1729, see Sassi's notice of death in *Novelle letterarie pubblicate in Firenze* (1751), T. XII, pp. 363-65.

[35]It also seems to confirm, what has been already mentioned in the same chapter III, that far more lay material entered convents than what might have been expected; for the education in convents see Zarri, pp. 21-22; for Borromeo's studies see Sassi, column LXVII. Many of Clelia Grillo Borromeo's papers are in the *Archivio Borromeo* of the Ambrosiana Library of Milan, which has been closed for many years, and thus are inaccessible; the information on the convent came from Alessandro Giulini, " Contributi alla biografia della contessa Clelia Borromeo del Grillo ", *Archivio storico lombardo*, serie quinta, anno XLVI, parte prima, fasc. IV, (1919), pp. 584-92.

[36]For Montesquieu see his letter no. 201 to Abbot Conti of September 29, 1728 in Albert de Montesquieu, *Corrispondence de Montesquieu publiée par François Gebelin*, (Bordeaux: Gounouilhon, 1914), Vol. I, pp. 248-49; for De Brosses, see De Brosses, Vol.

I, pp. 93-94; for Guido Grandi and Vallisneri see Luigi Tenca, " Cinque lettere di Clelia Borromeo del Grillo al matematico Grandi ", *Archivio storico lombardo*, anno LXVIII-LXXIX, (1953), pp. 224-26; see also Vallisneri's letter no. 32 to Co. di Spilimberga of August 23, 1729 in A.C.R.: *Raccolta Concordiana 338 / 50.*

[37]For Borromeo's marriage, the importance of her husband's family, and Vallisneri's letter to Sassi which described his first meeting with Borromeo see Giulini, pp. 584-86; see also Albert de Montesquieu, *Voyages de Montesquieu publies par le Baron Albert de Montesquieu*, (Bordeaux: Gounouilhon, 1894), Vol. I, p. 96; for Vallisneri's meeting with the countess see Francesco Cusani, *Storia di Milano dall' origine ai nostri giorni*, Vol. 3, (Milan: Pirotta, 1864), pp. 61-62; see also Vallisneri's dedication to Borromeo in the first edition of Antonio Vallisneri, *De' corpi marini che su' monti si trovano; della loro origine; e dello stato del mondo avanti 'l Diluvio, nel Diluvio, e dopo il Diluvio. Lettere critiche di Antonio Vallisneri Pubblico primario Professore di Medicina teorica nell' Università di Padova...a sua eccellenza la...D. Clelia Grilla-Borromea*, (Venice: Domenico Lovisa, 1721); Rappaport,, pp. 75, 77, 90.

[38]He finished his degree at Reggio, because of changes in the law, which forced him in an university of his native region. See Tiraboschi, T. V, pp. 324-25; A. Vallisneri, " Dialoghi sopra la curiosa origine di molti insetti...primo Dialogo e secondo Dialogo ", *La Galleria di Minerva*, I, (1696), pp. 297- 322 and III, (1700), pp. 297-318, 353-72; Generali, "Introduzione" Vol. I, pp. 14-17; Ferrone, pp. 278-79; Rappaport, pp. 76-77.

[39]For a short summary of most of his works, of which only a few are mentioned see Tiraboschi, Vol. V, pp. 330-36; Ferrone, pp. 277-89; Generali, pp. 18-27.

[40]Vallisneri, *De' corpi marini*, pp. 19-20, 35-36, 46-55, 66; Ferrone, pp. 283-84; Rappaport, pp. 85-88.

[41]Vallisneri, *De' corpi marini...*, 1721 and 1722 editions.

[42]For a profile of Guido Grandi, and the role he had in the spread of calculus in Italy see Gicardi, pp. 195-238; Boyer, *A History of Mathematics*, p. 437; Moris Kline, *Storia del pensiero matematico*, Vol. I: *Dall' antichità al settecento*, (Turin: Einaudi, 1996), pp. 452, 519-20; Tenca, pp. 222-30.

[43]See Grandi's introduction in Guido Grandi, *Flores geometrici ex Rhodonearum et Cloeliarum curvarum descritione resultates, atque excellentissimae dominae D. Cloeliae Grillo-Borromeae...*, (Florence: Tartini & Franchini, 1728); see also letter no. 1 in Tenca, pp. 224-25; Boyer, *History of Analytic Geometry*, pp. 117-186. It is obvious from Vallisneri's letter to unknown from Padua January 6, 1728 that Borromeo was very generous in remunerating the natural philosophers who aided her in her scientific pursuits, such as Father Giovanni Crivelli, see A.C.R.: *Raccolta Concordiana*, 360, fasc. 32: Lettere di A. Vallisneri a Clelia del Grillo Borromeo, pos. 10 / II.

[44]See letter no. 3: Milan, March 3, 1728 in Tenca , pp. 226-27; this work was first published in Italian in 1722; there was a Latin version published posthumously in 1750, which referred to the Italian version, used most certainly by Borromeo see Guido Grandi, *Sectionum conicarum synopsis d. vir. D.Guidonis Grandis*, (Florence: G.P. Giovanelli, 1750), pp. 1-5.

[45]See Gicardi, pp. 199-221; her letter to Grandi of February 16, 1731 in Tenca, p. 229; Sassi, column LXVII.

[46]See Borromeo's letters to Vallisneri no.2: no date, no.3: Milan, 1727, no.4: Milan 8, 1727, no. 9: Milan, March 3, 1727, no.29: no date, all in A.C.R.: *Raccolta Concordiana* 338 / 50; Sassi, columns LXVIII-LXIX; Walter Tega, " Mens agitat molem. L' Accademia delle Scienze di Bologna (1711-1804) in *Scienza e letteratura*, pp. 65-108.

[47]Giacinto Gimma, *Idea della storia dell' Italia letterata esposta*, T. II, (Naples: F. Mosca, 1723), pp. 486-87; see Borromeo's letters to Vallisneri no. 2: no date, no. 3: Milan 8, 1727, no. 9: March 3, 1727, no. 29: no date all in A.C.R.: *Raccolta Concordiana* 338 / 50; Quondam, p. 29

[48]For Zeno see Rappaport, pp. 78-80; see letters no. 2: no date, no.5: 15, 1727, no.29: no date in A.C.R.: *Raccolta Concordiana* 338 / 50.

[49]For the regulations in their entirity see Sassi, columns LXIX-LXXI; Maylender presents a much abridged version of them, still in Latin, see Maylender, Vol. II, pp. 22-23.

[50]Sassi, columns LXIX-LXXI; Maylender, Vol II, pp. 22-23; for Vallisneri's work on insects see Tiraboschi, *Biblioteca modenese*, T. V, pp. 330-36.

[51]For her patronage and the apparent support of Count Spilimbergo see her letters to Vallisneri no.2: no date, no.13: Milan, November, 1725, no.23: no date, no.31: August 23, 1729, and Vallisneri's letter to Spilimbergo of August 23, 1729 all in A.C.R.: *Raccolta Concordiana* 338 / 50; see also Vallisneri's letter to Borromeo from Guastalla, June 8, 1729, pos. 17/I, and Vallisneri's letter to unknown from Padua, January 6, 1728, pos. 12/II all in A.C.R.: *Raccolta Concordiana* 360 / fasc. 32; for her failed attempt to get a licence for the restricted books see Leprotti's letter to Bianchi of March 4, 1733 in B.G.R.: Fondo: *Gambetti*, Posizione: Leprotti; for the difficulties facing academies in Lombardy see Ugo Baldini, " L' attività scientifica nelle accademie lombarde del settecento" in *Economia, istituzioni, cultura in Lombardia nell' età di Maria Teresa*, Vol. II: *Cultura e società*, A. De Maddalena, E. Rotelli, G. Barbarisi eds., (Bologna: Il Mulino, 1980), pp. 503-32; for the members see Maylender, Vol. II, pp. 22-23; for Ceva and Saccheri see Dugas, p. 224; Boyer, *The History of Mathematics*, pp. 436-37; Baldini, " Archimede nel seicento italiano ", pp. 272-79; for Crivelli see Ferrone, pp. 257-61.

[52]For her exile and short funds see Cusani, Vol. III, pp. 158-85; for her Bergamo salon see her letter to Pietro Calepio of December 20, 1750 in B.C.A.M.B.: *Archivio Calepio, Carteggio dal 1749 ottobre 22 al 1763 novembre 23*, Vol. II: Lettere di Clelia Grillo

Borromeo a Pietro Calepio; see also the introduction to Marco Tomini Forresti, *Rime dedicate a sua eccellenza la signora contessa D. Clelia Grillo Borromea*, (Bergamo: P. Lancellotti, 1751; the poems were dedicated to the electric machine, Newtonian attraction, the Cartesian principle: *cogito, ergo existo*, Boyle's machine, and so on.

[53]For records of Vallisneri's visits see her letters to him no.14: no date, no.15: no date, no. 19: Fedriano, October 30, 1729; for the experiments on the mule see letters no.4: Milan 6, 1727, no.10: April 8, 1727, no. 18: March 26, 1727, all in A.C.R.: *Raccolta Concordiana* 338 / 50.

[54]Sassi, column LXVIII; see also her letter to Vallisneri no.14: no date in A.C.R.: *Raccolta Concordiana* 338 / 50; Paula Findlen, " Controlling the Experiment: Rhetoric, Court Patronage and the Experimental Method of Francesco Redi ", *History of Science*, XXXI, (1993), p. 54.

[55]See her letters no.28: Milan, May, 1726, no. 7: no date in A.C.R.: *Raccolta Concordiana* 338 / 50; Vallisneri's letter to unknown from Padua, February 13, 1727 in A.C.R.: *Raccolta Concordiana* 360 / 32, pos. 10 / II.

[56]It is not clear why Borromeo did not care for Bourguet, unless because, unlike Vallisneri, he believed in the Universal Deluge as a geological explanation, see Rappaport, p. 87; for Crivelli see Ferrone, pp. 257-61; for her admiration for Crivelli see her letter to Calepio of December 20, 1750 in B.C.A.M.B.: *Archivio Calepio dal 1749 ott. 22 al 1763 nov. 23*, Vol. II.

[57]Maylender, " Accademia del Tarsia--Napoli ", Vol. V, p. 292.

[58]Antonio Vallisneri, " Introduzione " in *Discorsi accademici di varj autori viventi...*, pp. 1-3; see dedication of Vallisneri, *De' corpi marini;* see his letter to unknown, Padua, February 13, 1727 in A.C.R.: *Raccolta Concordiana* 360 / 32, pos. 10 / II.

[59]Pietro Nastasi and Aldo Brigaglia, who have studied the Neapolitan group associated with Faustina Pignatelli, have failed to provide a date of birth for the duchess. However, they have provided an important analysis of Pignatelli's activities, as well as of the activities of her teacher, Nicolo de Martino, and his brother, Pietro de Martino. They compared the group associated with Pignatelli with the one associated with Maria Angela Ardinghelli. I will cover much the same ground, as far as Pignatelli's scientific activities are concerned; but in my case, this scientific activity will be placed in context of the scientific activities of other women patrons of the period, and later. See Brigaglia, Nastasi, " Bologna e il Regno delle Due Sicilie..." in *Scienza e letteratura*, pp. 211-232, and slightly modified in the *Giornale critico della filosofia italiana*, sesta serie, Vol. IV, anno LXIII, fasc. II, (maggio-agosto 1984), pp. 145-178; see also P. Nastasi, " De Martino Nicola and " De Martino Pietro " in *D.B.I.*, Vol. 38, pp. 600-07. One assumes Pignatelli was born in the 1710s because in December 1732, Pietro de Martino, while presenting a mathematical dissertation to the Bologna Academy of Sciences, referred to Pignatelli as an adolescent. He also did not refer to her as the Princess of Colobrano. His

brother, Nicola referred to her as such in 1734, in one of the books dedicated to her. Therefore, it might be assumed that the marriage occurred between the two dates, see Pietro de Martino' s dissertation on two mathematical problems read at the academy on December 11, 1732 in A.A.S.B.: *Dissertazioni*; see also the dedication in N. de Martino, *Elementa sectionum conicarum*; for her inheritance see R. Ajello, " Poter ministeriale e società al tempo di Giannone. Il modello napoletano nella storia del pubblico funzionare " in *Pietro Giannone e il suo tempo*, p. 519; for her husband's name see Antonio Genovese, *Autografia, lettere e altri scritti*, Gennaro Savarese ed., (Milan: Feltrinelli, 1962), p. 42. Pignatelli died in 1785, see Federico Amodeo, *Vita matematica napoletana*, (Naples: F. Giannini e figli, 1905), Vol. I, p. 74.

[60]The information on her education comes from the dedication and introduction of N. de Martino, *Elementa sectionum conicarum*, p. 1; A. Ariani was the official professor of mathematics at the university, but the teaching was carried out by De Martino, see Amodeo, pp. 58-59; Nastasi, " De Martino Nicola ", p. 601.

[61]De Martino was the first in Naples to deal with infinitesimal calculus in his *Elementa Algebrae* of 1725, see Palladino, pp. 384-85, and notes; the summary for *Elementa statices* was taken from Nastasi, " De Martino Nicola ", pp. 601-02.

[62]Amodeo, pp. 78-79.

[63]*Ibid.*, p. 79; Nastasi, " De Martino Nicola ", p. 602.

[64]Nastasi, " De Martino Pietro ", p. 604; for Bassi's and Pignatelli's memberships see Rosen, pp. 178, 186, 189; see also paragraph 10 of Pietro de Martino's dissertation read at the academy on December 11, 1732 in A.A.S.B.: *Dissertazioni*; for Piscopia's membership at the Academy of Ricovrati see Desa, pp. 36-39; Bassi was decidely from the bourgeoisie, see Berti Logan, p. 786 and note.

[65]See section 7-12 of Pietro de Martino's dissertation of December 11, 1732 in A.A.S.B.: *Dissertazioni*; for the use of logarithms in geometrical progressions see U. Bottazzini, P. Freguglia, L.T. Rigatelli, *Fonti per la storia della matematica: aritmetica, geometria, algebra, analisi infinitesimale, calcolo della probabilità, logica*, (Florence: Sansoni, 1992), pp. 53-55; Nastasi, " De Martino Pietro ", p. 604.

[66]See Pignatelli's letter to Francesco Maria Zanotti of September 11, 1736 in A.A.S.B.: Tit. III, sez. I: *Lettere ricevute;* see index and article " Anonymae Napoletanae problemata mathematica ", *Nova Acta Eruditorum*, MDCCXXXIV, Lipsia mensis Januari, pp. 28-34.

[67]See dedication in N. de Martino, *Elementa sectionum conicarum*; for her welcome to Zanotti see his letter to Gabriele Manfredi from Naples, June 9, 1750 in F.M. Zanotti, *Opere scelte*, (Milan: Società tipografica dei classici italiani, 1818), Vol. I, pp. 623-27; Francesco Maria Zanotti, *Della forza de' corpi che chiamano viva. Libri tre del Signor Francesco Maria Zanotti al Signor Giambattista Morgagni*, (Bologna: C. Pisarri e G.

Primodi, 1752), pp. 8-12, 233-36; *Commentarii,* T. VI, (1783), pp. 23-24; for her assistance to Canterzani see his letter, dated July 8, 1769, and her answer in letter no. 12 of July 17, 1769 in B.U.B: Ms. 4174, caps. XLVIII.

[68]For her donation to the institute see " De iis quae Instituto ad facultates varias amplificandas accesserunt ", *Commentarii*, T. VI, (1783), pp. 23-24; see also the summary in *Anatomie Accademiche*, Vol. I: *I Commentari*, p. 374; for her house see F.M. Zanotti, *Della forza de' corpi*, pp. 233-36.

[69]The list of members dates from 1752, see F.M. Zanotti, *Della forza de' corpi...*, pp. 5-8; Nastasi, " De Martino Pietro ", p. 604; for the differences between Pignatelli's and Ardinghelli's group see Brigaglia and Nastasi articles in *Scienza e letteratura*, pp. 230-32 and in *Giornale critico della filisofia italiana*, pp. 173-77; Nastasi, " I primi studi sull' elettricità...", pp. 240-42, 263-64, 251-52; for the salon's continued existence see Pignatelli's letters no. 94: March 2, 1762 to Zanotti in B.C.A.B.: B.160, and no. 12: July 17, 1769 to Canterzani in B.U.B.: Ms. 4174, caps. XLVIII.

[70]See section 7-12 of Pietro de Martino's dissertation of December 11, 1732 in A.A.S.B: *Dissertazioni*; Pannekoek, pp. 289-90; see problems I, II, and III in " Problemata mathematica Neapoli ad collectores actorum eruditorum transmissa ", pp. 28-33; Brigaglia, Nastasi's article in *Giornale critico della filosofia italiana*, p. 159 and note for the dispute between De Martino and Lama see Ferrone, pp. 514-18.

[71]See scholium of ' Problema II ' in " Problemata mathematica ", p. 32; De Martino's dependence on patronage see Nastasi, " De Martino Nicola ", pp. 600- 05; for the arrogance of the Southern Italian aristocracy see Dollo, p. 245.

[72]For P. De Martino's use of Du Châtelet and Mairan's correspondence see Brigaglia and Nastasi , *Giornale critico della filosofia italiana,* pp. 162-63. I have been unable to get access to P. de Martino's *De corporum quae moventur viribus*, (Naples, 1741) in Northern Italy; for the debate on live forces between Du Châtelet and Mairan see Iltis, " Madame du Châtelet ", pp. 38-45; Pignatelli's letter of September 11, 1736 to Zanotti in A.A.S.B.: *Lettere ricevute.*

[73]For the debate on live forces see Iltis, " The Leibnizian-Newtonian Debates, pp. 343-77. Iltis explains in detail Giovanni Poleni's experiment to prove the Leibnizian concept of force; Bergia and Fantazzani, pp. 46-60; for the debate as it pertained the Academy of Sciences of Bologna, which affected Pignatelli see Neri, pp. 160-78; for Madame du Châtelet's role in it see Iltis, " Madame du Châtelet, pp. 28-48; in modern terms what the Cartesians defined as change of motion is change in momentum; momentum is conserved; *vis viva* is twice what we now call kinetic energy, Halliday and Resnick, p. 196.

[74]See ' Problema IV " in " Problemata mathematica ", pp. 33-34. Pignatelli in the problem seems to use the Cartesians' trick of reducing mv^2 to mv by considering the

effect per unit of time; since v = gt , one divides mv^2 by t to achieve mgv see Neri, pp. 163-64.

[75]See Pignatelli's letter of September 11, 1736 to Zanotti in A.A.S.B.: *Lettere ricevute.*

[76]See F.M. Zanotti, " De vi corporum viva ", *Commentarii*, T. II, parte 1^a, (1745), p. 384; Brigaglia and Nastasi provide an Italian translation of the relevant passages in their article in *Giornale critico della filosofia italiana*, pp. 161-62; for a summary of the article by Zanotti see " Mechanica " in *Anatomie Accademiche*, Vol. I: *I Commentari*, p. 138.

[77]Iltis, " Madame du Châtelet ", pp. 46-47; for Boscovich position see Neri, pp. 175-78.

[78]In 1984, Brigaglia and Nastasi attributed the nominal opinion on live force found in Pietro de Martino's book to Pignatelli, since it was so like the one Zanotti wrote she held in his 1745 article. P. De Martino, himself, referred to it as coming from a man, not a woman, who remained anonymous. Since then, Nastasi has discovered that according to a friend of the brothers, G. Orlandi, P. de Martino was referring to his brother's opinion in the book, not Pignatelli's; see first Brigaglia, Nastasi in *Giornale critico della filosofia italiana*, p. 162; then Nastasi, " De Martino Pietro ", *D.B.I.* ,(1990), p. 606; Voltaire, " Exposition du livre des institutions physiques dans laquelle on examine les idées de Leibnitz" in *Oeuvres completes de Voltaire, nouvelle edition, Melanges II*, (Paris: Garnier frères, 1879), (Kraus reprints 1967). p. 140; In 1762, at the age of about 50, Pignatelli was still referring to N. De Marino as her teacher, and what he thought of F.M. Zanotti's new book matttered more than what she thought of it., see her letter to F.M. Zanotti no. 94: Naples, March 2, 1762 in B.C.A.B.: B. 160.

[79]For a summary of Zanotti's book see Brigaglia and Nastasi in *Scienza e letteratura*, pp. 223-25.

[80]For some of the characteristics of dialogues and their role in court culture see Kolsky, " Wells of Knowledge...", pp. 60-62; Findlen, " Cataloguing the Experiment...", pp. 45-46; Mario Biagioli, *Galileo Courtier. The Practice of Science in the Culture of Absolutism*, (Chicago: Chicago University Press, 1993), pp. 216-17; for Serao see Dollo, pp. 242-43.

[81]F.M. Zanotti, *Della forza de' corpi*, pp. 77-78; for the debate on live forces on the salons see Neri, p. 173.

[82]F.M. Zanotti, *Della forza de' corpi.*, pp. 78-81, 137-49, 178-81, 251-305, 310; for a review and summary of Zanotti's book at the time see the review in *Storia letteraria d' Italia*, Vol. V, (1753), pp. 70-81. The parallelogram of forces is a vector quantity; velocity as well as momentum are vector quantities, and thus can be applied to the parallelogram of forces; kinetic energy is scalar and thus it cannot; Riccati was wrong in applying the live force to the parallelogram of forces see Halliday and Resnick, pp. 31-32, 53-54, 124-125.

[83]For Pignatelli's position in 1734 see Problema IV in " problemata Mathematica ", pp. 33-34; for her position in 1736 see her letter to Zanotti of September 1, 1736 see A.A.S.B.: Tit. II, sezione: *Lettere ricevute*; for her correspondence with Du Châtelet see Brigaglia and Nastasi in *Giornale critico della filosofia italiana*, pp. 159-63; for Du Châtelet's metaphysical position see Iltis, " Madama du Châtelet's Metaphysics...', pp. 31-42; for Poleni's experiment, and s'Gravesande's conversion see Iltis, " The Leibnizian-Newtonian Debates...", pp. 355-58.

[84]Zanotti, *Della forza de' corpi...*, pp. 100-01, 107-08, 307; Brigaglia and Nastasi in *Scienza e letteratura...*, pp. 224-25.

[85]For membership at the Naples Academy of Sciences see Amodeo, pp. 65-66.

[86]For the publicity on Lavoisier's chemistry see Elisabetta Caminer Turra's eclectic periodical *Giornale enciclopedico* from 1774 to 1793; for the popularity of Linnean classification see Koerner, pp. 145-62; for Laplace and Lagrange adherence to the geometrical spirit see Roger Hahn , " The Laplacean View of Calculation " in *The Quantifying Spirit in the 18 th Century*, Tore Frängsmyr, J.L. Heilbron, and Robin E. Rider eds., (Berkeley: University of California Press, 1990), pp. 363-80; for the victory of Newtonian philosophy in Italy see Ferrone, pp. 609-74.

[87]For biographies of Diamante Medaglia Faini, the daughter of a physician see Antonio Brognoli, " Elogio della Signora Diamante Medaglia Faini " in *Elogi di Bresciani per dottrina eccellenti del secolo XVIII scritti da Antonio Brognoli patrizio bresciano*, (Brescia: Vescovi, 1785); see particularly Giuseppe Pontera, " Vita di Diamante Medaglia Faini " in Diamante Medaglia Faini, *Versi e prose di Diamante Medaglia Faini con altri componimenti di diversi autori e colla vita dell' autrice. Il tutto insieme raccolto, e dato alla luce da Giuseppe Pontera*, (Salò: B. Righetti, 1774); the oration was most likely the dissertation referred by Medaglia Faini to Luigi Doglioni in letter II of 1763, see also " Orazione " in Faini, pp. 183-84, 173-77; Verri, pp. 153-99; Illibato, pp. 24-25.

[88]Many of Faini's poems were in honour of degrees achieved, marriages, or the taking of the habit by an acquaintance; see her amusing sonnet on the subject in Brognoli, p. 269. Medaglia Faini was not an aristocrat, but the social position of her husband was high enough to make her welcome as a student in the house of a friend, who was also a count. Indications that she studied Euclid with Suardi is found in the sonnet above. Medaglia Faini intended to continue to study mathematics when at home, but was impeded by an illness. In 1767 her friend Suardi died, making any return to his residence for extra mathematical studies impossible see her letters first to Luigi Doglioni of July 14, 1765 and no. VII of March 18, 1767 all in Faini, pp. 188-90, 195; for mathematical advances in the eighteenth-century see Boyer, *The History of Mathematics*, pp. 415-70; for the increased mathematical complexity of many subjects, see J. L. Heilbron, " Introductory Essay " , and all the following articles in Fränsmyr, Heilbron, and Rider eds., *The Quantifying Spirit*, pp. 1-23ff.

[89]Brognoli, p. 269; for developments in astronomy see Pannekoek, pp. 289-307.

[90]Quotation in Theodore S. Feldman, " Late Enlightenment Meteorology " in *The Quantifying Spirit*, pp. 153-54; for Toaldo's sketch of the meteorological constitution of Padua and Northern Italy in *N.G.E.*, (febbraio 1785), pp. 78-108.

[91]Volume two had little to do with Lavoisier's chemistry; most of the volume dealt really with meteorology. For the two ladies addressed by Compagnoni see the dedication and first letter, see also Giuseppe Compagnoni, *La chimica per le donne*, Tomo primo, (Venice: G. Pasquali, 1805), pp. 1-6, 30-41, 58-60, 72-99, 112-16, 126-33, 140-50, 172-243; see also for a comparison, Antoine Lavoisier, *Elements of Chemistry*, translated by Robert Kerr. (Nwe York: Dover Publications, 1965).

[92]Compagnoni, T. I, pp. 81-82. Paula Findlen makes the point that such works were not really designed to educate women since the audience for such works was unknown, see Findlen, " Translating the New Science...", pp. 167-70. I feel that such a work was ideal reading material for the ladies and gentlemen, who participated in the *conversazioni* of the salons, but, who had no deep interest in the science discussed therein; Abbri, pp. 377-78, 406.

[93]There might have been other women in Italy equally, and as officially, qualified in pharmacy during the period under discussion, but I am not aware of them. Margarita Trippi was one of Baldoncelli's teachers at the institution where they lived and practiced pharmacy; for Trippi's qualification see Die 14 Aprilis 1796 and Die 28 Aprilis 1796 in A.S.B.: *Archivio di Studio 295*: Acta collegium medicinae et philosophiae 1789 ad 1798; Baldoncelli received her degree in 1807, and her licence in 1808 see ' Sabina Baldoncelli ' in " Farmacia ", A.S.B.: *Archivio di Studio no. 549*: Esami di corso, gradi e lauree in medicina, chirurgia e farmacia: 1806-1807; Fasc. no. 1: Sabina Baldoncelli in A.S.B.: *Archivo di Studio no.567*: 1808-1809: Libere pratiche in medicina, chirurgia e farmacia; Maria dalle Donne received her degree in medicine in 1799, her licence to practice in 1800 see Laura Nicolini Burgatti, *Maria Dalle Donne (1778-1842).* (Loiano, 1971); see her thesis XXXVII in Maria dalle Donne, *Theses ex anatomia, et physiologia depromptae quas defendendas proponit Maria dalle Donne philosophiae, et medicinae dotrix Bononiensis Academiae Scientiarum Instituti socia*, (Bologna: S. Tommaso Aquino, 1800); see thesis LIX in Maria dalle Donne, *Theses ex universa medicina depromptae quas defendas proponit Maria dalle Donne philosophiae, et medicinae doctrix Bononiensiis Academiae Scientiarum Instituti socia.* (Bologna: S. T. Aquino, 1800).

[94]Maria dalle Donne had adopted some of Lavoisier's nomenclature, but she accepted phlogiston theory supporter, A. Crawford's explanation as to why blood was redder in the arteries, see thesis XXXVIII in Dalle Donne, *Theses ex anatomia*; for Crawford see Abbri, pp. 339-42; she also continued to use old chemical names in on some occasions, see thesis XLIX in Dalle Donne, *Theses ex aanatomia*, and theses LVII, and LIX in Dalle Donne, *Theses ex universa medicina;* for her dissertations see Rosen, pp. 307, 309, the dissertations have been lost; for the privileges allotted to Benedettini academics see Berti Logan, p. 788.

[95]Countess Isabella Teotochi Marin was born in Corfu, a possession of the Venetian Republic, and lived in Venice. Her first marriage to Carlo Antonio Marin was annulled; she then married the state inquisitor Giuseppe Albrizzi. Her biographical work included a life of the poet Vittoria Colonna; see her biographical sketch at the time of her death " Isabella Albrizzi nata Teotochi a Corfu (1760-1836) a Co. Urbano Pagani Cesa a Belluno " in B.C.B.G.: *Epistolario Gamba Lettere autografe...Donne illustri*, pos. XVI-A.26, lettere 2520-22; see also Spallanzani's letter no. 1254: Pavia, December 30, 1792 to Teotochi, and her answer of January 115, 1793 in Spallanzani, *Epistolario*, Vol. IV: *(1788-1793)*, pp. 383-387; for the popularity of natural history in Italy at the time see Ciancio, pp. 129-30, 233-34; and abroad see Guntau, pp. 227-28.

[96]Ciancio, pp. 233-34; Italian men engaged in those field trips in earlier centuries see Findlen, *Possessing Nature*, pp. 158-70.

[97]For some of the ladies Spallanzani taught and advised, and his comment on their patronage see letters no. 62: April 17, 1766, no. 84: June 6, 1767, no. 85: October 5, 1767, no. 92: March 28, 1768 in Vol. I, pp. 87, 145, 148, 154; see letter no. 1254: December 30, 1792 in Vol. IV, pp. 38-87.

[98]Letter no. 1472 to Segré of January 6, 1795 in Vol. V, pp. 228-230 of Spallanzani, *Epistolario*; for a discussion of his friendship with women see Maria Luisa Altieri Biagi, " Scelte linguistiche e stilistiche di Lazzaro Spallanzani ", in *Lazzaro Spallanzani e la biologia...*, pp. 158-59; for his teacher Bassi see Berti Logan, pp. 798, 804-05.

[99]Bertoloni, pp. 6-27; for a list of her books see B.C.B.Ge.: M.R.VII. 5.8: *Catalogo de' Libri Bottanici Legato della M.sa Clelia Durazzo Grimaldi alla Biblioteca Civica Berio, 1837*; Clelia Durazzo Grimaldi, *Catalogue des plantes cultivées dans le jardin de Madame Durazzo de Grimaldi à Pegli. Département et arondissement de Gènes*, (Genoa: Bonardo, 1812).

[100]Bertoloni, pp. 23-27; Lorenza Minoli, " Oltre le pareti dell' esclusione. Il caso dei salotti politico-letterari " in *Esistere come donna*, Rachele Farina ed., (Milan: Mazzotta, 1983), pp. 63-72.

Chapter V

Female Scientific Translators of the Enlightenment

Italian men had been translating Arabic, Greek, and Latin scientific texts since the Middle Ages. In the late fifteenth and sixteenth centuries, male humanists had been responsible for the rediscovery, reconstruction and/or translation from the original languages, of works in natural philosophy, mathematics and medicine by ancient Greek and Latin authors, such as Dioscorides, Galen, Archimedes, Aristotle, Pliny the Elder, Apollonius and others. From the second half of the seventeenth century onwards, the increased influence of French, and English scientific productions in Italian intellectual circles led to a new flourishing of translations in the peninsula, this time of works by French, and English authors.[1] Most of these scientific translators had been, and would continue to be men. In the past, a few women, such as De Pizan, and Moderata Fonte, had translated in part scientific texts which, as befitted the period, were of Greek and Roman extraction. These translations appeared in works of a literary nature. Danti had written a commentary on Euclid, which has been lost, and Sister Frescobaldi adapted several works in astronomy and geography for the benefit of the nuns in her convent. Thus, translation, at least in part, from ancient and recent texts in science was not a new enterprise to Italian women.[2] As might be expected, the increased popularity of the sciences during the eighteenth century brought to the fore a few female scientific translators.

Surviving sources appear to indicate that most of the female translators of scientific texts were active in the eighteenth century, when the sciences' popularity was at its peak

. As far as it is known, three of these translators were women from the Kingdom of Naples, and they represented a very small fraction of scientific translators in the peninsula at the time. In fact, translation appears to have been the favourite, and easiest way whereby Neapolitan women could claim some form of authorship in the sciences, by means of their introductions and notes. Translation of new, and sometimes controversial, material also gave women a foothold into the scientific community, thereby demonstrating that, like the men, they belonged to the group of innovators in natural philosophy. Such was the case of Eleonora Barbapiccola's translation of Descartes' *Principles of Philosophy*, which, because of its potential controversy value, helped place its translator amongst those Neapolitans demanding freedom to philosophize.

If, like Maria Vigilante, and Maria Angela Ardinghelli, women added their own commentaries to the translation, then they went further in their ability to call themselves natural philosophers. Such commentaries would allow translators to display their own knowledge on the subject, and enable them to present any research they had undertaken on their own; research, that as women, they would find difficult to publish under their own names. After all, writing commentaries on ancient authors had been an established way for men to claim authorship during the Middle Ages and Renaissance. As late as 1737, an established natural philosopher like Georges-Louis de Buffon could be proud of his commented translation of Stephen Hales' *Vegetable Staticks*.[3] Commentaries could be particularly useful to women unaccustomed to authorship in natural philosophy, and who had very limited, or no access to research facilities, as it occurred in Naples. These translators' desire was not so much to circulate knowledge, as to belong to the Neapolitan scientific community, in a region which was less amenable in the eighteenth

century to having women associated with public institutions of higher learning than Northern Italy. The translator who really made new scientific knowledge from abroad circulate was the Venetian Elisabetta Caminer Turra. She achieved this by acting as editor and director of her *Giornale enciclopedico* (1768-1796), a periodical of wide distribution throughout Italy, which presented abstracts, reviews, and articles on the latest scientific activities taking place abroad, and at home. Ultimately, all the women discussed made recent, and new scientific knowledge accessible, to different degrees, to those men and women who could only read Italian.

As a journalist in charge of a periodical, Caminer Turra was to inform her readers on a large variety of scientific topics. Caminer Turra's type of translation had no precedent amongst women of past centuries. It was, instead, associated with the rapid expansion of periodicals in Italy in the eighteenth century. The other women translated specific authors, who were chosen, to a great extent, because of the groups with whom the translators were associated. Thus, Maria Angela Ardinghelli, asssociated to the experiment-oriented Academy of Prince Tarsia, chose to translate the very experimental works of Stephen Hales. Maria Vigilante's translation of an elementary work in astronomy and geography--probably her textbook--was aimed at those families from the elite who came to believe in greater numbers by the second half of the eighteenth century, that their daughters were in need of an elementary education in the sciences. As the work was translated in 1789, it was no longer affected by the interdict on the Copernican system. Associated with a group of Cartesian natural philosophers, Eleonora Barbapiccola chose to translate in 1722 the principal book in which such a philosophy was expounded, Descartes' *Principles of Philosophy.* By her translation of a work which

expounded the Copernican system, but which had escaped interdiction because of careful wording, Barbapiccola was expressing her support for this system at a time when the Church's interdict was still in effect.[4]

I. *A Translator Who Demanded Freedom to Philosophize: Eleonora Barbapiccola*

Very little is known of Giuseppa Eleonora Barbapiccola's life, before and after her translation in addition to what she wrote in her introduction. Thus, it appears Barbapiccola had learned Latin, French, natural and moral philosophy. There are no indications she was particularly learned in mathematics; none was really required for the translation of Descartes' *Principles*, as mathematical concepts were few in the book.[5] Barbapiccola's dates of birth and death are unknown. It is assumed she was young when the translation was published, because the picture in the title page showed her as a young woman, and that she must have been close in age to her friend, Vico's daughter, Luisa, born in 1700.

Barbapiccola also wrote poetry, which earned her a membership in the literary Academy of the Arcadi, even before her translation was published. Nevertheless, her literary importance rests in her translation into Italian of a work that, if it was not prohibited, was certainly not viewed favourably by the Roman Inquisition. But Barbapiccola went further; in her introduction, she defended Cartesian philosophy against accusations of being contrary to the Catholic faith, when it was still risky to do so, and, ultimately, added her own contribution to the fight for freedom to philosophize.[6]

A treatise in philosophy and physics, René Descartes' *Principles of Philosophy* (1644) was written after Galileo's trial, and after a decision on Descartes' part to suppress

his more radical treatise, *The World.*[7] In his letter to his French translator, which Barbapiccola not only kept, but also translated in her Italian edition, Descartes stressed that the *Principles* were to be read as a tale, a fact that Barbapiccola re-emphasized in her own introduction.[8] He also camouflaged, as already discussed in chapter one, his support of the Copernican system by disguising the earth's diurnal rotation around its axis, and yearly movement around the Sun within its system of vortices. Furthermore, while affirming the prevailing orthodox view that the universe was created fully formed, he stated, nevertheless, the " imaginary " and evolutionary account found in the *World*, which propounded that the whole visible world could have sprung from very simple principles, as if from seeds. [9]

Thus, even if expounding subject matter that could be subversive to the Church hierarchy, such as the Copernican system, the earth's rotation, and, what might be considered, a rejection of the biblical genesis, Descartes, by the careful use of language, and by insisting on the term "hypothesis", had stalled any condemnation.[10] Anyone translating the text, and adding any explanatory commentaries to it, would have to be as careful as Descartes had been to avoid condemnation. That might explain why Barbapiccola elected to translate the text as accurately a possible, without adding any explanatory notes to it. Thus, her claim to authorship rested solely in her introduction.

In her introduction, Barbapiccola stated that it was not her intent to present an apology for Descartes' philosophy; that had already been done by very knowledgeable men, such as Constantino Grimaldi. Nevertheless, intent on defending the right to philosophize freely, and quoting from Catholic reformers, such as Ludovico Antonio Muratori, Father Bartoli, and others, she pointed out how closely connected Aristotelean

philosophy and Gospel truths had become in the minds of certain Italian religious groups. Descartes had come to a similar conclusion in 1629 in a letter to Mersenne.[11] To Barbapiccola, any human knowledge (Aristotelean philosophy) based on feeble principle could not possibly be of any use to the Faith. Furthermore, if the philosophy of impious pagans had become acceptable to the Church, thanks to the efforts of St. Thomas Aquinas, why should one not accept the philosophy of a Catholic Christian like Descartes, who submitted his physics, and metaphysics to the judgement and authority of the Catholic Church. After all, Cartesian philosophy was founded on very solid reasoning, whose method was to deduce things from established principles.[12]

By the time Barbapiccola translated the *Principles*, French influence in natural philosophy, expounded by the works of Pierre Gassendi, and René Descartes was widespread among Neapolitan intellectuals, and had been around since the second half of the seventeenth-century. Support for variations of Cartesian philosophy appeared quite early among the members of the more experiment-oriented Academy of the Investiganti. Descartes' sympathizers occupied chairs of logic, physics, and metaphysics at the University of Naples in the first half of the eighteenth-century. Men, such as Paolo Mattia Doria and Vico, apparently connected to Barbapiccola, were initially Cartesians. Furthermore, Neapolitans not only read prohibited books, but also published them in the private presses of lawyer Lorenzo Ciccarelli. It was through his presses that a new edition of Galileo's *Dialogue* was published in 1710, as well as Jacques Rohault's *Traité de physique* in 1713; the work was commented by Samuel Clarke and was referred to by Barbapiccola in her introduction. To translate Descartes' *Principles* was the easiest , and most secure way for a young woman like Barbapiccola to be part of this group of

Neapolitan intellectuals who were attempting to create an alternative to Aristotelean philosophy, and, at the same time, defend the right to *libertas philosophandi*, or to philosophize freely. Such enterprises led the men into a cat-and-mouse game with the Roman Inquisition which lasted until 1746.[13]

In 1688 the Roman Inquisition began a process against some members of the Investiganti accused of atheism. The Inquisition's intent was to stamp out atomism--the doctrine taught by the Greek philosopher, Democritus and accepted by Pierre Gassendi, Galileo and others, whereby all matter consisted of different arrangements of a limited number of indivisible particles--and related doctrines alleged to have been spread by the Investiganti Tommaso Cornelio, and Leonardo di Capua. The Jesuit Giovanni Battista De Benedectis in 1694, attacked atomism, and Cartesian philosophy for encouraging atheism. The trial lasted nine years, and ended with a public ceremony of public abjuration by the presumed atheists, reminiscent of Galileo's trial.[14] Constantino Grimaldi in his *Risposta alla terza lettera dell' Aletino* defended the new philosophy against accusations of atheism brought about by De Benedectis, and for that he was persecuted by the Inquisition. Two of Di Capua's medical works, *Paure...* (1681) and *Ragionamenti* (1689) were severely condemned, and placed in the Index, as was the Gassendian, Pietro Giannone's *Civil History of the Kingdom of Naples*, with Giannone himself dying in prison. Even former Cartesians, like Vico and Doria had come to the conclusion by the 1720s that Cartesian philosophy could be reduced to Epicurian materialism, and could be contrary to the faith.[15]

Considering the Neapolitan intellectual climate of the times and the activities of the Roman Inquisition, just translating the *Principles* was an act of courage in itself. To add

a commentary to the translation would have been foolhardy, and could have led Barbapiccola into trouble with the Inquisition, which could have been a dim prospect to a woman in the late teens, or early twenties. In her introduction to the *Principles*, Barbapiccola explained that it had been her intention to add brief reflections which would demonstrate how some philosophers had distorted Cartesian philosophy, attributing to him things he never claimed. She changed her mind when she learned that D. Francesco Spinelli was going to publish his learned work on the subject, in which he intended to point out the false statements in metaphysics attributed to Descartes.[16] Spinelli was to publish his *Riflessioni..sulle principali materie della prima filosofia* in 1733; but as it turned out, in spite of being a moderate Cartesian, a good Catholic, and a well-connected aristocrat, he was still unable to escape ecclesiastical censorship, because of what the Inquisition defined as his overflowing exaggeration in favour of Descartes.[17] Considering the difficult relationship that existed between Neapolitan intellectuals, and the Roman Inquisition, it is quite possible that Barbapiccola had been advised by her friends, men like Giambattista Vico, whose salon she frequented, to avoid any commentary to the text. Vico's thesis from his *De studiorum ratione*, referring to the secrecy of ancient philosophers, was quoted by Barbapiccola in her introduction to the *Principles,* and apparently, taken as advice.[18]

Since Barbapiccola did not comment on the translation, we do not know whether she agreed with everything Descartes stated in his philosophy. Erica Harth in *Cartesian Women* indicates that the French *Cartesiènnes* contested the dualism that stressed the separability of soul and body inherent of Cartesian philosophy. On one hand, such dualism seemed to support women as thinking subjects, on the other, it reduced the body

to mere machine.[19] Many of the Neapolitan Cartesians in the Academy of the Investiganti had similar objections; they refused the Cartesian dualism of a *res cogitas* and a *res extensa.* In addition, atomism, and the concept of vacuum survived among many Cartesians. Barbapiccola might have, or might have not, shared some of these objections. There are indications, however, in her introduction that she accepted some sort of dualism. Barbapiccola seemed to believe, if in a confused way, that senses could deceive, and that thought was the ultimate guide.[20]

Barbapiccola's introduction was also a defence of women's right to an education in the sciences. Her purpose for translating the *Principles* into Italian was to make accessible to many people, especially women, who, according to Descartes, were more inclined to philosophy than men. Still, for all her good intentions, Barbapiccola did not advocate the study of sciences to all women; the study of sciences was to be limited to those women whose spirits were raised, and who were not inferior to men in all the great virtues. From such a statement, one is to conclude that the translator accepted the "exceptional woman" paradigm which had been in existence since the early Renaissance, if not earlier. Her reference to Paolo Mattia Doria as one who, with solid reasoning, demonstrated in his *Ragionamento* the excellence and dignity of women, seems to indicate that she also accepted his statement that if women could study science, they could not create it. It is more likely, that like women in the past had done, Barbapiccola borrowed from male authors only their positive statements on women, while choosing to ignore the misogynous ones.

Like many others who preceded her, Barbapiccola provided the reader with a list of past learned women, who by their example had encouraged her to study, first languages,

then philosophy. The list is interesting more for the women Barbapiccola left out, than for those she included. In it, she mentioned the physicians from the old school of Salerno, Trota and Constanza Calenda, and foreigners such as Christine of Sweden, Mme Dacier, and Anne Marie de Schurman, but left out, perhaps out of ignorance, all the Italian women from the same period as the foreigners, with the sole exception of the Duchess of Limatola, whose sole claim to fame was the dedication of Doria's *Ragionamenti* to her.

Thus the Neapolitan, Margherita Sarrocchi, very learned in mathematics, and natural philosophy was ignored, as well as Moderata Fonte, Arcangela Tarabotti, and Lucrezia Marinelli, who, as seen, defended with original works, women's abilities and rights far more effectively than Barbapiccola. Also ignored were Elena Cornaro Piscopia, the first woman to receive a degree in philosophy, as well as Ludovica Montecuccoli Foschiera, who in 1701 translated Pierre le Moyne's *La Galerie des Dames fortes.*[21] Barbapiccola might have been motivated to neglect learned Italian women of the recent past, perhaps, for fear that her accomplishments would be diminished, and appear not really unique as compared to theirs. She needed not have feared, for Barbapiccola's translation ultimately defines her historical persona. It is impossible to know how popular was Barbapiccola's translation at the time, or how effective it was at advertising freedom to philosophize. It appears not to have ensured her a membership to any public scientific academy at the time. Nevertheless, the translation has ensured her a place in history, in the modern *Dizionario biografico degli italiani*, a place that was denied another Neapolitan translator, Maria Angela Ardinghelli. The latter's annotated, corrected, and learned translations of the much safer, religiously speaking, *Vegetable Staticks* and

Haemostaticks of Stephen Hales seem not to be considered important enough for her to merit a biography in either the original volume, or in the later addition of the *Dizionario*.[22]

The Roman Inquisition was to quit Naples in 1746, during the papacy of the enlightened Pope Benedict XIV (1740-1758). On April 16, 1757, while Benedict XIV was still pope, the Roman Church revoked the anticopernican decree on new publications on the basis of new physico-astronomical studies, and by intervention on the part of the Jesuit Ruggero Boscovich. Thus, after 1757, it became possible to publish works that expounded the Copernican system, without running the risk of having the work placed on the Index.[23] It was in this more relaxed atmosphere that Maria Vigilante was able to translate into Italian, and publish in 1789, Isaac Watts' *The Knowledge of the Heavens and the Earth Made Easy: Or the First Principles of Geography and Astronomy Explained by the Use of Globes and Maps*, a work in elementary astronomy and geography, first published in English in 1725, and which would make an excellent textbook for young women from the elite in need, as a parent would see it, of a veneer in astronomy and geography.[24]

II. *Maria Vigilante: Translator of a Textbook in Astronomy and Geography*

Isaac Watts (1674-1748) was not a natural philosopher. As a dissenter and a pastor, he was known in his lifetime as a writer of hymns, philosophy, and educational manuals; many of his publications dealt with religious topics. His purpose for writing his *First Principles of Geography and Astronomy* was to educate young minds in subjects that

helped them arrive at a clear conception of many things delivered in the scriptures, and to raise their ideas of God the creator to a very high pitch.[25]

Maria Vigilante had other purposes in mind when translating Watts' treatise, and God had nothing to do with them. As she, herself, put it, in spite of such draw backs as the imbecility of her sex, and her tender age, her intent had been to entertain the public, and to be useful to society through the application of her knowledge in languages, and in the sciences. Furthermore, men who were conversant with astronomy and geometry, had encouraged her to take up the translation, because they had felt there was a need for such an elementary treatise on these subjects in Italy. The book had been popular in England, because it was a nation that practiced commerce, and navigation. Vigilante saw no reason why it should not also achieve popularity in the Kingdom of Naples, which had an extensive coast , and where commerce and navigation, although previously neglected, had been improving in recent years under the protection of Ferdinand IV, and his Minister of War, General Acton. Most importantly, Vigilante was determined, through her annotated translation, to prove wrong those people who believed that women were more suited to perform domestic tasks than literary ones. Unlike Barbapiccola, Vigilante promoted scientific education for women in general, and not only for those considered exceptional, arguing that women who philosophized were better managers of homes, and educators of children.[26]

As Watts and Vigilante stressed, the book was designed to teach young people the first elements in astronomy, and geography. Although, very little is known of the translator's life, and education, it appears that she was translating a text which was used in her own education in astronomy. The first part of the book defined and explained

astronomical terms such as, for instance, the greater and lesser circles, the longitudes and latitudes of the Earth, and of the heavenly globe, and the various risings and settings of the sun and stars, the fixed stars, planets and comets themselves. The second part dealt with geography, and therefore described maps and charts, the earth's inhabitants, according to the five zones they inhabited, the lands and waters of the terrestrial globe, and its political divisions.[27]

The contents found in Watts' astronomy section did not differ greatly from those found in Piccolomini's *Sphere*, written for the benefit of Laudomia Forteguerri, except that they included changes brought about by new geographical and astronomical discoveries. Thus, there were references to the Southern constellations previously unknown to the ancients Greeks; comets no longer belonged to the sublunar region, but were dark bodies that orbited the sun with ellipses of prodigious lengths. Planets became dark bodies, which received their light from the sun. Most importantly, the system supported by Watts was Copernican. Thus he stated, and Vigilante translated, that the latest and best astronomers had found that the sun was fixed in the center of our world, and that the earth rotated on its axis every twenty-four hours with a circular motion, and round the sun once in a year with a progressive motion; but to make matters intelligible, the unskillful readers were to suppose that the sun moved around the earth, both with a daily and yearly motion, as it appeared to the senses. Thus, the celestial coordinates explained by Alessandro Piccolomini in his *Sphere of the Universe* in 1540, were also explained by Watts.[28]

But while Piccolomini's *Sphere of the Universe* had been written to facilitate Forteguerri's observations of the heavens, Watts' work was designed to teach young

people how to solve elementary problems in astronomy and geography by means of a globe, and/or the plain scale and compasses. The tables for the London meridian of the daily sun's declination at midday, the right ascension every tenth day for the years 1753 to 1756, and the right ascensions and declinations of the principal fixed stars for 1754, were provided for such purposes. These tables were good enough for students to practice their problems in elementary astronomy for approximately 50 years, without any remarkable errors. Watts also taught how to use the tables for meridians, others than London. Yet, Watts felt that the tables for the London meridian could be applicable to any place which differed from London by less than five hours in longitude, if used exclusively for solving problems. Vigilante published her translation in 1789, about thirty five years after Watts tables were made, to be used in a place at about one hour's longitude from London (Naples). She felt no need to make any changes to Wattts' tables. Thus, one finds Watts' original tables from his latest edition in Vigilante's translation.[29]

Vigilante provided notes to the translation. Mostly, they added information, which had not been available to Watts, on recent geographical discoveries by European powers, imperial expansions, and political changes. For example, Vigilante mentioned Captain Cook's trip to the Northern Straight (Bering) in 1779, as well as his attempts to reach the Southern Continent (Antartica). She also referred to Russian expansion East through the Bering Straight, and South into Asia, as well as mentioning the political changes which had occurred in North America, such as the United States' independence, and France's loss of Canada to the British. As expected, Vigilante also expanded on the

scant political, and geographical information Watts provided on Italy, and provided Naples', and Rome's longitudes, useful information to those reading the translation.[30]

Vigilante notes on astronomy were few, elementary, in keeping with the book's goal, and usually added information not mentioned by Watts, particularly as it pertained to Italy. Thus, she referred to the number of southern and northern constellations found in the most recent catalogues, unknown to Watts. Vigilante pointed out that for the inhabitants of the oblique sphere, or who lived in latitudes between the north or south poles (90° latitude), and the equator (0° latitude), their twilights increased as the obliquity of the sphere increased (latitude), with the maximum obliquity, and thus, the maximum twilight length, found at the poles. At Naples' latitude, or pole altitude, twilight on June 21 would last 2 hours, 12 minutes and 23 seconds. One could also calculate the length of twilight at any pole altitude, which she then proceeded to teach. Vigilante also provided the twilight length in the parallel sphere, or at the poles, when the sun's declination, or its position below the horizon, was 18 degres, something Watts had failed to do. Whereas Watts discussed the fact that in London from May 20 to July 18 there was constant twilight, Vigilante noted that such events did not exist for Naples, or any place below 48 degrees, 51 minutes and 50 seconds of latitude. In the section dealing with longitude, and latitude, Vigilante disclosed John Hanson's invention in 1760 of a marine chronometer which permitted more accurate measurement of longitudes at sea.[31]

Vigilante also indulged in national pride in some of her notes. Thus in the problem in which one was to find the circumference, diameter, surface, and the solid content of the Earth (volume), she pointed out that such calculations were taken from the theorems

of "our" immortal Archimedes, who established the ratio between the diameter and the circumference to be 113 to 355. By the same token, it was "our" great Galileo, who first turned the telescope to the heavens, and discovered that the milky way consisted of innumerable stars. Interestingly enough, Vigilante seemed unaware that the method for measuring longitude from the Jovian satellites' eclipses was first devised by Galileo, and then used by another Italian, Domenico Cassini, to determine the longitudes of French cities.[32]

In fact, rather than indicating national pride, the translation illustrated the hegemony of French, and especially English, scientific and philosophical culture in Italian, and particularly, Neapolitan intellectual circles. When Sister Frescobaldi had composed her *Sphere of the Universe* for the edification of her convent's sisters, she had drawn mostly from Italian authors, such as Piccolomini for astronomy, Pope Pius XI's *Cosmography* for Europe, Giovanni Leoni for a description of Africa, and Amerigo Vespucci for the Occidental Indies. In 1789, Maria Vigilante needed to translate the textbook of an English dissenter, who was not even an astronomer. Piccolomini had felt free to write an elementary textbook on Ptolemaic-Aristotelean cosmology and astronomy in 1540. Galileo's trial and the Vatican's interdict on the Copernican system ensured that a similar textbook on Copernican cosmology would not be authored by an Italian after 1633 and prior to 1757. As similar textbooks in Italian to Watts' *First Principles of Geography and Astronomy* were unlikely to exist in Italy, probably, even after 1757, Vigilante translation might have proven more popular and useful to young women in need of an elementary education in science than Barbapiccola's translation of Descartes' *Principles of Philosophy.* [33]

It is difficult to assess the extent of Barbapiccola's, and Vigilante scientific learning from their translations, since the former provided no learned notes to her translation, and the latter's notes were as elementatry as the texbook itself. Maria Angela Ardinghelli's annotated translations into Italian of most of Stephen Hales' (1677-1761) experimental works illustrate clearly that she was no mere translator, but a natural philosopher in her own right, at par with Neapolitan men deserving of this title. Translating works in 1750, 1752 and 1756, which had no religious controversy attached to them, since these dealt mostly with animal and plant physiology, Ardinghelli felt free to express her opinions, and thus her learning in her notes. Barbapiccola might have been as learned as Ardinghelli, however, the topic she chose to translate, fraught with religious controversy as Descartes' *Principles of Philosophy*, ensured that whatever knowledge she might have had, would not be displayed.

For all her knowledge, Maria Angela Ardinghelli (1730-1825) did not publish any works in natural philosophy, or mathematics, under her own name. The French astronomer Joseph Jerome de Lalande, who knew her personally, believed this lapse to be the result of her modesty, and domestic cares, as he pointed out in his *Voyage en Italie* (1766). Modern historians of Neapolitan science, as P. Nastasi and A. Brigaglia attribute it to the difficulties she encountered, as a woman, in having her own material published in Naples. Nastasi and Brigaglia may be accurate in their assessment, since the only Neapolitan woman known to have published her own scientific works at the time, Faustina Pignatelli, published them not in Naples, but in a German journal. The Kingdom of Naples might have been less amenable to women's publications in science than the other Italian states during that period, as it had proven to be less amenable, again

in Pignatelli's case, at making women members of public academies of sciences.[34] Thus, the commentaries found as footnotes in her translations of Hales' works remain her scientific contributions. These took the form of corrections of errors made in calculation, completion of calculations, left uncompleted by Hales, mathematical demonstrations of how the author achieved a certain result, additional explanations when the author, or/and his French translator were not clear enough. On one occasion Ardinghelli provided her own mathematical formula, where Hales only provided estimates; on a few occasions, she designed and carried out her own experiments, either to confirm Hales' results, or because these results were not suited to Neapolitan circumstances.

In spite of an auspicious beginning, by the time the third edition of the Italian version of Hales' *Vegetable Staticks* appeared on the scene in 1776, Ardinghelli appears to have become isolated from one of the most important scientific debates of the period, to which the book was particularly relevant. This isolation might have reflected, in great part, the state of scientific research in the Kingdom of Naples at the time and the fact that, as a woman, Ardinghelli was shut out of relevant institutions, as academies of sciences and universities. But it was also indicative of how she had failed to understand the need a woman on the margins of academic life, and with scientific ambitions had of networking with as many natural philosophers as possible.

III. *Maria Angela Ardinghelli: Translator and Natural Philosopher*

Maria Angela Ardinghelli, born in 1730, was the only surviving child of Niccolò Ardinghelli of Florence, descendent of an illustrious Florentine family, and of Caterina Riccillo. An unsuitable marriage by her father had cut him off from his family, and had

resulted in his mediocre circumstances.[35] Ardinghelli had shown an inclination to study from a very early age. Her father obliged this inclination by engaging several tutors to instruct her, perhaps intending to regain his lost social position by means of an exceptionally learned daughter. As expected, Ardinghelli was taught Latin, rhetoric, and classical literature; but as she lived in the eighteenth century, a time when the popularity of the sciences was at its peak, and not in the Renaissance, her exposure to natural philosophy and mathematics was far more extensive than that of her Renaissance counterparts.

According to Abbé Jean-Antoine Nollet (1700-1770), who knew her personally, Nicolò Bammacaro, professor of philosophy at the Royal Neapolitan Academy, and the author of one of the few books on electricity written in Naples at the time, taught her moral philosophy and metaphysics.[36] Vito Caravelli, who arrived in Naples only in 1748, was her principal teacher in more advanced mathematics; but his instructions must have begun only after Nollet's departure from Naples, for the philosopher made no mention of him in 1749. From Caravelli's publications one might surmise that he taught Ardinghelli plenty of synthetic geometry, his specialty, perhaps, a bit less algebra, and little, if any, infinitesimal calculus.[37] Ardinghelli did not really have much of an opportunity to show all she knew in mathematics, when she translated Hales' *Statical Essays*; the mathematics found in them was not of a high degree of difficulty, nor did it require new methodology, as infinitesimal calculus.[38]

Since Caravelli came into the scene only after 1748, Ardinghelli must have learned her basic mathematics from her principal teacher, the Somascan father, Giovanni Maria Della Torre (Rome 1710- Naples 1782), the man who also taught her physics. He must

have begun teaching Ardinghelli after 1741; before that time he had been teaching in Rome. That same year Della Torre became mathematics teacher at the Somascan College of Naples, for which he composed in 1744, *Arithmetical Institutions.* However, Della Torre's most influential work was the encyclopedic *Scienza della natura* (1748-1749) in two volumes. The first volume dealt with general physics, and had chapters on statics, hydrostatics, dynamics, hydrodynamics and thermometry. The second volume dealt with the earth and its atmosphere, and covered topics as minerology, vulcanology, geodynamics, taxonomy, plant and animal physiology, hydraulic, optics, acustic and electricity. Each argument discussed began with a critical assessment of its historical development, and how such development was relevant to eighteenth-century inquiries. The fact that mathematics was kept to a minimum, and so many topics were discussed, meant that several of these topics would not be detailed enough for specialists.

Metaphysics played no role in the *Scienza della natura.* Both Descartes and Leibniz were criticized for denying the existence of vacuum, and for replacing it with vortices, and subtle matter. Della Torre left no doubts that his heroes were Galileo and Newton, who followed the real method in physics; a method based on experiments and observations, guided by the most sublime geometry.[39]

Scienza della natura, following the real method, contained much research carried out by many natural philosophers, past and present; but the work itself, as Ugo Baldini suggests, was not really based on the author's own research. However, there were a few exceptions, like when Della Torre tested various animals in the asphyxiating atmosphere of the Cave of Dogs, just as the members of the Academy of Investiganti had done in the 1660s and 1670s.[40] Della Torre also carried out a series of experiments in electricity, the

first to be undertaken in Naples since the acquisition of an electric machine by the Prince of Tarsia for his academy. These experiments were similar to those carried out elsewhere in Europe by philosophers like Francis Hawksbee. From them, Della Torre concluded that electric matter was a continuous current of infinitely small particles that diffused from the electric body and moved with almost infinite velocity. It appeared to him that electric matter might be nothing other than light which was diffused in all bodies, and which could be revived by rubbing, or by rapid spinning of bodies. The connection Della Torre made between light and electricity led him to conclude that lightning was an electric phenomenon.[41] Ardinghelli herself discoursed once on the electric force in Latin, when many curious people had gathered at the Academy of Prince Tarsia to see experiments with the new electric machine. One assumes she expounded her own teacher's theories on electricity.[42]

Della Torre in *Scienza della natura* made many references to Stephen Hales'*Statical Essays*. In the chapter dealing with gravity, the *Vegetable Staticks* and the *Hemaestaticks* were mentioned in the context of Hales' demonstrations of the forces of attractions there existed in plants and animals.[43] As expected, references to Hales'*Vegetable Staticks* were frequent on the chapter dealing with vegetating bodies, or plants, where Della Torre essentially agreed with Hales most important findings, such as the fact that sap did not circulate, or that the force of attraction found in the capillary tubes, of which the plants were formed, was mostly responsible for raising the water to considerable heights.[44]

Della Torre mentioned Hales' *Hemaestaticks* in sections of his work in which he described the principle parts of the human body. Whereas " the Analysis of Air " in Hales'*Vegetable Staticks* served as a basis for the chapter in *Scienza della natura* dealing

with air. Like Hales, Della Torre was concerned with the physical properties of air, such as its weight and elasticity, and the fact that air contained a particular force of attraction, which caused it to be tenaciously fixed into bodies. [45] Since Della Torre's *Scienza della natura* was written before Ardinghelli's translations of Hales' *Statical Essays*, it is almost certain that her teacher was responsible for introducing her to the French translations of both works. These were the versions quoted in the *Scienza della natura*, and not their English originals. It was, most likely, at Della Torre's suggestion that Ardinghelli undertook the Italian translation of *Hemaestaticks* from the French.

Ardinghelli would have received a good grounding in physics just by studying her teacher's work. From Della Torre she would also have learned the importance of experimentation and observation. In addition to the experiments that were mentioned in the *Scienza della natura*, he was a keen observer of the activities of Mount Vesuvius, and published important works on the subject. He was also the inventor of a microscope, which contained as a lens a perfect sphere, free of impurities and distortions, and which allowed him to make very important anatomical observations, such as the annular shape of corpuscles in the blood (erythrocytes).[46]

Della Torre also belonged to the more experiment-oriented academy founded by the Prince of Tarsia (Ferdinando Vincenzo Spinelli) in 1747 in opposition to the more mathematically-oriented salon of the Princess of Colobrano, Faustina Pignatelli. The Prince of Tarsia had equipped his library, not only with books, but also with machines and instruments, which were quite often not even found at the university.[47]

Ardinghelli was also part of this experimental group, as mentioned by several of her biographers. How often she attended their academic meetings, or was given access to

any of the machines, is far more difficult to fanthom. As already mentioned, we know that she appeared once at the academy to expound on electric force. The fact that all her biographers referred to such an occasion, seems to indicate its exceptionality, rather than it being a commonplace event. Nollet seems to have recorded in his letter on electricity, addressed to her, her attendance, as an observer, at another occasion. Ardinghelli was present when a glass globe the astronomer Sabatelli was attempting to electrify, blew up in his hands.[48] Thus, what might have been exceptional was the fact that Ardinghelli might expound any theory, or demonstrate any experiments, in what was essentially a public meeting, and not the fact that she might be present while men undertook such tasks.

It is important to be aware that customs could vary in the Italian peninsula. For instance, members the Academy of Sciences of Bologna were willing to make the learned Neapolitan Faustina Pignatelli, as well as the Bolognese Laura Bassi members of their academy. On the other hand, Pignatelli did not become member of Naples Academy of Sciences founded by Galiani. In his trip through Italy in 1739 and 1740, Charles de Brosses pointed out some of the differences in behaviour amongst women, as he saw and understood them to be. As far as he was concerned, women in Naples were far more withdrawn than elsewhere in Italy.[49] Even if one assumes that De Brosses was grossly exaggerating, it is quite possible that Ardinghelli might not have had the personal freedom her northern sisters enjoyed.

Ardinghelli might have been welcomed at the Tarsia Academy by is male members, but one suspects that custom dictated that she attend meetings only on special occasions. In fact, Nollet did not record any of her attendances at the academy's meetings in his

journal of his voyage in Italy; but he certainly recorded plenty of meetings at her own home. One way learned women could circumvent their inability to participate in academic meetings, either because of custom, or because they were not welcomed, was to create their own salon.[50] Thus, it appears that not only Faustina Pignatelli had her own salon, but also Ardinghelli, at least during Nollet's visit to Naples. Nollet went to meetings at her home practically every day, where he met several learned men, who would discuss scientific topics, such as disputes on Newtonianism.[51]

Ardinghelli would not have had any trouble supervising, and participating in a dispute on Newtonianism. Her translations of Hales' works show that she was familiar with Newton's *Opticks* in Latin, as well as his *Principia.*[52] Unfortunately, what the salon failed to offer was access to equipment, like the one available at the Tarsia Academy. Ardinghelli was able to overcome to some extent this shortcoming by doing experiments at home, and by providing her own equipment; the results of her efforts appeared as footnotes in her translation of Hales' works.

In his biography of Ardinghelli, Diego Vitrioli referred to her correspondence with several members of the Paris Academy of Sciences, such as Nollet, De Lalande, whom she knew personally, Jean Jacques Dortous de Mairan, and Alexis Claude Clairaut (1713-1765). Nollet in his journal mentioned the fact that she had given him some problems in geometry to take to Clairaut. Whether these were problems Ardinghelli wanted the mathematician to solve, or whether these were her own solutions, which she hoped merited publication is difficult to ascertain. Her Neapolitan rival, Faustina Pignatelli, had had four of her problems published in Leipzig's *Nova Acta Eruditorum* of 1734.[53] Perhaps Ardinghelli might have hoped that the problems she sent to Clairaut

would have been good enough to be published in the *Memoires* of the Paris Academy. Apparently, her hopes were never fulfilled, for the problems were never published.

Ardinghelli had also wished Nollet to send her from Paris not only his own publications, but also Clairaut's textbooks, *Eléments de géométrie* (1741), and *Eléments d' algèbre* (1746), designed with the intent to improve the teaching of mathematics. In addition, Ardinghelli had asked for the accounts of the expeditions organized by the Paris Academy in the 1730s to measure the lengths of a degree along a meridian at the Peruvian Equator, undertaken by P. Bouguer, and C.M. de la Condamine, and in Lapland, by de Maupertuis, Clairaut, and A. Celsius to prove empirically that the earth was *aplatie* at the poles, as Newton had suggested, and not *allongée*, as Gian Domenico Cassini's measurements seemed to indicate. Bouguer's results of the Peruvian expedition, *La figure de la terre* had been recently published (1749), while Maupertuis's accounts and result from the Lapland expedition dated from 1738.[54]

Ardinghelli's requests to Nollet demonstrated her desire to become known abroad, and to keep abreast of the latest scientific information, but also of the difficulties she experienced in finding these works in Naples. Furthermore, Ardinghelli might have been informed about the works by Nollet himself, indicating how important her meeting, and then, her correspondence with the abbot would be. It was Nollet, who upon his return to France, encouraged others philosophers, such as De Mairan, and Clairaut to correspond with her.

How profitable, and how extensive was her correspondence with Clairaut is difficult to ascertain. They appeared to have had little in common when it came to mathematics. Clairaut, Maupertuis, D' Alembert, and others in the Paris Academy made extensive use

of infinitesimal analysis in their works. Clairaut had used partial differential calculus in his *Théorie de la figure de la terre, tirée des principes de l' hydrostatique* (1743).[55] Ardinghelli's main instructor in mathematics, published a work on calculus only in 1786; it is doubtful he ever taught it to Ardinghelli, when his own late publication had shown his little familiarity with the subject. Furthermore, if Vitrioli is to be believed, Ardinghelli cared very little for finite or infinite analysis, for in her correspondence with Clairaut she singled out her preference for synthetic geometry, contrary to Clairaut, who thought the analytical method the best.[56] In stating this preference, Ardinghelli was expressing an opinion shared by many Neapolitan mathematicians, who, with the exception of Celestino Galiani and Nicola de Martino--Pignatelli's teacher--felt that infinitesimal calculs lacked rigour. Although Cartesian geometry spread uniformely through the Italian peninsula, when it came to infinite analysis, the south lagged decidedly behind the north in its use. Ardinghelli certainly lagged behind other Italian women, such as Laura Bassi, who used differential calculus in a problem in mechanics she presented to the Bologna Academy of Sciences in 1749, and published in the *Commentarii* of the Academy in 1757, and Maria Gaetana Agnesi, who published a whole volume on the subject in her *Instituzioni analitiche* (1748).[57]

Considering that Ardinghelli and Clairaut had disparate mathematical interests, one might expect that their correspondence would be of short duration. Thus it was to Nollet that she would turn for the latest information in physics. Such was the case, when having learned from the *Gazette de France* that thunderbolts electrified iron points erected towards stormy clouds, Ardinghelli contacted Nollet for further information on the subject. Ardinghelli was referring to the experiment suggested by Benjamin Franklin,

but tried by T.F. Dalibard and assistants at Marly-la-Ville under the sponsorship of the Count de Buffon on May 10, 1752, whereby a metal pole, pointed and insulated would, and did draw electricity from the passing thundercloud. Dalibard reported the results of the experiments at Marly to the Paris Academy on May 13, which demonstrated to him the connection between lightning and electricity. To Dalibard, the tests also proved another of Franklin's conjectures, that a pointed rod, properly grounded, would protect a building from thunderbolts. Thus, a hundred, or so iron rods, strategically placed around Paris, would serve to protect the whole city from thunderstorms.

Nollet, who had been personally insulted by Dalibard in the preface of the latter's French translation of Franklin's *Experiments and Observations on Electricity* (March 1752), commissioned by Buffon, objected to the sanguine claims made by Dalibard. He also objected to the fact that he, himself, had already connected lightning with electricity, and had not been given credit for the discovery. Thus, Nollet urged the academy not to publish Dalibard's results, until they were proven valid by other experiments, including his own. Others had success with the experiment, and to his chagrin, Nollet, himself, had success with a variation of it, as he informed William Watson and the Philosophical Transaction in a letter from July 22.[58]

Ardinghelli had apparently asked in her letter whether the phenomenon was real, what caused such a discovery, and whether the conclusions drawn from the experiment were well founded. Nollet published his answer to her letter as the first letter in his *Lettres sur l' electricité*, mostly, as Heilbron suggests, as a slap to Buffon, who prided himself on his translation into French of Hales' *Vegetable Staticks*. Ardinghelli, a woman, had succeeded in translating Hales' *Hemaestaticks* with plenty of commentaries at the age of

19.[59] In the letter, Nollet explained how the idea to do the Marly test came about, and how other natural philosophers had carried out similar experiments, which helped confirm Dalibard's results, but not before he pointed out that many of Franklin's experiments had already been done in Europe. Then he warned her that if Father Della Torre wanted to attempt the Marly test, he was to be circumspect because those who repeated it at Bologna, and Florence almost repented for having been so curious. They paid for their curiosity with the electrical violence they experienced. It was misguided to believe that one could free humanity from the fear of thunder by erecting iron points.[60]

It is surprising that Ardinghelli was ignorant of Giovanni Battista Terrè's test on June 23 in Florence, and of the experiments done at the Bologna Academy of Sciences by Tommaso Marini and Giuseppe Veratti in July and August of the same year, and thus had to learn of them from Nollet. Della Torre had been aware of Veratti's 1747 experiments, which claimed cures and benefits from electric therapy, and had been critical of them. Perhaps, Ardinghelli had been aware of these atmospheric electricity experiments, but was skeptical of them, until they were confirmed by Nollet.[61] This apparent ignorance, or disregard, on her part of what took place in Italian academies of sciences, which will be again illustrated in her translation of Hales' *Vegetable Staticks*, caused her problems, and increased her isolation in the long run. With no apparent correspondence with Northern Italian natural philosophers, Ardinghelli was dependent on her foreign correspondence for new information; but since, from Vitrioli's statements, it appears that this correspondence never amounted to more than a few letters, she was left dependent on her steady correspondence with Nollet. This dependence on Nollet left her vunerable when

he was to die, and new knowledge on the chemistry of gases, so relevant to Hales' *Vegetable Staticks*, came to the fore.[62]

If again Vitrioli is to be believed, Nollet, who seemed a genuine friend, had attempted to make her a member of the Paris Academy, as her own teacher had become one. This attempt failed, as had failed previous attempts to make Mme. du Châtelet and Maria Gaetana Agnesi members of the same academy. The less prestigious, publicly-funded, Bologna Academy of Sciences, which contained experimentalists with similar interests to her own, was more favourable to the membership of women. It had, amongst its members, besides Laura Bassi, Agnesi, du Châtelet, and Faustina Pignatelli, Ardinghelli's competitor in Naples. Correspondence with experiment-oriented members of the academy might have proven fruitful in the long run. Neither her teacher, Della Torre, nor Ardinghelli, were made members of the academy; one suspects, because they did not actively seek the membership. Their interests were aimed elsewhere.[63]

Ardinghelli achieved fame through her annotated translations of Hales' *Statical Essays*. The first of these translations, *Emastatica, o sia Statica degli Animali* had been completed by 1749, but published in 1750. In 1752, she published *Esperienze ed osservazioni di Stefano Hales*. This work should really be viewed as a continuation of the *Emastatica*, for it contained material found as appendices in both the English original (Hales experiments on kidney and bladder stones), and in the French translation (Sauvages' dissertation on inflammation and fevers). It also contained more recent material on kidney stones done by Hales and others. Hales' *Statica de' vegetabili ed Analisi dell' Aria* appeared in 1756. All three works went through three editions. In 1776, *Esperienze ed osservazioni* was published separetely from *Statica de' vegetabili*

and *Emastatica*, which then constituted a single volume, like its English counterpart, published by Hales as *Statical Essays* in 1733.[64]

The first of Ardinghelli's translation, the *Hemaestaticks*, took its inspiration from the works of physicians and natural philosophers, like Alfonso Borelli, Giorgio Baglivi, Archibald Pitcairne, and James Keil, who believed that mechanical principles could be applied to understand animal functions (iatromechanics). To Hales the body was a machine subject to the laws of hydraulic. Thus his work dealt with the mechanics of circulation, and contained his experiments on blood pressure, carried out on live animals, such as dogs, horses, an ox, sheep, and a fallow doe. He succeeded in recording arterial and venal pressures of the animals, how they changed during exsanguination, and the fact that the force of arterial blood was precisely greater in larger animals. He also concluded that the force of arterial blood, found in the capillaries which entered the muscles, was too little to produce " so great an Effect, as that of muscular motion", that it " must therefore be owing to some more vigorous and active Energy, whose force is regulated by the Nerves". He questioned then, whether such a force would operate by means of a fluid, which ran along the nerves, or whether it would act like an electric force, along the nerves' surface. According to Guerlac, Hales was the first to connect electricity with neuromuscular movement.[65]

The experiments to determine the blood pressure were performed on live animals, and were bloody indeed. No doubts, they caused considerable suffering to the animals concerned. In fact, their unpleasant nature caused Hales to interrupt them for many years. There is no evidence Ardinghelli attempted to repeat any of the experiments. But, there is also no evidence that she disapproved of them in any way. Ardinghelli

seemed quite ready to accept Hales' dictum that the body of animals was "effectively an aggregate of channels and fluids that circulated in these channels with force and velocity." It was a machine organized with number, weight, and measure. Ardinghelli was critical of physician François Boissier de Sauvages, the translator of the *Hemaestaticks* into French, for adding many notes to the translation which had little to do with Hales's text. According to her, Sauvages not only had faulty mathematics, but was also guilty of attempting to re-establish the ancient system, whereby all spontaneous motions of the body depended immediately on the soul. From this fact he drew his theory on inflammation and fevers.[66]

Sauvages had decided to translate Hales' *Hemaestaticks* because the work provided direct experimental evidence (the force of the blood was not enough to move the muscles) that the hydraulic machine of the body could not work without " la nature ", as Galen and Hippocrates would have it, or without " cette puissance mouvante [the soul] qui anime nos corps" (animism).[67] Hales believed the nerves to regulate such a force, either by means of a fluid, or electricity. He made no reference to the soul. To Sauvages, the soul was primarily the non material source of motion for the body machine. It was because the body was a true hydraulic machine that it needed such an immaterial supply of motion to replace what was lost through friction, inertia and attraction. He made this point on several sections of his translation.[68]

It is important to stress that Ardinghelli's teacher, Della Torre, expounded some form of animism in his *Science of Nature*, which went so far as to admit a soul in animals in general. In the book he stated that the soul had the power to move immediately the parts of the body, or the body itself, in a variety of ways. It did so by means of the nerves. If

the nervous fluid did not circulate, the soul caused movement by agitating it; if it did circulate, the soul increased its velocity. He did not go far as to speculate like Sauvages that the soul might have played a role in illness causation, or in repairing the body machine, which harked back to Hippocrates' " healing power.[69]

That is not to say that Ardinghelli did not believe that the soul had a role to play in the movement of the body machine. In fact, in a note on Volume Two of *Emastatica*, or *Esperienze ed osservazioni* (1752) it is clear that she did not approve either of the medical teacher at Halle, Frederick Hoffmann's belief that the source of motion was located entirely in a mechanical body.[70] What Ardinghelli objected to was the fact that Sauvages' remarks on the "puissance mouvante" were out of context in his translation of Hales' work; the latter had not discussed, or dealt with the factor of a soul. Also, she appeared to object to the fact that Sauvages' animism had carried him back to ancient theories on the body.

However critical Ardinghelli was of Sauvages notes, she did not exclude them as she would Buffon's notes, found in his French translation of *Vegetable Staticks*.[71] She may have left Sauvages' notes because she had used the French text for her translation of the *Hemaestaticks*, whereas *Vegetable Staticks* was translated directly from the English. Furthermore, Sauvages' mathematical errors served to emphasize her superior mathematical skills.

Ardinghelli had accused Sauvages of using the translation of Hales' work to his own ends, but the same accusation could be levelled against her. The translation gave her an opportunity to show her mathematical abilities, her knowledge in mechanics, and, most importantly, it served to procure her a position, however marginal, in the world of natural

philosophy. But as a woman, who had most academic venues closed to her, she could be better excused than Sauvages, a professor at Montpellier, for taking such liberties with Hales' text.

Since Ardinghelli had found most of the calculations to have been wrong, she had plenty of opportunities to show her mathematical skills.[72] However, her notes went further than simple mathematical corrections. For instance, Hales had estimated the number of arterial extremities (capillaries) in the human body, but had failed to explain how he had achieved this estimate. Thus, Ardinghelli demonstrated how he had calculated the estimate. In addition, Ardinghelli pointed out Hales' error: the area of a single capillary, which he had used for the calculations, was not the one he had calculated elsewhere in the book. He was off by two decimal points; thus, the error had affected the number of arterial extremities by, at least, the same amount. Therefore, Ardinghelli not only corrected Hales calculations, but also explained how he achieves his results.[73]

The astronomer De Lalande, meeting Ardinghelli in 1765, was impressed not only with her abilities, but also with her modesty.[74] In reality, she appears to have been quite confident of her abilities, as she demonstrated not only in her scorn for Sauvages' mathematical skills, but also in her lack of hesitation to criticize Hales, when she disagreed with his methodology. Thus, in the section where Hales had calculated the number of red globules (red blood cells) in a cubic inch of blood, he was criticized for assuming each red globule to be a cube, whose side was 1 / 3240 inch, and then calculating the number of cubes (globules) in a cubic inch of blood. According to Ardinghelli, what Hales really had to find was the number of spheres (globules), which occupied that cubic inch of blood, for what he had used as his initial number: 1 / 3240

inch, represented not the side of a cube, but the diameter of each globule. As geometry demonstrated, the solidity of a sphere inscribed in the solidity of a cube had a proportion of 157 to 300; such a proportion ultimately affected the number of globules in the cubic inch of blood by almost a factor of two.[75]

In another section, Ardingelli's disagreement with Hales was purely academic since neither she, nor he, or anybody at the time, understood the mechanism of respiration, and the roles of oxygen, and carbon dioxide had in it. Hales admitted not to understand what role air played in the lungs and in the blood, and thus, considered it, as did Ardinghelli, in purely mechanical terms. To Hales, the fact that the blood was diffused over such a large area in the lungs, meant that it would sustain less pressure than if it were concentrated in great amounts in a small surface area. Ardinghelli disagreed with Hales, and believed that the pressure of air in the lungs increased in proportion to its surface area. Thus, the blood in the lungs was exposed to greater air pressure by being difused over a large area than by being concentrated in a small one.[76]

In 1752, Ardinghelli published *Esperienze ed Osservazioni intorno a' calcoli della vescica, ed i reni* containing Hales first experiments on human calculi, which the author had published with his *Hemaestaticks*. Hales having in his possession a human calculus, and finding that on distilling the stone, it released a great quantity of elastic air previously fixed within, decided to test whether some solvent could be found, which dissolved calculi in the kidneys and bladder without damaging these organs. As Guerlac points out, his attempts to find a useful solvent came to naught. However, his perceived expertise on human calculi, made him the obvious candidate to determine, what were the useful ingredients in Mrs. Joanna Stephens remedy for the treatment of human calculi. Mrs

Stephens remedy, to be taken orally, consisted of a mixture of mostly egg shells' white ash (calcium oxide) and a little soap in solution. As Mrs. Stephens' remedy was believed to be successful in the treatment of kidney stones, Parliament payed her 5000 pounds for the recipe in order that it might be published, as it was on June 19, 1739. After analysing Mrs. Stephens' remedy, Hales concluded that the remedy's active ingredients to be lye, used in the soap making, and lime, which was the residue of the burned egg shells. Hales' findings on Mrs. Stephens' remedy was published in 1740, and its French translation in 1742.[77]

Ardinghelli was not aware of the French translation, and thus translated directly from Hales' publication because she was certain of the remedy's utility. As she mentioned in her introduction, the *Memoires* of the Paris Academy of Sciences had a list of forty people, who had been healed, or markedly improved, by using Mrs. Stephens' remedy. Dr. Whytt testified again to its efficacy in the *Medical Essays* published by the Edinburgh Society. According to Ardinghelli, the efficacy of lime water on human calculi was known, well before Mrs. Stephens remedy appeared on the scene. Robert Boyle, himself, had successful used soap in the treatment of kidney stones. To Ardinghelli, what made Mrs. Stephens' remedy effective was, perhaps, how the two main ingredients were combined [78]

After carrying out experiments on human calculi, Hales had concluded that the foods and, particularly, the liquids consumed were responsible for the formation of human calculi. According to Hales, liquids were prone to deposit their particles of tartar in the urine, thus producing stones. He felt it was necessary to analyse the waters around London for sediments. Ardinghelli appropriately pointed out that the analysis of the

London waters were not useful to the Neapolitans. Thus, she provided her own analysis of various Neapolitan waters with an apparatus of her own design, and made at her own specifications. Readers could then decide after the analysis, which were the best waters, because she agreed with Hales that many illnesses could develop from drinking impure waters.

Ardinghelli first measured the specific gravities of the various waters, and found them to be different. She attributed this difference to the different qualities, and quantities of heterogeneous particles with which the waters became impregnated. Therefore, her intent was to measure how much sediment was there left after evaporation for each of the waters under study. To ensure slow evaporation at a constant temperature, Ardinghelli designed a heating system that consisted of a sandbed within an elliptoid copper oven heated by the flame of an oil lamp. The temperature achieved by this method was 135° F. The water was enclosed in a light glass container, which was embeded in the sandbed. Ardinghelli chose a light glass container so as to better discern the very light weight of the sediment, over that of the glass. Then the glass container was weighed with the original water volume before heating, and after evaporation, with the sediment. Ardinghelli also tested rainwater in the same manner. She found that the sediments of spring waters, and well waters were all white, and off white. Only rainwater had a reddish sediment. All the sediments had an unpleasant taste, with the exception of Umbria water, appreciated by many for its medicinal properties. Umbria water had also less sediment than the rest.[79]

As seen, the water analysis Ardinghelli undertook was physical in nature. There was no attempt on her part to identify the sediments chemically, even using the standards of

chemical knowledge of the early 1700s . Nevertheless, by choosing the method of slow, gentle, evaporation, Ardinghelli decreased the possibility that the sediment under examination might contain material from the glass container, which held the waters; such glass residue could, and was found when water was distilled over stronger heat.[80] Also, this experiment illustrates the sort of experiment Ardinghelli could undertake in her own home, once the waters were collected. It required little equipment, as well as little, or no assistance; and the apparatus itself could probably be acquired at a moderate price. The other experiments Ardinghelli made and published in her translation of *Vegetable Staticks*, again required little equipment , and could have been easily carried out in her own home. It was one way she could overcome her inability to use the facilities of physics cabinets found in schools, universities, or even the Tarsia Academy.

Ardinghelli published also in *Esperienze* Sauvages' dissertations on inflammation and fevers, which the French physician had published as an appendix to his translation of the *Hemaestaticks*. No doubt, she felt a duty to publish them since they were in the French version she had used for her own translation of the work. Nevertheless, Ardinghelli had to warn the readers that she had to correct most of the calculations, which contained many errors. To add insult to injury, Ardinghelli published alongside the dissertations, the criticisms the editors of the *Biblioteca ragionata* had levelled against them. Still, the dissertations gave Ardinghelli an opportunity to demonstrate her knowledge of Newton's *Principia*, specifically of Book II, Proposition 36, which dealt with the motion of water running out of a cylindrical vessel through a hole made at the bottom. Sauvages had applied the proposition to the motion of blood in the arteries, when the relationship between the diameters of the trunk to that of the branches changed due to constriction, or

phlebotomy. As expected, Sauvages had failed to explain himself in a felicitous manner, and thus he presented Ardinghelli with an opportunity to clarify mattters.[81]

The most influential of Hales' works to be translated by Ardinghelli was his *Vegetable Staticks and Analysis of Air*, which she published in 1756. Hales publication dated from 1727, and Buffon's influential French translation appeared in 1735. Apparently, Hales, himself, having seen her translation of the *Hemaestaticks*, had asked her to translate the *Vegetable Staticks*. This time, having improved her knowledge of the English language, Ardinghelli made use of the English original for her translation, and thus, only used the French translation as a guide.[82]

In his *Vegetable Staticks*, Hales used the methods of hydrostatics to study the flow of sap in plants. To measure the force with which trees imbibed moisture from the soil, Hales devised " aqueo-mercurial " gauges; with them Hales was able to detect that in the summer months, when trees and vines had leaves, the more the sun shone on the plants, the faster and higher the mercury rose, subsiding only towards the evening, when the sun set. He believed transpiration, which was considerable, played a role in the rise of the sap. As a good Newtonian, he attributed the rise of the sap also to the force of attraction exerted by the capillary vessels in plants. As Guerlac points out, through a series of experiments, Hales discovered root pressure, which he found to be greater during the daytime than at night, and particularly high during the bleeding season.

At the time, there was a widespread belief that sap circulated in the plant, as blood did in animals. Hales experiments showed instead that there was lateral communication along the stem, that the sap moved upwards, between the bark and the wood, but not downwards. This led him to conclude that there was no circulation of the sap. Again,

Hales demonstrated experimentally that shoots grew mostly by longitudinal extension between nodes in an uneven manner: the younger shoots grew more than the eldest ones. He noticed that not only a great quantity of air was inspired through the roots, stems, and, principally the leaves, but that also light might enter the " expanded surfaces of leaves and flowers and contribute to the principles of vegetation". [83]

Having discovered that plants attracted great quantities of air, Hales decided to investigate the nature of air. The results of these investigations were published on chapter six, entitled the "Analysis of Air", a chapter, which was very influential in the development of the chemistry of gases.[84] As a Newtonian, Hales believed that when air was in a fixed state within a body, its particles attracted each other with force; heat and fermentation caused repulsive forces to come into effect, and the particles of air to be released, and pass into a repulsive, and thus, elastic state. Without these properties of attraction and repulsion, matter would be inert, and without action.[85] Unaware that the " airs " he had obtained from various substances varied chemically, Hales approach to air analysis was physical: the " airs " obtained were either in a fixed, or elastic state.[86]

In her translation, Ardinghelli only used Buffon's own translation when it was useful in clarifying some obscure passages. Thus, her translation differed from Buffon's in various places because his version differed from the original. Like in *Hemaestaticks*, but not to the same degree, apparently, Ardinghelli found that various calculations were wrong in the English text, and thus, took the liberty to correct them. Otherwise the purpose of her notes were either to clarify the author's meaning, or to validate his findings.

The notes Ardinghelli attached to his famous experiment on transpiration were designed to clarify Hales' meaning, complete the calculations he had left unfinished, and correct a few mathematical errors. Having found that a sunflower transpired 34 cubic inches of water in twelve hours, Hales decided to determine the rate of flow of this liquid in the roots, stem, and leaves for the same time period. To do this, he determined first the surface areas of the roots, stem, and leaves. By dividing each surface area (of stem, roots, leaves) by the quantity of water the plant transpired in twelve hours, Hales was able to determine the depth of water which passed through each of these sections in this twelve-hour period, and thus each corresponding velocity. However, the velocities Hales had calculated, were the velocities of completely hollow plant sections. But stems, roots and leaves were not completely hollow. Thus, Hales had to adjust for the fact that there was solid matter in the plant. He did this adjustment for the stem, by finding the ratio between the weights of a green stem (full of water), and the same dry stem (deprived of water), and then applying this ratio to the velocity. For this he kept in mind that the velocity increased as the empty space within the stem decreased. Hales had also assumed that there should have been the same ratio for the leaves and roots, but failed to adjust the velocities for these sections.

In her note, Ardinghelli clarified several of the steps Hales had taken to calculate the rate of flow, adjusted, or otherwise, of the different sections; these were not always obvious in the English version. Then she calculated the adjusted velocities for the leaves and roots, which, as seen, Hales had failed to do; furthermore, Ardinghelli also corrected the error he had made in calculating the surface area of the roots.[87] Ardinghelli's correction of the root surface, as well as Hales and her subsequent calculations of the rate

of flow in the roots were of little significance, for neither Hales, nor Ardinghelli, were aware " how small a part of the roots is absorbent, nor how enormously the surface of that part is increased by the presence of root-hairs. "[88]

Ardinghelli provided plenty of mathematical corrections in her translation, which are obvious when one compares the English original with the Italian translation.[89] But, like in the *Hemaestaticks*, she went further than providing simple corrections. Thus, to Hales's conclusion that evergreens, like the lemon tree, transpired less, and thus were better able to survive the winter's cold, as they needed, due to little transpiration, relatively smaller supplies of fresh nourishment to support them, Ardinghelli added her own thoughts on the matter. In them, she made no reference to the plants' ability to survive in winter due to little transpiration; instead, she attempted to provide an explanation to their little transpiration: evergreens like lemons, oranges, and oaks transpired littte , and as a consequence, needed less nourishment from the soil because, from observation, they seemed to be denser, and contain more solid matter than other plants. Consequently, if they had less capacity in their vases, less sap entered them, and less would also be consumed by transpiration.[90]

In the appendix of *Vegetable Staticks*, there appeared two " sea gauges " which Hales had designed in order to measure the depths of the ocean. One such an instrument consisted of a tube of iron, or copper, long fifty inches and closed at the upper end, which could be used for depths 99 times 33 feet. The other gauge consisted of a sphere of nine times the capacity of the fifty inches tube, connected to a tube fifty inches in length. This instrument was designed for depths greater than those reached by the tube gauge. The sea depth was estimated by how much the instruments' air, initially at atmospheric

pressure, was compressed due to the water entering from below, as they sank. According to Guerlac, Hales did not test the instruments to see whether they could function at the depths envisioned by him.

For the translation of the appendix, Ardinghelli invented two mathematical formulas, one for each instrument, which allowed the user to calculate the sea depth from the height of the air in the instruments, a depth, which was only estimated by Hales from the height. Since the instruments were not tested, her efforts were purely academic, but these formulas gave her again an opportunity to display her mathematical skills.[91]

In experiments XXXIX, Hales had come out with an instrument which measured the dilation and contraction of the stem of a vine with heat, or cold, wet or dry, during the bleeding season, or not. His intent was to demonstrate that the sap (even in the bleeding season) was confined to its proper vessels, and that the stem dilated, when it rained, when the water entered through its transpiring pores. Outside of saying that the instrument was a piece of brass-wire, eighteen inches long, whose end would rise or fall about one tenth of an inch, if the stem contracted or dilated about one hundredth of an inch, Hales failed either to provide an illustration for it, or explain it in detail. Thus, it befell Ardinghelli to explain how this instrument could be set up in the vine, in order to achieve the desired results. It is not clear from her explanation whether Ardinghelli tested the instrument herself to see how it functioned; one assumes she did. It could be easily done at her home, in Naples, where vines would not have been in short supply.[92]

Ardinghelli attempted other experiments in her translation of *Vegetable Staticks*. The fact that these experiments were carried out on plants, rather than on live animals, was, no doubts, a determining factor of their being attempted at all. An important set of

experiments was carried out to show the lateral motion of sap, and thus the lateral communication of sap vessels. Ardinghelli did not question Hales' findings, but, as far as she was concerned, others might suggest that Hales had failed to cut all the longitudinal fibres that carried the sap in his experiments. For instance, in the experiment which he carried out on the oak branch, as Ardinghelli pointed out, the branch had a circumference of a bit less than three inches, due to its 7/8 inch diameter. The two one-inch by one-inch long and deep gaps cut by Hales in opposite directions only covered 2/3 of the circumference, thus some longitudinal vessels might have been left uncut. In the experiment carried on a Duke-cherry branch, Hales not only did not provide the width, depth, and height of the cuts, but also failed to provide the diameter of the branch. Like the other, this experiment brought into question whether all longitudinal fibers had been cut.

Ardinghelli carried out experiments similar to Hales, but hers were more precisely executed, and more carefully worded than Hales'. Ardinghelli used two similar branches of cherry trees, both with leaves. The slightly shorter branch had a 3/4 inch diameter, the other, a bit longer, had a 7/12 inch diameter. She removed the bark of the first branch, and made four opposite cuts (North, East, South, and West) in the pith, three inches apart. Each cut was two lines high, 1/4 of the branch's circumference wide, and was deep to its centre. Thus, each cut was one quarter of a cylinder, 2 lines high. She placed both the cut and uncut branches in water for twenty two hours. During this period, the cut branch absorbed six ounces of liquid, as compared to the seven ounces of the uncut branch. Then Ardinghelli made two opposite cuts in the uncut branch. Each cut was a semi circle in width and depth, and 2 lines high. Placing it in water for twenty four

hours, it absorbed and transpired six ounces of liquid, almost the same quantity it had absorbed before being cut. As far as Ardinghelli was concerned her experiments, together with those carried by Hales, demonstrated the lateral communication of the vessels that carried the sap.[93]

Ardinghelli also shared a common belief with Hales that plants did not have a system of circulation like animals, and thus decided to re-enforce his findings with her own experiments. In experiment XLII, Hales had repeated an experiment, which according to Ardinghelli, the Frenchman Perrault had used many years earlier to prove the circulation of the sap in trees. She informed the reader Perrault had believed that plants were endowed with ascending channels, which brought a subtle, light sap from the roots, and descending channels, incompatible with the first, which carried a watery, coarse, liquid down to the roots. Although some accepted that sap circulated, others disputed it, none more so than M. Magnol, who like Hales, believed liquid penetrated either the roots, or branches, descending by the same channels, which also raised it. Also, Magnol felt that many of Perrault's experiments were false. Ardinghelli decided also to try one of these experiments to see whether Perrault's conclusion had been accurate.

Perrault had taken an oak branch, which he had cut at both ends, so that a wax funnel could be adapted at each of these extremities. According to him, water (coarse liquid) passed only through the channels, when poured from the upper towards the lower parts of the branches; from the root-side of the branch towards the lower, it did not, but spirit of wine (subtler liquid) did pass most easily. Like Magnol, Ardinghelli did not believe the experiment to be true, but attempted it by using, instead of an oak branch, several branches of elms cut at both ends. By putting funnels at either end of those branches,

she found water passed, at various speeds, from the lower to the upper parts, as well as from the upper to the lower parts in some branches; in others , the water did not pass at either end, probably, because of some obstruction in the fibres. Thus, Perrault's experiment did not prove the circulation of sap in plants. Nevertheless, Ardinghelli was ready to accept M. Dodorat's opinion, based on sound experiments, that, there might have been a type of sap ascending from the roots, while another type descended from the leaves, without any circulation occurring, for the leaves appeared to have had a role in the nourishment of the lower parts of plants.[94] The experiments Ardinghelli had carried out either in *Esperienze*, or *Statica dei Vegetabili* had, with variations, already been done by others. But if she had shown some lack of originality, Ardinghelli had also demonstrated care, precision, and an eye for details. Unfortunately, the experiments she attempted, and which survive in the records are few. Apparently, Ardinghelli did not try a single experiment from the Analysis of Air chapter, in spite of the fact that several, if not all, were carried out with relatively simple glass apparati, and with easily available material, such as peas, sulfur, or sal ammoniac, to cite a few. In this chapter, her notes were limited to either corrections, further clarification of Hales' mathematics and text, the occasional quotation, in Latin, of a relevant passage of Newton's *Opticks*, as well as reference to possible measurement errors in his distillation experiment, caused by variations in atmospheric temperature and pressure.[95]

One could explain Ardinghelli's small experimental output, by the fact that, as a woman, she had no access to places where, in principle, experiments might have been encouraged, such as the various military academies founded by the Bourbons in Naples during that period. Although she was associated with the more experiment-oriented

Tarsia Academy, it is difficult to determine whether Ardinghelli had access to any of their equipment.

But there were also personal and social factors, which influenced her experimental output. As far as personal factors are concerned, one might say that a lack of technical skill, combined with her own inclinations, might have led her to favour mathematical sciences over experimental ones. One is also left with the impression that Ardinghelli felt it was not really her office to carry out experiments, unless they were needed to clarify, or to prove, an important point made in the book, such as, for instance, to disprove sap circulation. For the sake of the translation, Ardinghelli seems again to have felt obliged to undertake the analyses of Naples' waters, as those of the London waters were completely irrelevant.

Social factors would also discourage Ardinghelli from dabbling extensively in the experimental sciences. Historians, like Vincenzo Ferrone and Pietro Nastasi, who have studied eighteenth-century Neapolitan sciences, agree that the experimental sciences were never a priority in the region at the time. Nastasi points out that experiments on electricity had begun well at the Tarsia Academy in 1747, after the acquisition of an electrical machine, but by 1761, when the Italian translation of Nollet's *Letters on Electricity* was published, no one was interested in the subject. According to Ferrone, if one seeks an echo of Lavoisier's chemical revolution in Naples, one would find no signs of it. One could not find in Naples experimental philosophers like Alessandro Volta, Lazzaro Spallanzani, Marsilio Landriani, or Felice Fontana, or a mathematician like Lagrange. Naples was a region more inclined to philosophical debates, and to the development of the social sciences, than to experimental activity at the time.[96] Thus, in

this context, if one exempts her teacher, Ardinghelli's output, was perhaps greater than average at the time of the first editions of her translations of Hales' works.

Ardinghelli's claims that, with the exception of Professor Taglini of Pisa, other Italian natural philosophers had failed to repeat, or examine, the experiments in Hales' " Analysis of Air ", were not true, and it illustrates how ignorant she was already of the activities of Northern Italian philosophers, as early as 1756. In 1746, 1748 and 1752, natural philosophers like Giuseppe Veratti, Francesco Vandelli, and Tommaso Laghi respectively, working out of the Bologna Academy of Sciences, had carried out, and published experiments, which were directly influenced by Hales' "Analysis of Air ", and in 1753, Giambattista Beccaria of the University of Turin in his *Elettricismo artificiale e naturale*, confirmed several of Hales' findings. No doubts there were other Italian natural philosophers, who had made use of Hales' "Analysis of Air" in the first half of the eighteenth-century; like Hales, the approach they took to the properties of "air" was physical, rather than chemical.[97] As their research predated Ardinghelli's translation of *Vegetable Staticks*, and as very few philosophers knew English at the time, their source of information was Buffon's French translation. Thus, one might conclude that Ardinghelli's 1756 translation was not very relevant, and might explain why it is relatively rare nowadays.

If Ardinghelli's first edition of *Vegetable Staticks* is relatively rare nowaday, the same cannot be said of the 1776 edition. One suspects that the availability of the third edition reflects increased interest in Hales' work in Italy, particularly in his "Analysis of Air", found in chapter six, brought about by the new discoveries in the chemistry of gases. One would not have known such discoveries, all related in some way to chapter six, had

taken place by reading the 1776 edition. Ardinghelli had made some changes in her translation from the earlier edition, but her all important long note at the end of chapter six remained exactly the same in 1776, as it had been in 1756: she was still criticizing Taglini, and suggesting that no one in Italy had attempted Hales' experiments on air. She was still stating that, although Hales' had found a way of measuring the air released, or absorbed by bodies, his experiments had failed to prove that the air the bodies absorbed was actually consolidated inside them. That Ardinghelli was still doing this in 1776, is particularly puzzling in view of the fact that in 1756, in a demonstration of insight, she had pointed out that the airs Hales obtained artificially from various bodies, might have been different from common air, and still have the same elasticity, and specific gravity.[98]

If Ardinghelli's note at the end of chapter six had been problematic in 1756, it would have become obsolete by 1776 in view of the fact that variations of Hales' experiments and apparati were used to produce and identify fixed air (carbon dioxide) (Joseph Black, 1756)[99], inflammable air (hydrogen) (Henry Cavendish, 1766), nitrous air (nitric oxide) (Joseph Priestley, 1772)[100], marine acid air (hydrogen chloride), vitriolic air (sulfur oxide), vegetable air (ammonia), modified nitrous air (nitrous oxide), and dephlogisticated air (oxygen) (Priestley, 1775).[101] Antoine Lavoisier also used Hales' experiments on phosphorus and sulfur, and a modification of Hales' pedestal apparatus to show that phosphorus and sulfur, when heated combined with air and produced respectively acid spirit of phosphorus (phosphoric acid), and " vitriolic acid ", both weighing more than the initial phosphorus, and sulfur. Lavoisier's findings were included in his publication *Opuscules physiques et chimiques* which appeared in 1774.[102]

Priestley's 1772 paper, which announced the identification of nitrous air, and its property to absorb common air, was translated into Italian at Milan in 1774. In 1775, Marsilio Landriani published a work on the salubrity of the air, in which he discussed the reasons for the acidity in fixed air, and provided his own eudiometer models to test air salubrity. In Florence, Felice Fontana, director of the Museum of Physics, and Natural History, published a work on fixed air, where he discussed its acidity. and another work, where he described several eudiometers of his own design. Several of these eudiometers were sent in 1775 to Laura Bassi in Bologna, with whom Fontana and Landriani corresponded. On March 14, 1775, G. Veratti presented to the Bologna Academy a paper on fixed air; his wife, Bassi, was to follow in May with a paper on the effect of flame on fixed air. In 1774, Bassi had presented a paper that pertained to various experiments on electricity carried out by Hales, and also found in his " Analysis of Air ". As Guerlac, and Abbri point out there were others in Italy interested in Hales' chapter six, such as the Count of Saluzzo, and Giovanni Francesco Cigna, both members of the Academy of Sciences of Turin, with whose works Lavoisier was familiar.[103] Even an eclectic journal like the one published by Elisabetta Caminer Turra was very much up to date on the new discoveries associated with the chemistry of gases.

All this widespread interest on gases, and thus on Hales' *Vegetable Staticks*, explains why the Italian publishers decided it might be a good idea to have a third edition of the work in 1776. However, it does not explain why Ardinghelli failed to modify her notes so as to reflect all the changes that had occurred since 1756. It seems that Ardinghelli was not informed enough on the new research on gases to be able to discuss it in her notes, making her 1776 note on the subject painfully out of date. She would not get

much information from her Neapolitan acquaintances for, as Ferrone points out, one would be hard pressed to find an echo of the chemical revolution in Naples at the time; and as the naturalist Alberto Fortis stressed, for all his talents, her teacher, Della Torre, lacked a chemical language. Her ignorance of the activities of Northern Italian natural philosophers in 1756, as well as in 1776, is indicative of her inability to establish meaningful contact with them. This left her contacts in England, and France. These men could have proven more useful than their Italian counterparts; after all, much of the new research on gases began in Great Britain, and spread later on to France and elsewhere. Unfortunately Stephen Hales had died in 1761. Her main contact in France, Nollet, had died in 1770, as did Clairaut in 1765. De Lalande was still alive, but we know of only two letters from him to Ardinghelli, one from 1766, where he recalled his visit to Neapolitan sights in her company; and another letter from 1769, where De Lalande, having received her new book on " les professions religieuses ', and her translation of Telemacus, suggested that she translate the then existing volumes of Buffon's *Natural History*.[104]

Historians have stressed Ardinghelli's contacts with natural philosophers from across the Alps. These contacts were certainly there in the 1750s and 1760s, especially her contact with Nollet, who exchanged with her some seventy letters, if Vitrioli is to be believed. But, again from Vitrioli's indications, it does not appear that her correspondence with other philosophers amounted to more than a few letters. Thus, Nollet's death left her isolated, and little able to receive the latest information on the scientific activities in France. Had Ardinghelli formed contact with philosophers in Northern Italy, the information on gases could have come from them. As such, her

isolation is painfully obvious in her note at the end of chapter six of her third edition of *Vegetable Staticks*. Nollet's death left her dependent on the arrival of new works to Naples via the book stores. These latter, if De Lalande is to be believed, had little trade, and thus left much to be desired. At the margin of scientific activity, women had to work hard not only at maintaining, but also at diversifying their correspondence with those who were at the centre of this activity.[105]

One should also consider that Ardinghelli, herself, might have decided to move away from the sciences, and dedicate herself to literary subjects. De Lalande's 1769 letter seems to indicate such a move. This decision might have been caused by her realization that she would never be considered part of that community of natural philosophers she respected the most, the members of the Paris Academy of Sciences, in spite of Nollet's best efforts. According to Vitrioli, Nollet had read to the Paris Academy one of Ardinghelli's papers whereby she demonstrated the futility of submitting to meaningful calculation the quantity of rainfall in a year, as Sedilous and Mariotte had attempted to do, because of the unpredictability of the topic. Apparently, the academy had agreed with her point of view at the time; but apparently failed to publish the paper.[106] Her attempts to have her scientific output published in the *Memoires* of the Academy always came to naught, and must have discouraged her in the end.

Thus, Ardinghelli may not have been as interested in the sciences in 1776 as she had been in 1756. It is also important to stress that after 1756 Ardinghelli married Carlo Crispo, a judge at the Sacred Royal Council, and then became his widow. The marriage, of which we know little, might have curtailed her scientific activities, particularly in view of the fact that she was supposed to have assisted Crispo, at home naturally, on civil law

matters.[107] Whatever the reasons, it is safe to say that Ardinghelli was not as informed on the latest scientific research in 1776, as she had been in the late1740s, 1750s, and early 1760s.

Nastasi also attributes to Ardinghelli the anonymous translation of Nollet's 1752 and 1760 *Lettres sur l' electricité* which were published in two volumes in Naples in 1761 as *Lettere intorno all' elettricità*. He bases his thesis on three facts: firstly, the introduction of the *Lettere* was similar in tone to her introduction to Hales' works. Secondly, she was a personal friend of Nollet, and thirdly, Ardinghelli was certainly the author of the dedicatory sonnet.[108] The first letter of the series was the one Nollet had addressed to Ardinghelli personally. Most of the other letters in the first volume were addressed to Benjamin Franklin, and objected to the Franklinian system, particularly its concept of negative electricity, and the impenetrability of glass. The letters in the second volume were addressed to various natural philosophers, who had defended the Franklinian system against Nollets attacks.[109]

Very much as Ardinghelli had done at the end of " Analysis of Air ", the translator criticized Neapolitan natural philosophers for failing to apply themselves seriously to the study of electricity. Many were interested when the electrical machine was brought to the Tarsia Academy in 1747, but soon the novelty wore off. Still electricity was a matter that deserved the attention of most nations. Even America had found its amateur in Mr. Franklin.[110] Then, the translator proceeded to praise Franklin for having carried out so many vague and curious experiments, in spite of the fact that many of those had already been done in Europe; but probably, he was unaware of this fact in America.

Franklin was given the credit by the translator for designing the experiment, carried out for the first time in Paris, which proved that thunder clouds were electrical phenomena. This is all the credit the translator was willing to give Franklin; otherwise, she/he found his system bizzare and new. It was Nollet, who did much to elucidate the science of electricity through the discovery of many new phenomena, and by means of his double flux mechanism of electricity as the afflux and efflux of two fluids. This laudatory tone towards Nollet and his system continued throughout the introduction. As far as the notes are concerned, these were few when compared to those found in the translations of Hales' work, and nowhere were they critical.[111]

Ardinghelli had been ready to criticize Sauvages severely for his mathematics, animism, and ability to express himself; she felt free to correct all of Hales' mathematical errors, to disagree with his findings, and to improve on his experiments when she felt it was necessary. Considering how Ardinghelli had behaved in the other translations she had undertaken, one is almost tempted to say that this later translation could not possibly be hers. And yet, Nastasi has a point, for, as seen, Ardinghelli owed too much to Nollet to be critical of his work: it was he who read her paper at the Paris Academy, tried to have her become one of its members, had other members correspond with her, and kept her informed on the scientific activities therein. It would have been too disloyal to be critical. One could say that Ardinghelli took up the translation of Nollet's *Letters* anonimously, not to gain credit for herself, as she had done with Hales' works, but to help a friend when his system was increasingly under attack. Furthermore, Ardinghelli simply did not have the experimental expertise in electricity, or even the possibility to

test many of the experiments, to write critical and learned commentaries on them, as she had done with Hales' work. She took her friend's system at face value.

Ardinghelli's annotated translations clearly demonstrate that she was not just a mere translator, but a natural philosopher, whose abilities in mathematics, experimentation, and natural philosophy would have made her a fitting member of any European Academy of Sciences; and yet, she was not made a member of any academy, or offered any university post. Being cut off from academic life, Ardinghelli was in great need to make contact with as many natural philosophers as possible to keep abreast of the latest scientific developments. Her learned translations provided her with ideal introduction cards to other philosophers in Italy. However, she failed to use these introduction cards, except to the Paris Academy of Sciences. Ardinghelli should have attempted to vary, and expand her contacts. Eighteenth century male natural philosophers understood the importance of networking, as did the women who were to succeed in their fields. By the eighteenth century, one could no longer do science, or even write about it, in isolation. Elisabetta Caminer Turra had neither the formal education, nor the interest in science that Ardinghelli had. She was essentially self-taught, and her main interest was theatre; but she understood well the importance of expanding and varying one's contacts in order to keep informed on the latest scientific developments. As assistant to her father in his journal, *Europa letteraria*, and then, as owner and editor of the same journal, Caminer Turra was responsible for keeping her readers informed, amongst other things, on the latest scientific activities, at home and abroad. She achieved this, by consulting several important foreign journals, and through contact with, and the collaboration of some of the most important men in the sciences in Northern Italy, men such as Lazzaro

Spallanzani, Alberto Fortis, Antonio Dondi dall' Orologio, Giuseppe Toaldo, and Antonio Maria Lorgna to name a few. Such efforts on her part made of her journal, " one of the most luminous, and best informed periodicals of the Enlightenment culture."[112]

IV. *Elisabetta Caminer Turra and the Circulation of New Science*

Elisabetta Caminer Turra, born in Venice on July 29, 1751, to Domenico Caminer, a journalist, and historian, did not receive, like Ardinghelli, a formal education in Latin, mathematics, natural philosophy, or literature. After receiving a summary education from her mother, Elisabetta was sent at the age of 12 to a milliner to learn the trade. However, her interests lay elsewhere. The availability of French literary works in her father's library drew her interest, and in order to read and study them, she taught herself French. By 1769, her translation of a Fenouillot de Folbaire play was performed at S. Lucia Theatre of Venice, some of her poetry was published, as well as her translation of D' Arnaud's *L' Efemia ovvero Il trionfo della religione.* Four volumes of her translation of *Modern Theatrical Compositions* followed in 1772, as well as six volumes of *The New Collection of Theatrical Compositions* from 1774 to 1776. In addition to theatrical compositions, Caminer also translated the *Works* (1781) and the *Idyls* (1782) of S. Gessner, *The New Collection of Moral Tales* by Marmontel (1783), *Picture of Modern History* by Mehegan (1780), and a series of pedagogical works by Madame de Beaumont.[113] As it is apparent, none of the translations mentioned above were of a scientific nature, unlike Barbapiccola's, Vigilanti's, and particularly, Ardinghelli's translations. From her publications, one would conclude that theatre and literature were her chief interests. An inventory of her books, compiled by her husband, Antonio Turra,

at the time of her death on June 1796, seems to confirm these interests. Along with French-Italian and English-Italian dictionaries, and several works pertaining to education, the list contained ancient classics as for instance, Euripides' *Electra,* and Virgil's *Aeneid*, Italian works as Tasso's *Gerusalemme liberata,* and Metastasio's *Opere*, foreign works as Corneille's *Tragedies*, Milton's *Paradise Lost*, and Bossuet's *Universal History,* and volumes on contemporary French theatre, as well as on Danish, German and Spanish theatres .

The publications of a scientific nature were few and included Buffon's *Geography*, a work on peat, a Discourse on Natural History, Three Letters on Fossil Fish, a Popular Instruction on the Domestic Cure of Smallpox, Physical Observations on the Recoara's [Mineral] Waters, Instructions on Bovine Epidemics, papers pertaining to the Public Academy of Agriculture of Vicenza, and a Herbal. There are no doubts Caminer Turra had other scientific works at her disposal, but these were not inventoried because they belonged, and were claimed by her husband, who was a physician and botanist, and the permanent secretary to the Public Academy of Agriculture of Vicenza.[114]

It is obvious from her publications, the books she possessed, and the performances of the plays she translated in Venetian theatres that Caminer never became a milliner. In fact, by the time she was 17 years old, Caminer had been taken away from her apprenticeship, and had joined her father in his journalistic enterprise. By September 1768, Domenico Caminer had launched his *L' Europa letteraria*, published in Venice, which was one of several periodicals carrying literary and bibliographical information from abroad, and from home, in the form of abstracts, notions and reviews. As the periodical progressed, the editors also added full length articles to their repertoire, which

appeared usually in the form of letters , written mostly, by members of the Italian learned public.

The editors' intent was to provide the readers, in this case, associate members, with the latest information on a variety of subjects, such as literature, arts, philosophy, manufacture, agriculture, medicine, technology, and sciences. The information that came from abroad was drawn mostly from French periodicals. such as *Mercure de France*, *Journal des Savants, Les Observations sur la Physique, l' Histoire Naturelle et les Arts* of the Abbé Rozier and Mongez, and particularly, from the *Journal encyclopédique pour une societé de gens de lettres*, printed at the principality of Bouillon by Pierre Rousseau and others. Through the years, the editors also drew from Italian periodicals as Carlo Amoretti's *Opuscoli scelti sulle scienze e sulle arti,* G. Griselinis's *Giornale d' Italia spettante alla scienza naturale, e principalmente all' agricoltura e al comercio*, Giuseppe Toaldo's *Giornale astro-metereologico*, G. Orteschi's *Giornale di Medicina,* A. Calogerò's *Nuova raccolta di opuscoli scientifici e filologici*, and others.[115]

Caminer Turra also gathered the latest information in a variety of topics from a network of Italian men of letters, natural philosophers, physicians, reformers, and amateurs of science, who not only came from the cities of the Venetian Republic and the University of Padua, but also from Pavia, Milan, Turin, Florence, Bologna, Naples, and other places where the journal's members could be found. She ensured that they provide her with dissertations, abstracts of their works, or of others, which could then be published in the journal.[116] The relationship was symbiotic: Italian authors needed a place in which they could publish, and/or publicize their works, and Caminer needed up-to-date information on a variety of topics, which she could then share with her readers.

Thus, as shall be seen later, when the French Revolution disrupted her French sources, Caminer Turra was able to replace those sources with a greater number of Italian ones. When a contributor to her journal moved away, Caminer was able to replace him with another for the period he was unable to contribute. Consequently, the periodical was able to maintain a high standard throughout due to the loyalty of many of her contributors, and her ability to maintain this loyalty. As the naturalist, and most important contributor to the paper, Alberto Fortis stressed to the naturalist Lazzaro Spallanzani in 1768 that one had to be humbled by a young seventeen years old woman, who assembled all the material for the paper, and also worked, especially, around the poetic pieces with a maturity well beyond her years.[117]

In 1773, the periodical changed name, and became the *Giornale Enciclopedico*, still the work of father and daughter. The father remained director of the journal until 1777, when Caminer Turra took over. But since 1774, she and a new collaborator Giovanni Scola, a lawyer, had been the editors. In 1777, the periodical's printing had passed to Vicenza (Venetian Republic), where Elisabetta lived after her marriage to Antonio Turra on September 19, 1771. From 1780 to 1790, when again it was published in Venice, the journal came out of her husband's press at Vicenza. Scola remained with the periodical until 1781. In 1782, Elisabetta proposed that Alberto Fortis, who had had an off and on relationship to the journal since its inception, become co-director, so that nothing could be printed without his approbation. From 1783, under his co-directorship, the journal became known as the *Nuovo Giornale Enciclopedico*, to change its name to *Nuovo Giornale Enciclopedico d' Italia*, after it returned again to Venice in 1790. It is important to stress that if co-directors influenced the journal's contents, they were not

responsible for its survival, for the journal was able to survive their individual departures. The *Giornale enciclopedico*, under its various names, owed its existence to Caminer Turra, the driving force behind it. The moment she died, the journal ceased to exist.[118]

Her co-director and collaborator, Abbot Alberto Fortis (1741-1803) had begun his career as an Augustinian monk, under pressure from his family. His dislike of, and unsuitablity for, monasticism won him dispensation from the pope, and allowed him to become a secular clergyman. He also abandoned theological studies for natural history and literature. But, it was to the field of natural history, and particularly, to minerology that Fortis made his greatest contributions.[119] His extensive publications on the subject, translated into several languages, made him one of the top minerologists in eighteenth-century Italy, together with Ludovico Moro, and Giovanni Arduino.[120]

Before joining father and daughter as a collaborator to the *Europa letteraria*, Fortis had co-directed the short-lived *Magazino italiano.* His previous journalistic experience must have proven useful to the Caminers. Fortis was to influence the journal in many ways; for instance, while present as a collaborator and co-director, his interests in natural history and, particularly, in mineralogy, were reflected in the contents of the paper. Furthermore, Fortis was dominant in introducing the Caminers to men of letters, and natural philosophers, such as Lazzaro Spallanzani, Melchiore Cesarotti, Giuseppe Barbieri, Antonio Vallisneri Jr., Giuseppe Toaldo, Giovanni Arduino, Marcantonio Caldani and others. Many of these men were known to him through the salon Fortis' mother, Francesca Capodilista, kept at her home in Padua. He was even responsible for introducing Caminer's future husband to her. Fortis and Antonio Turra had undertaken several field trips together, before the former joined the *Europa letteraria.*[121]

De Michelis claims that Fortis gave some scope and direction to Elisabetta's self-acquired education, and he is most probably right. The naturalist was a man of extensive culture, not only in natural history, which he loved, and theology, which he was forced to learn, but also in astronomy, architecture, literature, philosophy, economics, and even agriculture.[122] It is clear from his letters to Spallanzani, that Fortis was absolutely convinced of Elisabetta's intellectual abilities, which he felt to have been superior to those of her father. He referred to her several times as " our Du Châtelet ". Caminer Turra had not Du Châtelet's knowledge, or interest in mechanics and mathematics, but she certainly had the ability to understand a variety of scientific topics well enough to summarize them adequately for her journal.[123]

It was not Caminer's intent to become a natural philosopher. She only wanted to ensure that her periodical would contain up-to-date, and useful information on a variety of topics to make it attractive to as many people(men and women) as possible, and thus guarantee its survival. At a time when periodicals quickly appeared, and just as quickly died, the fact that her journal survived for 28 years, and was to disappear only after her death in 1796, is indicative of the loyalty Caminer Turra inspired amongst the journal's members, and its collaborators, as well as of her ability and determination to make it viable.[124]

Caminer Turra's success as a journalist came at a price; her friendship with Fortis, and with other collaborators, was subject of considerable gossip, as were the salons she had organized first in Venice, and then at Vicenza, which acted as centres for gathering ideas and information for her journal. The gossip had made her the lover, not only of Fortis, a clergyman, but of several other men, some of them her collaborators. It is true that Fortis

and Caminer Turra remained friends throughout her life; and it is also obvious from his letters to others, that he greatly admired her; whether this friendship had taken a physical turn, is open to question. Nina Rattner Gilbert in her article on seventeenth and eighteenth century women journalists in France and England makes reference to their irregular family life; perhaps the same could be said of Caminer Turra. Nevertheless, one should also be aware that malicious gossip was often associated with women like Laura Bassi, Margherita Sarrocchi, Clelia Borromeo, and also, Elisabetta Caminer, who were not suitably humble, were independent, and determined to break some of the barriers society had imposed on them.[125]

As already discussed, the Caminer Turra journal covered a variety of subjects; but for the purpose of this work, only science-related topics will be taken into account, to show what sort of up-to-date scientific information the journalist offered her readers,and how she was able to provide such knowledge over the twenty years of the periodical's existence. The first topic to be considered will be the development of the chemistry of "airs" (gases), so important in the second half of the eighteenth-century, and so relevant to Ardinghelli's translation of Hales' *Vegetable Staticks*. As early as 1756, Ardinghelli had shown to be ignorant of the use some Northern Italian natural philosophers had made of Hales' "Analysis of Air ". By 1776, this ignorance had spread to advances made on the chemistry of gases in England, and France, to which Hales' work was fundamental. As shall be seen Caminer Turra and her journal were better informed.

In April and May 1774, the Caminers printed two abstracts of Joseph Priestley's " Observations on Different Kinds of Air ", which had appeared in England in 1772, and which contained, amongst other things, methods to produce and collect fixed air, and

nitrous air, and a means to measure air salubrity. Two abstracts of French works discussing fixed air were published in April 1774 and January 1775.[126] In February 1775, Domenico Caminer reviewed the *Raccolta di opuscoli fisico-medici* (Florence, 1775), which contained many articles from France, England and Italy on fixed air and its properties, and on other types of gases. These abstracts were followed in rapid succession by two others on May 1775 of works by major players in the chemistry of gases in Italy, Felice Fontana and Marsilio Landriani. The May volume also provided the readers with a summary of the articles in the Abbé Rozier's *Observations sur la physique* for the months of November and December 1774, and January 1775. Amongst these articles, there was one of the dissertation Lavoisier had presented to the Paris Academy of Sciences on November 12, 1774. It dealt with the calcination of metals (tin and lead) in enclosed recipients (a variation of Hales' pedestal apparatus), and the reasons for the increased weight these acquired during this operation.[127]

Thus, by mid 1775, and well before the third edition of *Statica dei Vegetabili* was published, an eccletic periodical like the *Giornale enciclopedico*, published by a father and daughter with no formal training in natural philosophy, had notified its readers of several important works in the chemistry of airs. They achieved this by borrowing information from French and Italian periodicals, as well as by publishing abstracts provided by the various authors themselves, or by natural philosophers who had read the books.

The periodical contained many excerpts or/ and abstracts on the topic of chemistry, which informed the reader of its latest developments, such as Priestley discovery of dephlogisticared air (oxygen), as well as some of its important debates. For instance,

the translation of Priestley's *Experiments and Observations on Different Kinds of Airs* (Paris, 1777) received attention in 1777, as well as Fontana's *Recherches physiques sur la nature de l' air nitreux et de l' air déplogistiqué* (Paris, 1776).[128] Jean Senebier's seminal works on the roles "airs" and light played in plant economy, *Physical Chemical Memoire on the Influence of Sunlight in Modifying the Beings of the Three Kingdoms of Nature* (Geneva 1782), and *Recherches sur l' influence de la lumière solaire pour metamorphoser l' air fixe en pur par la vegetation,* (Geneva, 1783), abstracted by the author himself, were published in 1783 and January 1784 respectively. Most likely, the editors had obtained these abstracts through Lazzaro Spallanzani, a friend and correspondent of Senebier, as well as a friend of both Caminer Turra and Fortis.[129]

Abstracts in the periodical dealt with attempts by Guyton de Morveau, Lavoisier, C.L. Berthollet and A.F.de Fourcroy to reform existing chemical nomenclature, whose alchemically-based terms bore little resemblance with actual composition, such as Morveau's *Mémoire sur les dénominations chymiques, la necessité d' en perfectionner le système et les règles pour y parvenir* (May 1782) which appeared in September 1782, and *Méthode de nomenclature chimique, proposé par M.M. de Morveau, Lavoisier, Berthollet, & de Fourcroy* (Paris 1787), published in 1788.[130] The journal also covered the controversy associated with Lavoisier's theory of the composition and decomposition of water which established water as a compound, and not the element natural philosophers since Aristotle's time believed it to be. Sparked by claims to priority of discovery, by theoretical differences, as well as by experimental uncertainties, the controversy spread through Europe.[131] Thus in 1784, the journal published excerpts from memoirs by De la Métherie (April) and Lavoisier (June) which presented

opposing views of the debate. [132] In April 1785, it covered Priestly's 1783 paper which explained the water formed at the end of the process of burning inflammable air (hydrogen) in dephlogisticated air (oxygen) in terms of the phlogiston theory.[133]

Most of the abstracts and excerpts, published in the periodical from 1786 to 1791 either of Italian, French, Swiss origins which dealt with the chemistry of water, disagreed with Lavoisier's theory of the decomposition and recomposition of water. These negative reviews were, in part, motivated by attacks on the theory, which appeared in the French periodical that Caminer Turra used. But they were also motivated by her co-director, Fortis' attitude towards Lavoisier's theory. Supporters of the phlogiston theory, such as William Scheele, Fontana, Sennebier, and Cavendish, and their works were suitably praised. But it was Priestley who merited the greatest attention. Abstracts, excerpts and reviews of his works appeared in the periodical in 1786, 1787, 1788, 1789 and 1791.[134]

In spite of abstracts of works by phlogiston die hards, like Priestley and Fontana in 1791, and Ermenildo Pini in 1794, the tide began to turn in favour of Lavoisier's theory and nomenclature in Caminer Turra's journal from 1791 onwards. The changes began to occur mostly within the Italian community of chemists, at a time when the French were mostly occupied with the political events of the French Revolution.[135] Already by September 1789, unable to get a copy of Lavoisier's seminal work, *Elements of Chemistry*, Caminer Turra felt it to be her duty, due to the importance of the work, to translate a review of it which had appeared in a foreign journal. In 1792, Giuseppe Olivi, who had already adopted Lavoisier's theory and nomenclature, had the opportunity to review the 1791 Italian translation of *Elements of Chemistry* by Vincenzo Dandolo.

Dandolo's annotated second edition of his translation, which appeared in 1792, was reviewed by another convert to Lavoisier's theory, Giovanni Battista di San Martino. In 1795, Dandolo was to provide his own abstract of his new publication, *Fondamenti della scienza chimica-fisica* (Venice 1795), dictionaries, which compared the old chemical language with the new one, and vice-versa. In 1793, another of Lavoisier's supporters, Abbot Giuseppe Tomaselli reviewed Giovanni Antonio Giobert's *Esame chimico della dotrina dei pneumatisti...*(Turin, 1793). Giobert, from the Turin Academy of Sciences, had begun using Lavoisier's nomenclature as early as 1790, one of the first natural philosophers in Europe to do so.[136] By April 1796, a few months before Caminer Turra's death, Francesco du Pré of Verona, a former anti-Lavoisirian, had come to the conclusion, perhaps optimistically, that Lavoisier's theory and nomenclature was by then understood by all the learned.[137]

Most likely, Caminer Turra did not place any more importance to chemistry than to any other scientific topic which appeared in the journal; still by focusing on abstracts and excerpts, which dealt mostly with pneumatic chemistry, one is able to trace the debates that eventually led to the affirmation of the new chemistry. Caminer Turra was able to show such developments in chemistry because she was able to draw from a variety of sources; thus she drew from Italian, and occasionally, English sources when the French sources had become erratic due to the French Revolution. The journalist seemed to have understood that to a woman, excluded from scientific institutions of learning, varied and extensive contacts were essential ingredients to keep one well-informed. Ardinghelli seemed not, or cared not to undertand this fact.

Caminer Turra tended to avoid discussing in the journal subjects of considerable difficulty in great detail, as celestial and terrestrial mechanics, and mathematics. These subjects were often given brief mention when the paper printed abstracts from the acts of different Italian and foreign scientific academies. Thus, abstracts from the acts of such Italian academies as the Institute of Sciences of Bologna, Verona's Military Academy, and the Academies of Sciences of Padua, Naples, Siena and Turin covering these topics appeared in the periodical, but not on a regular basis, in part because they were not regularly printed, and in part because the priorities of Caminer Turra and her co-directors lay elsewhere.[138]

From the journal's inception, Caminer Turra's main scope had been to inform the readers of the scientific activities of academies from across the Alps, and this she did to the best of her abilities. Thus extracts of the *Philosophical Transactions of the Royal Society of London*, and of the *History of the Royal Academy of Sciences and Letters of Berlin*, taken from the *Journal Encyclopedique de Bouillon* and translated frequently by Caminer Turra herself, or commented by Fortis, appeared very often indeed from 1768 to 1793. Acts from Academies of Sciences of Paris, St. Petersburg, Sweden and Dijon were also to appear with some regularity in the journal. The acts of these academies would contain articles by Lagrange, Euler, Laplace, Bernoulli, Legendre and others, which would be too specialized for an eclectic journal like the *Giornale enciclopedico*, and thus would receive the barest of description in the journal, like their Italian counterparts.[139] The editors intent to give priority to foreign periodicals, over Italian ones, was never as evident as when Fortis had the greatest control over the journal. From May 1782 to September 1784, Caminer Turra and Fortis gave extensive coverage to three major

French periodicals on a regular basis, Rozier's *Observations sur la physique*, the *Journal des Savants*, and the *Journal Encyclopedique de Bouillon.* By giving such an extensive, regular, coverage to these foreign journals, it follows suit that Italian periodicals would be forced out of the journal due to lack of space.[140]

There is not to say that works by Italians in mathematics and physics would be neglected by the editors, for they received regular coverage throughout the journal's history. This coverage normally took the form of abstracts by collaborators, or by the authors themselves,such as Anton Maria Lorgna, a friend of Caminer Turra, of works already published; or it could include letters, problems, dissertations, or points of dispute between mathematicians. [141] Ravoux-Rollo stresses that Caminer Turra left excerpt, abstracts and reviews of scientific subjects to the experts, which is only partially true. As she lacked the mathematical background, Caminer Turra would certainly shy away from providing abstracts on Italian works in physics and mathematics; except that she was responsible for several translations of foreign abstracts of books in these subjects. For instance, in 1769, Caminer Turra provided the Italian version of the *Mercure de France*'s abstract of the mathematical dissertations by the Abbé de Rondon and by d' Allembert. And, at least on one occasion, she provided her own abstract to an Italian work in physics.

In 1771, Caminer Turra summarized a letter by the Venetian Republic's public optician, Domenico Selva, on his own findings on the Flint glass needed for the concave lenses of achromatic telescopes. Dollard, the British discoverer of Flint glass, had kept its composition a secret. Many across Europe had tried to duplicate the formula, but, according to Caminer Turra, Selva was the first optician, who succeeded in doing so.

This achievement gave her the opportunity to encourage other Italians to follow in Selva's footstep, so that those who lived across the Alps would learn not to despise, as it was often done, Italian productions.[142] This was a recurring theme, undertaken by Caminer Turra and Fortis, throughout the journal's existence: the editors praised Italians who achieved results, and scolded and prodded those who did not, so that Italians might also be at the forefront in technology, science, and agriculture, as their Northern European counterparts.

Caminer Turra would certainly provide plenty of abstracts from scientific works which did not require extensive mathematical knowledge. For instance, her marriage to physician and botanist Antonio Turra, who was also Perpetual Secretary to the Agrarian Public Society of Vicenza and director of the botanical garden of Mons. Marco Corner, Bishop of Vicenza, facilitated her introduction to botanical works.[143] This fact is reflected in the journal, where works in botanics began to appear with regularity only after September 1771. Within a year of the marriage, at least eight abstracts of Swedish, German, Russian and Italian botanical works were printed. Several of these summaries were made by Turra himself, but others carried Caminer Turra's signature, and, one suspects, that some of the works originated from Turra's personal library.

The abstracts came from taxonomical works in Latin by Linnaeus, Scopoli, Gmelin, Necher, Vandelli and others. Now, Caminer Turra, by her own admission, was no expert in the Latin language; therefore one might assume that the abstracts might have been translations, taken from foreign journals she had failed to name. But, since the abstracts provided only a brief, and straight forward summary of the books' contents, her Latin might have been adequate enough to cover such contents. For instance, her summary of

Vandelli's work referred to the fact that the author had described, and provided drawings, of four new genera of Brazilian plants, and also of nineteen new species, which she then proceeded to name. No extensive knowledge of Latin was required for such an exercise. In later years several of the abstracts in botany, which carried her name, were taken from the *Journal Encyclopedique*, and were most likely translations. One of the exceptions to this rule was her abstract of Lamarck's *Methodical Botanical Encyclopedia*, where no references to a journal were given by Caminer, and thus it might have been her own.[144] As might be expected, the works of her botanist and physician husband also appeared in the journal, either as abstracts or full length articles. [145]

The journal contained many abstracts, and also original articles, on health-related topics. Caminer Turra and co-directors covered Italian and foreign works in anatomy, physiology, clinical nomenclature, and other subjects relevant to the teaching of medicine.[146] But the greatest majority of the abstracts pertaining to medicine, dealt with the treatment, and/or the prevention of diseases. Caminer Turra's intent was to inform, reform, and at the same time, be useful to her own reading public, and other members of society affected by that public. In spite of their desire to reform, and enlighten society, Caminer Turra and Fortis remained realistic, and even skeptical, as to what could ultimately be achieved. One of the diseases, the editors hoped to help eradicate through inoculation was smallpox. Inoculation had been available in England since the 1720s, and would only be regularly carried out on the wealthy. But, as infection, or a case of "natural" smallpox would often follow these early inoculations, even the rich would opt out of such a treatment, unless faced with a smallpox epidemic. People also feared that those ill with inoculated smallpox might spread the disease to the rest of the community.

However, by the 1760s the Sutton family of surgeons had developed a less dangerous method of inoculation which made it more attractive to those enlightened enough on the subject.[147]

Caminer, Caminer Turra and Fortis began their campaign in favour of extensive inoculation from the journal's inception, but, unlike the campaign initiated by Haygarth in England in the 1770s, their efforts had little to do with religious dissent, and were more in the spirit of any reform encouraged by the *Encyclopedistes.* A fair number of the abstracts published had foreign origins, and either covered better methods of inoculation, and/or dealt with the campaign for inoculation in specific places. Caminer Turra herself translated Voltaire's letter to Paulet on the history of smallpox from the *Mercure de France.* [148] Other abstracts were Italian in origin, and dealt with inoculation programs in Italian towns, such as Padua. Believing that aristocrats needed to lead the way by inoculating their children, the editors singled out for praise in 1771, Countess Marianna de' Bertolozzi de' Bettai who had her four children inoculated. [149]

The editors also discussed other diseases, in addition to smallpox. Many of these diseases were relevant to the inhabitants of the Venetian Republic. In 1782, Caminer Turra translated a discourse presented by Pringle at the London Academy of Sciences, which dealt with the dietary means to preserve sailors from scurvy during long sea voyages. The discourse was printed in full for it was deemed extremely useful to a state with a navy, like Venice.[150] Pellagra was another disease that received the editors' attention, as it affected farm workers of Austrian Lombardy and the Venetian Republic. It appeared not to be contagious, and be related to bad food, and thus could be treated by a vigorous dietary regimen, which included butter and milk.[151]

If physicians, and the editors recognized the value of a proper dietary regimen for scurvy and pellagra, however, haphazardously, Caminer Turra failed to recognize another disease, also affected by diet, which was as endemic as pellagra in approximately the same region. In this, she may have been misled by the author of an article that appeared in the *Memoirs of the Philosophical and Literary Society of Manchester.* In the article, a certain Clayton described, what he defined, undoubtedly influenced by the Linnean classification of man, a race of men called crestins, who inhabited the Valois in France. They were short, pale faced, imbecile, had a large mouth and thick lips. Caminer Turra was quick to point out that the districts of Bergamo, and the mountains and valleys of Brescia also had this degenerate race. They had a strange, irregular twisted physiogomy. The majority had also a large goitre, and dull and crude abilities. What the journalist described were people, who suffered from goitre, a disease endemic of alpine valleys of Lombardy at the time, caused by iodine deficiency in the diet and drinking water. Before the fashion of classification took hold amongst the public in the eighteenth-century, goitre was considered an illness. As early as the twelfth-century, Ruggero da Parma, of the Salernitan school, treated people suffering from goitre with *spongia marina*, which is now known to contain iodine. Such a knowledge, which was most likely available to the women of the Renaissance, and early Baroque periods familiar with herbals, seemed to have been lost to Caminer Turra, and others who classified people with physical abnormalities as subspecies of "true" man (Homo sapiens).[152]

In spite of Caminer Turra and her collaborators attempts to assist and reform society through the contents of the journal, they remained skeptical as to the value of several of

the works they presented. For example, German, Italian, English, French, and Austrian works on hydrophobia and its cures appeared often enough in the paper. Nevertheless, by 1785, Caminer Turra had come to the conclusion that the true antidote to this poison, as she called it, was yet to be found, in spite of the fact that new cures appeared almost daily.[153]

Caminer Turra was also skeptical of electrical therapy, which had been first used in Italy in 1747 by Giovanni Francesco Pivati, Giuseppe Veratti, and G.B. Bianchi of Turin. Veratti, a physician, had claimed that electricity aided in the cure of arthritis, rheumatism, headaches, and paralysis. The Italians' claims were disputed at the time both at the Royal Society of London by Priestley and others, and at the Paris Academy, by members like Nollet. Such bad early publicity abroad might have taught Italian physicians to approach electric therapy with caution in later years. In fact most of the works in electric therapy covered by Caminer Turra were not Italian, but had originated abroad in places like France and Scandinavia. Their claims, far more exaggerated than those of Veratti's twenty years earlier, were readily dismissed by Caminer Turra. As far as she was concerned, Italians had known for a long time that electric therapy had little success in re-establishing health. It had been used many times in the past with little result.[154]

The greatest skepticism was, however, reserved for magnetic therapy, as expounded by Mesmer and his supporters. Abstracts of works on animal magnetism appeared in the journal as early as 1776; but they were rare until 1784, when the popularity of Mesmerism reached a peak in France. Then, within a period of one and a half years, at least eleven abstracts on the subject, many penned by Fortis, a few by Caminer Turra, were printed.[155] In August 1784, Caminer Turra had limited herself to state that animal

magnetism had become fashionable, and thus, it was a topic which could not be avoided by the editors. Fortis was not so kind. In December he congratulated the anonymous French author who made fun of the credulity of many, and of the charlatanism of the mesmerizers. This same charlatanism was in danger of crossing the Alps, invading Italian capitals, and making them ridiculous to wiser nations.[156] With such a negative attitude towards animal magnetism, it is not surprising that Fortis and Caminer Turra decided to publish in its entirity the report of the French Royal Commission on animal magnetism. The Commission, ordered by the crown, and headed by Lavoisier and Franklin, concluded that animal magnetism could not be detected by any experiments, that the convulsions experienced by those being cured were nothing but a case of mass hysteria, and that these mass convulsions were particularly contagious amongst women. To this Fortis added that in praise of Italy the Mesmers would not make money in the majority of the most important Italian cities, because such a public display between men and women, encouraged in magnetic cures, would not be tolerated by officials a week.[156] If abstracts covered by the journal can serve as a guide, it appears that Fortis was essentially right. It appears that only one abstract of an Italian translation of a French work in favour of animal magnetism appeared in the journal, which seems to indicate that mesmerist theory and therapies never caught on in Italy to the same extent they did in France and England.[157]

If Caminer Turra was ready to be skeptical in print about many therapies, it is harder to explain her silence when it came to abstracts--most of them French-- on the *maladies des femmes*. As seen in the introduction, the journalist had been ready to defend the achievements of contemporary Italian women learned in science. Furthermore, in her

review of *Disgrazia di Donna Urania*, Caminer Turra savaged the author, by referring to his attempts to ridicule women who studied, as obscenities not worthy of rebuttal. She also provided eulogies in her journal for Italian female luminaries like Laura Bassi, Clelia Borromeo, and Maria Pellegrini Amoretti when they died. Pellegrini Amoretti's degree in law from the University of Pavia also received attention, as well as her work on Roman law. Cristina Rocccati's lectures in particular physics and astronomy given at Rovigo's Academy of Concordi in 1771 were mentioned in the journal under the title of women who study and teach good works.[158]

The women mentioned above had broken the boundaries of domesticity, and played a very public role: Amoretti, Bassi and Roccati had degrees; the last two taught for many years, and Borromeo had founded her own experimental academy. Caminer Turra herself published extensively: her translated plays were popular in theatres; she had her own salon, and instead of nourishing a child with her own milk, as proposed by several of the works on the *maladies des femmes*, she nourished her journal instead. It was precisely this kind of very public lifestyle that the authors of these works, influenced by Rousseau, saw as the root of all evils. The public life of theatres, salons, and academies endangered women's nervous health, made them subject to vapours that emanated from the womb, and made them hysterical. The cure was domesticity, and the breast feeding of children.[159] Caminer Turra's only contact with children seems to have been limited to her teaching them theatre from a stage set in her own home. Rousseau, whom she apparently admired, could not have approved of such an enterprise; as he would not have approved of the fact that she ran a journal with greater success than many men. One is tempted to conclude that Caminer Turra may have accepted such a restrictive view of

womanhood as expounded by Rousseau, and by the authors of the articles so favourably reviewed in her journal, for she allowed them to be printed without any objections on her part. These objections often appeared when she did not agree with the subject discussed. Why did she did not object to such restrictions when her own lifestyle was so different? For an answer one should turn to Gita May's article " Rousseau's Antifeminism Reconsidered ". According to May, Germaine Necker could admire Rousseau because she was not concerned with the rights of women in general, but only with those of exceptional women, whose abilities set them above the rest. Caminer Turra, brought up in a country, where, as seen, even conservative men accepted that exceptional females were not bound by the rules that affected ordinary women, no doubts considered herself exceptional. Thus, Rosseau's restrictions needed not to concern her personally.[160]

The journal covered two other, somewhat related, topics, meteorology and agriculture, which again reflected the various governments' policies, and Caminer Turra and her collaborators' desire to encourage reform, and to be useful. In meteorology, one of the first arguments to get the attention of the journalists was the installation of lightning conductors in various parts of the Venetian Republic, the Duchy of Tuscany and Austrian Lombardy.[161] From 1782 onwards, Caminer Turra began printing monthly meteorological observations carried out first at Padua by Giuseppe Toaldo, then at Vicenza and Zara by Giovanni Battista de S. Marino. San Martino and Toaldo believed that meteorological observations would be useful in agriculture.[162] Undoubtedly, it was this view on utility, which also determined Caminer Turra's printing of meteorological tables in the journal, month after month, and year after year. How useful were observations taken at Padua and Vicenza to readers in Naples, or Florence, is open to

debate. Still they could provide a printed local record of the previous year, which then could serve as a guide in the next.

Caminer Turra's intent to make her journal useful, and to encourage reform was never more obvious than in her coverage of agriculture-related topics. Agricultural reform became a topic of great concern to the intellectual elites and governments alike after a severe dearth hit large areas of Northern Italy in 1764-66. In Tuscany, Peter Leopold refounded the Agricultural Academy of Georgofili so that it might become a technical consultative body attached to the government. A similar institution appeared in Austrian Lombardy in the Milanese Società Patriotica. In the Venetian Republic, the impetus to transform literary academies into agricultural societies came from Venice by means of an alliance of magistrates and reformers,who forced the goverment into action. Ultimately, these academies would be more concerned with technical scientific topics than with socio-economic changes.[163] The Public Academy of Agriculture of Vicenza, to which Antonio Turra was the permanent secretary, was one such a body.

The journal did present some abstracts, or articles, which emphasized socio-economic changes.[164] But, on the whole, Caminer Turra and her collaborators, such as her husband, found it easier to print abstracts and articles from Italy, or abroad which provided technical scientific advice, rather than socio-political solutions to the problems of agriculture. In addition to providing abstracts of textbooks that taught better farming methods, Caminer Turra printed also abstracts, or articles, which dealt with improvements of existing products, the introduction of new crops, and attempts to find and understand diseases in plants and animals. Furthermore, since Caminer Turra was associated with the Agrarian Academy of Vicenza through her husband, the periodical

did not fail to cover its activities.[165] For instance, a greatly debated topic at the time dealt with the manufacture and conservation of wines for exports. In 1774, Caminer Turra provided a summary of the dissertation which won the first prize at the Vicenza Academy. It was a work by Count A. Pajello on the best way to cultivate grapevines in the Vicenza Province in order to make wines in the French manner, so that they would last, and thus be suitable for exports. Caminer Turra used the summary to stress the importance of agriculture to a state, and the relevant role agricultural academies played in solving problems and in spreading useful information. She then pointed out that if any positive results would come of wine production in the region, it would have been due to Count Pajello's efforts, which had succeeded in producing a wine that was far superior than the common wine of the region.[166]

L. Ciancio points out that attempts at reforms on the part of the naturalists and natural philosophers within Venetian academies of agriculture led nowhere, for the Venetian patriciate was not responsive enough. Elisabetta Caminer Turra might have agreed with him, for she was skeptical as to how effective agricultural reforms would be. Interestingly enough, she laid most of the blame on the farmers themselves; these latter were obstinate, lacked education, and were set in their ways. Theories carried little weight when confronted with habit and prejudice. To Caminer Turra, and no doubts, to many of the learned inside the agrarian academies, the practical knowledge of farmers was of little value. With attitudes like those expressed by the journalist, meaningful communication between the learned within academies, and those who worked the land must have been very difficult indeed, and undoubtedly prejudiced reform.[167]

Abstracts in natural history, foreign and Italian in origin, appeared frequently in the journal. The great popularity the subject enjoyed amongst members of the bourgeoisie and aristocracy of both sexes in the second half of the eighteenth-century demanded that Caminer Turra pay atention to the subject.[168] Abstracts of works on the natural history of various locations were popular. But the journal covered also some of the most important works in the field of natural history, particularly minerology. Some examples of foreign works discussed were several volumes of Buffon's *Natural History* and the *Oeuvres Completes*, William Hamilton's *Observations on the Volcanoes of the Two Sicilies* (1776), Romé de l' Isle's *Essays in Crystallography* (1772), Abbé Haüy's " Memoir on the Structure of Crystals " (1782), Charles Bonnet's *Palingénesie philosophique* (1769), Déodat de Dolomieu's *Mémoire sur les îles Ponces* (1788), Faujas de St. Fond's *Minerology of Volcanoes* (1784), Louis J.M. Daubenton's *Methodical Picture of Minerals* (1784), Peter S. Pallas's *Observations on the Formation of Mountains* (1779), Richard Kirwan's *Elements of Minerology* (1785), and Tobern Bergman-J.C.de la Métherie's *Manual of Minerology* (1794). As expected, the works of Italian naturalists also received attention, such as Antonio Carlo Dondi Orologio's *Prodromo dell' Istoria Naturale dei Monti Euganei* (1780), Ermerengildo Pini's *Osservazioni minerologiche* (1777), Scipione Breislak's *Saggio di osservazioni minerologiche sulla Tolfa* (1786), or Serafino Volta's *Elementi di minerologia analitica e sistematica* (1787).[169]

The importance of Lazzaro Spallanzani in the field of natural history, and his friendship with Caminer Turra and Fortis ensured that his works receive immediate attention. The first number of *Europa letteraria* in 1768 had a Fortis abstract of

Spallanzani's *Prodromo di un' opera sopra le riproduzioni animali* (1768).[170] Some of his other works reviewed in the journal were his dissertations on the phenomena of circulation (Modena 1773), the *Opuscoli di fisica animale e vegetabile* (Modena 1776), a note on his successful insemination of a bitch, and a frog by means of injections (1781), as well as his article *Osservazioni fisiche istitute nell' isola di Critera* (1786). The sole exception to this trend occurred in the journal's review of Spallanzani's lithological study *Viaggi alle Due Sicilie*, a six volume work of his vulcanic trip to the South of Italy, which began appearing in print in 1792. However, abstracts of his *Viaggi* did not appear in the journal until 1795, three years after the publication of the first volume. Caminer Turra's delay in printing abstracts of Spallanzani's latest work, might have been brought about by a loss of contact between the journalist and the naturalist, caused by a rift between Spallanzani and Fortis. Caminer Turra corrected this loss of contact with a letter to Spallanzani, in which she begged him to send her any of his works.[171] If Fortis could afford to break his friendship with Spallanzani, Caminer Turra could not; the success of her journal depended on her keeping on good terms with as many contributors as possible.

Caminer Turra owed much to Fortis. He had been responsible for broadening her education He introduced her to important natural philosophers she would not have met without his assistance, since she was not even remotely associated with any academic institution before her marriage. As an experienced journalist, he must have provided valuable advice to both Caminer Turra and her father at the time of the journal's inception. As an expert minerologist, Fortis' scientific advice again was useful to someone like Caminer Turra with no scientific background. With so much owing to

Fortis, it is only natural that Caminer Turra would allow him to use the journal to put forward his own agenda in minerology, which he did many times, such as when, for instance, as a vulcanologist, he used the journal to attack neptunists like Köstlin and others of the German school.[172] Undoubtedly, Caminer Turra provided space in her journal for Fortis' interests, and vicissitudes out of gratitude and friendship. But it should not be forgotten that they shared goals, such as a desire to reform the institutions of the state, so as to promote the public happiness of all within that state. They were also intent on enlightening their readers, to show them what might have been to their greatest interest and benefit. Furthermore, Fortis was a respected, and well known minerologist, with a sharp writing style whose works and reviews could only add prestige to the journal. Caminer Turra might have favoured Fortis, over other collaborators, but this perceived advantage was also the natural result of his sharing the paper's directorship in the 1780s. Still other collaborators, such as San Martino, Toaldo, Tommaselli, Turra, Spallanzani, and others were offered an opportunity to present their views and scientific interests. To Caminer Turra such interests and concerns, often shared by herself, could only heighten the value of her periodical.

In the nineteenth century another woman was to follow in Elisabetta Caminer Turra's journalistic footsteps: Caterina Scarpellini, who in 1847 founded, then co-directed and edited the *Corrispondenza scientifica* (Rome) with her cousin and husband Erasmo Fabri Scarpellini. The *Corrispondenza scientifica* was not an eclectic journal; it was designed to divulge scientific and technical works in the form of articles, letters, abstracts, and reviews, from Italy and abroad. As one of its editors, C. Scarpellini was responsible for translating many pieces from abroad which were printed in the journal.

But C. Scarpellini's journalistic activities were secondary to, and of shorter duration than her activities of astronomer and meteorologist. She published extensively in these subjects, and was associated with a public observatory, and therefore she will be discussed in the appropriate chapter.[173]

Scientific translators, like patrons, appears to have peaked in the eighteenth century, when the sciences in general were very popular. It appears that one woman E. Pepoli, of whom nothing is known, except that she was probably English, but of Italian descent, translated Mary Somerville's *Physical Geography* in 1856. Pepoli's role was to translate the work, and contribute nothing to the translation, not even an introduction, or note.[174] Therefore she could not claim authorship in science, unlike Barbapiccola, Vigilante, and Ardinghelli. To them, translation was one of the easiest ways they could claim some form of scientific authorship, by means of their notes and introductions. The fact that most of these translators came from Naples, an area which was not very amenable to women's participation in academic life, seems to indicate that the translators' intent was to belong to the community of natural philsophers, and not really to make scientific knowledge circulate. The real circulation of new scientific knowledge was carried out by the journalist Caminer Turra, who by means of her translations of abstracts, excerpts and reviews of scientific works from abroad, kept her readers informed on the latest scientific developments.

Like women patrons, female translators required some knowledge in science, but that knowledge needed not to be extensive. Caminer Turra was well read in a variety of scientific topics, but was not particularly learned in any of the topics to which she contributed her own journalistic commentaries. Ultimately, commentaries determined

how learned a person was in the topics being translated. Since the Middle Ages, men had used commentaries in their translations of ancient texts to show their scientific learning. The commentaries found in Ardinghelli's translations of Hales' work illustrate her extensive learning, and define her as a natural philosopher. The absence of commentaries in Barbapiccola's translation of Descartes' *Principles of Philosophy* might indicate that she was not as learned as Ardinghelli, or even Vigilante, who translated, and annotated an elementary work in astronomy. However, Ardinghelli translated works in animal and plant physiology which were not associated with any theological controversy. Therefore she was free to comment on them as she chose. Vigilante's translation of a Copernican work in astronomy was undertaken after the anticopernican edict on new works was lifted by the Catholic Church in 1757; like Ardinghelli, she was also free to comment on her translation, without fear of persecution. On the other hand, Barbapiccola translated a work which had escaped censorship by disguising its support of the Copernican system with carefully chosen words, at a time when the edict on the system was still in effect. Any commentary on the translation might have brought Barbapiccola before the Roman Inquisition. Barbapiccola's translation and introduction should not be seen as a measure of her learning, but as her contribution to the battle in favour of the right to philosophize freely.

A comparison between Caminer Turra and Ardinghelli has shown that the latter, in spite of her learning, failed to understand the importance of networking to keep abreast of scientific developments. Ardinghelli's failure to expand and diversify her contacts, ultimately would isolate her scientifically, since the information she required could not be obtained in Naples at the time. Caminer Turra seems to have understood that one could

not participate, or/and write on scientific topics in the eighteenth century in isolation, since the sciences were changing too quickly by then. Successful male natural philsophers tended to build up extensive contacts with other natural philsophers throughout their careers. Women who wanted to succeed, even marginally, in this male-dominated academic world needed to do the same. As the following chapters will demonstrate. the few women who succeeded academically, also built up an extensive correspondence.

[1]Ferrone, pp. 609-674; Carpanetto and Ricuperati, pp. 25-58;Venturi, *Settecento Riformatore*, Vol. I, pp. 523-644; Rose, pp. 26-75, 78, 208, 293; Siraisi, *Medieval and Early Renaissance Medicine*, pp. 190-91; Findlen, *Possessing Nature*, pp. 249-50, Nauert, Jr. , p. 76; Boyer, *The History of Mathematics*, pp. 119, 261, 283, 301.

[2]Pizan, *La vision*, pp. 37-38; Fonte, pp. 81-83, 92-113; Pierattini, Vol. 57, pp. 106-08, 264-65; Pascoli, pp. 75-79, 147-51.

[3]Findlen, *Possessing Nature*, p. 250; Siraisi, *Taddeo Alderotti*, pp. 25-71; for examples of commentaries see P.V. Danti's commentaries in his translation of Sacrobosco, *La Sfera*; for Buffon see Heilbron, *Electricity*, p. 357 n.

[4]A comparison betwen the French version of Descartes'*Principles* and Barbapiccola's Italian translation reveals both to be closely matched, leading Eugenio Garin to define Barbapiccola's translation as accurate see Renato Descartes, *I principi della filosofia di Renato Descartes. Tradotti del francese al confronto del latino in cui l' Autore gli scrisse di Giuseppa Eleonora Barbapiccola tra gli Arcadi Mirista*, (Turin: Mainesse, 1722); René Descartes, *Les principes de la philosophie ecrits en Latin par René Descartes Et traduits en François par un de ses Amis*, (Rouen: Bensongue, 1698); Eugenio Garin, " Note al testo" in Cartesio, *Opere filosofiche*, 3: *I principi della filosofia*, (Rome: Laterza, 1986), p. X; for which of Descartes' books were on the Index see *Index Librorum Prohibitorum usque ad diem 4 junii Anni MDCCXLIV regnante Benedicto XIV D.O.M.*, (Rome, 1744), p. 455. I would like to thank prof. Marta Cavazza for pointing out to me that the *Principles* were not in the Index.

[5]Barbapiccola, " La Tradutrice ai Lettori "in Descartes, *I principi*; Cottingham, pp. 117-18, 122.

[6]For references to Barbapiccola's poetry and her portrait see Findlen, " Translating the New Science ", pp. 176-78, 183; for Luisa Vico's date of birth see Giambattista Vico,

Autobiografia. Il carteggio e le poesie varie, B. Croce e F. Nicolini eds., (Bari: Laterza, 1929), p. 129; E. Grillo, " Giuseppa Eleonora Barbapiccola " in *D.B.I.*, Vol. 6, p. 39.

[7]Gary Hatfield, " Reason, Nature and God in Descartes ", in *Essays on the Philosophy and Science of René Descartes*, Stephen Voss ed. (New York: Oxford University Press), p. 266; Cottingham, p. 126.

[8]See "La Traduttrice ai Lettori" and " Lettera a colui che ha tradotto il libro " in Descartes, *I principi*.

[9]*Ibid.*, Parte prima, LXXVI, Parte terza, XXIV-XXXIII, XLV; Cottingham, pp. 126-27, 129-30; Hatfield, p. 266.

[10]Geneviève Rodis-Lewis, " From Metaphysics to Physics " in *Essays on the Philosophy and Science*, p.248.

[11]Quoted in Hatfield, p. 268.

[12]Barbapiccola, " La Traduttrice ai Lettori ".

[13]Maurizio Torrini, " L' Accademia degli Investiganti Napoli 1663-1670 ", *Quaderni storici*, no. 48, (1981), pp. 845-83; Max H. Fisch, " The Academy of the Investigators " in *Science, Medicine and History: Essays on the Evolution of Scientific Thought and Medical Practice Written in Honour of Charles Singer*, E. Ashwater Underwood ed., (London: Oxford University Press, 1953, pp. 521-63; for Cartesian influences in Naples see Raffaele Ajello, " Introduzione. Cartesianismo e cultura oltremontana al tempo dell' *Istoria Civile* " in *Pietro Giannone e il suo tempo*, R. Ajello ed., (Naples: Jovene, 1980), pp. 101-03, 114, 137-38, 143-45, 156-63; for the activities of Ciccarelli see Ferrone, pp. 91-93, 138-42; for the importance of translation to women, particularly to Barbapiccola, and her relationship with Vico's family see Findlen, " Translating the New Science...", pp. 174-84.

[14]Ajello, p. 10; Ferrone, pp. 6-12; Fisch, pp. 544-45; Maurizio Torrini, " Il Cartesio di Giannone " in *Pietro Giannone e il suo tempo*, pp. 423-25.

[15]Torrini, pp. 424-25; Ajello, p. 155; Fisch, p. 543; Ferrone, pp. 478-81, 668-69; Max H. Fisch and Thomas G. Bergin, " Introduction " in *The Autobiography of Giambattista Vico Translated from the Italian by Max H. Fisch and Thomas G. Bergin*, (Ithaca: Cornell University Press, 1944), p. 35.

[16]Barbapiccola, " La Traduttrice ai Lettori".

[17] Ajello, " Introduzione ", pp. 152-56.

[18]Barbapiccola, " La Traduttrice ai Lettori "; Grillo, p. 39.

[19]Erica Harth, *Cartesian Women: Versions and Subversions of Rational Discourse in the Old Regime,*(Ithaca: Cornell University Press, 1992), p. 82.

[20]Barbapiccola, " La Traduttrice ai Lettori "; Ferrone, pp. 118-19; Ajello, pp. 102-03, 156-57.

[21]Barbapiccola, " La Traduttrice ai Lettori "; for Foschiera see Traversi, pp. 20-21, 31-32.

[22]See Grillo's article in Volume 6 of *Dizionario biografico degli italiani*, p. 39.

[23]Fisch, " The Academy of the Investigators ", p. 745; Baldini, " L' attività scientifica nel primo settecento ", p. 529; Mario Rosa, *Riformatori e ribelli nel '700 religioso italiano*, (Bari: Dedalo, 1969), pp. 75-76.

[24]Isacco Watts, *Elementi di Geografia, ed Astronomia del Signore Isacco Watts Tradotti dalla settima ed ultima edizione inglese nell' idioma italiano da Maria Vigilante con alcune piccole osservazioni, e aggiunzioni della medesima, tanto in rapporto alle differenti posizioni di Napoli, e Londra, che per comutazione de' Dominj di varie parti della Terra*, (Naples: Ramondi, 1789); for the English original see Isaac Watts, " The Knowledge of the Heavens and the Earth Made Easy: Or, The First Principles of Geography and Astronomy Explained by the Use of Globes and Maps with a Solution of the Common Problems by a Plain Scale and Compasses, As Well As by the Globe " in *The Works of the Reverend and Learned Isaac Watts D.D. Containing, Besides His Sermons, and Essays on Miscellaneous Subjects, Several Additional Pieces. Selected from His Manuscripts by the Rev. Dr. Jennings and the Rev. Dr. Doddridge in 1753*, Vol. V, (London : J. Barfield, 1810), pp. 407-95.

[25]See Watts' dedication of his *First Principles* to Mr. John Eames F.R.S. in Watts, " The Knowledge of the Heavens ", p. 410; H.L.B., " Watts, Isaac ", *The Dictionary of National Biography*, Vol. XX, pp. 978-981.

[26]See Maria Vigilante, " La Traduttrice a chi legge " in Watts, *Elementi*, pp. VII-X.

[27]Watts, " The Knowledge of the Heavens ".

[28]Piccolomini, *Sfera del mondo*, p. 15v-16r, 18r-28v, 44r-46v, 54r; Watts, " The Knowledge of the Heavens ", pp. 446-51; the same celestial coordinates are found in modern books of astronomy, where the eye of the observer is at the centre of a celestial sphere of infinite size, see Charles M. Huffen, F. E. Trinklein, M. Bunge, *An Introduction to Astronomy*, (New York: Holt, Rinehart & Winston, 1967), pp. 81-93.

[29] Watts, *Elementi*, pp. 278-284; Watts, " The Knowledge of the Heavens ", pp. 488-96.

[30]Watts, *Elementi*, , pp. 92-93, 66-67, 101-02, 112-13, 26,142-43.

[31]*Ibid.*, pp. 122, 127, 60-63, 34, 211-14.

[32]*Ibid.*, pp. 127, 217; Drake, *Galileo Pioneer Scientist*, pp. 154-55.

[33]For Frescobaldi's sources see Pierattini, Vol. 57, (1940), pp. 264-65.

[34]P. Nastasi and A. Brigaglia refer to the dissertation of a certain Dr. Giuseppe Sembrano entitled, " Dissertazione del Sig. Dott. Giuseppe Sembrano sopra il Trattato del Movimento degli Animali nell' opera del Sig. Gio: Borelli " found at the Biblioteca della Società Siciliana di Storia Patria Ms. ID. 13 amongst the papers of the mathematician Girolamo Settimo. They believe Sembrano to be a fictitious name, but offer no concrete proof that it was Ardinghelli, who actually wrote the dissertation, see Brigaglia e Nastasi, " Bologna e il Regno delle Due Sicilie " in *Scienza e letteratura*, p. 230; see also. Brigaglia e Nastasi, " Bologna e il Regno delle Due Sicilie ", *Giornale critico*, pp. 172-74; Joseph Jerome de Lalande, *Voyage en Italie fait dans les années 1765 et 1766*, (Paris: Desant, 1769), Vol. VI, pp. 368-69.

[35]Diego Vitrioli puts Ardinghelli's date of birth in 1728, see Vitrioli, pp. 9-13; a date also repeated in Bandini Buti ed., " Ardinghelli Crispo Maria Angela" in *Poetesse e scritrici*, Vol. I, p. 43; Findlen, " Translating the New Science...', p. 193; P. Nastasi, " I primi studi sull' elettricità a Napoli e in Sicilia ", *Physis*, Anno XXIV, (1982), fasc. 2, p. 242; Gianmaria Mazzuchelli receiving his information from Abbot Paolo Quintilio Costelucci of Naples placed her date of birth in 1730. Most importantly, Ardinghelli herself in a letter to Giovanni Lami dated May 31, 1751 referred to having turned twenty, placing her date of birth around 1730 see B.R.F.: *Carteggio Giovanni Lami*, Vol. 3, seg. 370, f. 76; see also Gianmmaria Mazzuchelli, *Gli Scrittori d' Italia cioè Notizie storiche e critiche intorno alle vite e gli scritti dei letterati italiani*, Vo. I, parte II, (Brescia: G. Bossini, 1753), pp. 979-80. Nollet referred to her father's unsuitable marriage, and the fact that all he was allowed to retain after marriage was a house, and an estate he had inherited at birth see B.M.S.: Mss. no. 150: Jean Antoine Abbé Nollet, *Journal du Voyage de Piemont e d' Italie en 1749*, p. 170 v.

[36]Vitrioli, p. 7; Mazzuchelli, p. 979; B.M.S.: Mss. no. 150, pp. 170v-171r; for Bammacaro's work in electricity see Nastasi, " I primi studi sull' elettricità...", pp. 245-48; Heilbron, *Electricity*, pp. 288-89.

[37]Caravelli's first book was a commentary on Euclid; it was followed by a work on Archimedes, or the dimension of the circle, sphere and cylinder. Between 1759 and 1770, Caravelli published his *Elements of Mathematics*, which contained several volumes on plane and solid geometry and five volumes on algebra. Only in 1786 did he publish a treatise on differential calculus. This treatise did not deal with derivatives, nor with differential of trigonometric functions; the geometrical applications of it were limited to conics, cycloids and logarithms. The integral section was written by another, see Amodeo, Vol. I, pp. 107-121.

[38]Guerlac suggests that Hales would have been incapable of following the mathematical intricacies of Newton's *Principia*; but he was still able to master the main features of the new system, see Guerlac, " Stephen Hales ", p. 36.

[39]U. Baldini, " Della Torre, Giovanni Maria ", *D.B.I.*, Vol. 37, pp. 573-77; Pietro Franceschini, " Della Torre, Giovanni Maria, *D.S.B.*, Vol. IV, pp. 25-26; Nastasi, " I primi studi sull' eletricità...", pp. 249-51; for a contemporary review of the book see *Novelle della Repubblica letteraria di Venezia*, (1750), no. 28, pp. 221-22, and (1751), no. 7, pp. 49-51; Giovanni Maria della Torre, *Scienza della natura di P. Gio: Maria della Torre C.R. Somasco professore di fisica nel Liceo Arcivescovale, membro della Accademia Reale Napoletana.*, (Venice: Recinti, 1750), Vol. I, pp. v-xiv, 42, 101, 165-70, 234.

[40]Della Torre, Vol I, pp. 345-46; Baldini, " Della Torre...", pp 374-75; for the experiments carried out at the Academy of Investiganti see Fisch, pp. 530-31.

[41]Della Torre, Vol. II, pp. 310-23; for further explanation of his electric theory and the Newtonian influence on such a theory see Nastasi, " I primi studi sull' elettricità...", pp. 248-50; for Newton's theory and Hawksbee's experiment see Heilbron, pp. 229-31, 239-41.

[42]Both Vitrioli and Mazzuchelli mentioned Ardinghelli's discourse on electricity see Vitrioli, p. 7; Mazzuchelli, p. 927; Nastasi, " I primi studi sull' elettricità ", pp. 241-42.

[43]Della Torre , Vol. I, p. 254.

[44]*Ibid.*, Vol. II, pp. 430-36.

[45]*Ibid.*, Vol. II, pp. 471, 464, 475-88.

[46]Baldini, " Della Torre...", pp. 575-76.

[47]For a comparison between Faustina Pignatelli' salon and Tarsia's Academy see Brigaglia e Nastasi, " Bologna e il Regno delle Due Sicilie ' in *Scienza e letteratura*, pp. 251-53 and in *Giornale critico...*, pp. 145-178; Nastasi, " I primi studi sull' elettricità ", pp. 240-44; for the Tarsia Academy see Lorenzo Giustiniani, *Breve contezza delle accademie istitute nel Regno di Napoli*, (Naples:, 1801), pp. 60-62; Maylender, " Accademia del Tarsia ", Vol. V, p. 292.

[48]Abbé Nollet, *Lettres sur l' electricité M. l' Abbé Nollet*, première partie, (Paris: H.L. Guerin, L.F. De la Tour, 1754), pp. 18-19.

[49]De Brosses, Vol. I, pp. 330, 288, 217-18, 239, 187-88, 153-54, 133, 101-03, 94, 90-91, 57.

[50]For the role of the salon in Enlightenment culture see D. Goodman, " Enlightenment Salons: The Convergence of Female and Philosophical Ambitions, " *Eighteenth-Century Studies*, 22 (Summer 1989), pp. 329-50; Schiebinger, *The Mind Has No Sex?*, pp. 30-32; Minoli, pp. 63-72.

[51]B.M.S.: Mss. no. 150, pp. 170v, 176v, 178v, 190v, 191r.

[52]For Ardinghelli's uses of Newton's works see Stefano Hales, *Esperienze ed osservazioni intorno a' calcoli della vescica, ed i reni, e allo specifico di Giovanna Stefens contro questo male del Signor Stefano Hales della Società delle Scienze, Ministro di Teddington nel contado di Middlesex e Rettore di Farington. Aggiuntavi del dottor Hartley altre osservazioni intorno allo stesso soggetto. E due mediche dissertazioni del Sig. Sauvages intorno alla teoria dell' Infiammazione della Febbre. Tradotta nell' Italiano idioma della Sig. M.A.A. e accresciuta e corretta da alcuni errori nelle antecedenti edizioni,* (Naples: Gaetano Castellano, 1776), pp. 131-32; Stefano Hales, *Statica de' vegetabili ed analisi dell' aria. Opera del dottore Stefano Hales della Società Regale delle Scienze. Tradotto dall" Inglese con varie annotazioni,* (Naples: G. Raimondi, 1756), pp. 86, 142-43

[53]Brigaglia e Nastasi, " Bologna e il Regno delle Due Sicilie...", *Giornale critico...*, p. 159 and note.

[54]B.M.S.:, Mss, no. 150, p. 191r; for Clairaut's mathematical textbooks see Boyer, *The History of Mathematics*, p. 452; for the expeditions to determine the shape of the earth see Rob Iliffe, " 'Aplatisseur du monde et de Cassini ' Maupertuis, Precision Measurement, and the Shape of the Earth in 1730s " , *History of Science*, Vol. 31, part 4, no. 94, (December 113), pp. 335-75.

[55]For the use of calculus at the Paris Academy of Sciences, and Clairaut in particular see Boyer, *The History of Mathematics*, pp. 420-22, 443-53; how it was applied to theories of the earth by Maupertuis, Clairaut and others see John L. Greenberg, *The Problem of the Earth's Shape from Newton to Clairaut. The Rise of Mathematical Science in Eighteenth-Century Paris and the Fall of " Normal Science "*, (Cambridge: Cambridge University Press, 1995), pp. 107-31, 243-399, 426-617.

[56]Vitrioli, p. 13.

[57]For problems with the acceptance of calculus in Naples see Palladino, pp. 384-90; Ferrone, pp. 524-44; for Bassi see Berti Logan, pp. 805-06; see also dissertation no. 116 of Laura Bassi in *Anatomie accademiche*, Vol. I: *I Commentari,* p. 273; for the publication of Agnesi's book see D.J. Struik ed., *A Source Book in Mathematics 1200-1800,* (Princeton: Princeton University Press, 1969), pp. 178-80.

[58]Buffon, who did not care for Nollet's system of electricity, and had been offended by Nollet's critique of his *Histoire naturelle* saw the translation of Franklin's work , and the test at Marly as an opportunity to get even; for the whole question see Heilbron, pp. 339-

52; see also Nollet's letter to Ardinghelli in Nollet, *Lettres sur l' electricité* (1754), pp. 1-22; for Nollet's results see also Abbé Nollet, " Extracts of Two Letters of the Abbé Nollet F.R.S. to Mr. William Watson F.R.S. Relating to the Extracting Electricity from the Clouds ", *Philosophical Transactions*, Vol. XLVII, (1751-1752), pp. 553-58.

[59]See letter no. 1 in Nollet, *Lettres sur l' electricité* (1754), pp. 1-22; Heilbron, p. 357n; Ardinghelli was 19 years old when she completed the *Hemaestaticks*' translation in 1749.

[60]Nollet, *Lettres sur l' electricité*, pp. 13-27.

[61]The experiment was dangerous; the first one to succeed in drawing a lightning bolt from the atmosphere was electricuted. In the Bologna case, all the researchers felt a severe shock, one was thrown to the ground. For the experiments done by the Italians to confirm atmospheric electricity see Antonio Pace, *Benjamin Franklin and Italy*, (Philadelphia: American Philosophical Society, 1958), p. 20; Heilbron, pp. 364-65; for Veratti's account of experiments see a summary in dissertation no. 86 in *Anatomie Accademiche*, Vol. I: *I Commentari*, p. 231; for an account of Veratti's experiment with electrical therapy see Berti Logan, p. 803; Heilbron, p. 354; for Della Torre's objection to them see Della Torre, Vol. II, pp. 315-17.

[62]My attempts to trace Ardinghelli's letters to the members of the Paris Academy of Sciences came to naught; none have survived. Vitrioli's father, who was Ardinghelli's student, seems to have inherited the letters she had received. Vitrioli had them at his disposal, and described their content in his biography of Ardinghelli. They also seem to have disappeared. Even if she had had a steady correspondence with Clairaut, which is doubtful from Vitrioli's statements, and as demonstrated, he was also dead by 1765, see Vitrioli, pp. 9-13.

[63]Vitrioli, p. 13; for memberships at the Bologna Academy of Sciences see Rosen, pp. 177-93; for the Paris Academy of Sciences see Schiebinger, *The Mind Has No Sex?*, pp. 26-30; for Della Torre's membership see Baldini, " Della Torre...", pp. 576-77.

[64]For the dates of Ardinghelli's first publications see Amodeo, pp. 70-71. Of all the three editions, the third, in 1776, appears to be the less rare, and it is available in several of the Northern Italian libraries. I have seen the first editions only at the Biblioteca Nazionale di Firenze, and the Biblioteca Universitaria di Bologna, which has inherited many of the books from the old Academy of Sciences. Unfortunately, the *Emastatica*, published in 1750, was not accessible at Bologna, and the Florence copy was damaged by the flood. I have never come across a second edition of any of the works; a similar conclusion was arrived by Findlen, " Translating the New Science...", p. 196 n.

[65]For a summary of *Hemaestaticks* see Guerlac, " Hales ", pp. 37-38; Stefano Hales, *Emastatica o sia Statica degli Animali. Esperienze idrauliche fatte sugli animali viventi del Sig. Stefano Hales della Società Regale delle Scienze, Ministro di Teddington nel contado di Midlesex e Rettore di Faringdon. Tradotto dall' Inglese nel Franzese e commentata dal Sig. Frances Boissier de Sauvages Consigliere di Medicina nell'*

Università di Monpellieri. E dal Franzese nell' Italiano Idioma trasportato e parimenti commentato dalla Sig. M.A.A. Edizione terza accresciuta e corretta da alcuni errori nelle antecedenti edizioni trascorsi, (Naples: Gaetano Castellano, 1776), pp. XXIX, 13-66, 134-70.

[66]Hales, *Emastatica,* pp. IV-VII.

[67]Quote found in Roger French, " Sickness and the Soul: Stahl, Hoffman and Sauvages on Pathology " in *The Medical Enlightenment of the Eighteenth-Century*, Andrew Cunningham, Roger French eds., (Cambridge: Cambridge University Press, 1990), pp. 106-09.

[68]*Ibid.*., pp. 106-07; Hales, *Emastatica,* pp. 14-15, 145-47, 154-57, 166-70, 207-09.

[69]Della Torre, Vol. II, pp. 473-74; Baldini, " Della Torre...", p. 576; French, 108-09.

[70]For Hoffmann see French, pp. 93-98; see note a in Stefano Hales, *Esperienze ed osservazioni,* pp. 121-22.

[71]Buffon's notes were not many, and were rather straightforward see Stephen Hales, *La statistique des vegetaux et l' Analyse de l' air...Ouvrage traduit de l' Anglois par M. De Buffon...,* (Paris: Debure, 1735); see Stefano Hales, *Statica dei Vegetabili ed Analisi dell' Aria. Opera del dottore Stefano Hales della Società Regale delle Scienze. Tradotta dall' Inglese con varie annotazioni,* (Naples: G. Raimondi, 1756).

[72]Since I have been unable to compare Ardinghelli's translation with Hales' original text, I cannot be certain whether some of the errors were made originally by Hales, or later when Sauvages attempted to change English units into French ones. From Ardinghelli's preface, one would say the latter case was most often true, and in some sections of the text Sauvages errors are very obvious, see Hales, *Emastatica,* pp. IV, 3, 4, 7, 54, 58, 70, 71, 73, 108, 159, 180; for Ardinghelli's contempt of Sauvages' abilities, see Findlen, " Translating the New Science, pp. 200-01.

[73]Hales, *Emastatica*, pp. 76-78, 68-71.

[74]De Lalande, Vol. VI, pp. 368-69.

[75]Hales, *Emastatica*, pp. 100-02.

[76]Oxygen at the partial pressure of 100 mm Hg. in the lungs diffuses through the very thin alveolar membrane (0.001 mm) to the blood, which at time of contact contains oxygen at the lower pressure of 40 mm Hg.; by the same token, how carbon dioxide at the pressure of 46 mm Hg in the blood diffuses to the lungs, which contains carbon dioxide at the partial pressure of 40 mm Hg., until the pressures of both gases are equal in the blood and lungs; see Knut Schmidt Nielsen, *Animal Physiology*, (Englewood Cliffs, New Jersey: Prentice Hall, 1965), pp. 18-19; Hales, *Emastatica*, pp. 113-16.

[77]Hales, *Esperienze ed Osservazioni*, pp. 11-17, 23-33, 59-88; Guerlac, " Hales...", pp. 44, 48.

[78]Hales, *Esperienze ed Osservazioni*, pp. 3-7, 90-112.

[79]*Ibid.*, pp. 41-50.

[80]J.B. Van Helmont and others believed the residue found in the container, after water had been distilled, to be earth, which proved the transmutation of water into earth; Boyle began to question these findings, and began to believe that residue from the glass container was left after distillation, and not water transmuted into earth. Ardinghelli was most likely aware of Boyle's *The Origins of Forms and Qualities*, where such doubts were expressed; see Nash, pp.328-35.

[81]Hales, *Esperienze ed Osservazioni*, pp. 8, 132, 175-80, 286-94; see Proposition 36, Problem VIII, Book II, I. Newton, *Principia*, Cajori edition, pp. 337-45.

[82]For the importance of Buffon's translation in continental Europe see Guerlac, " The Continental Reputation..., pp. 394-404; for Ardingheli see Mazzuchelli, p. 980.

[83]For summaries of the work see Guerlac, " Hales...", pp. 38-41; Nash, pp. 336-44; M.A. Hoskin, " Forward " in Stephen Hales, *Vegetable Staticks*, (London: Mc Donald, 1969), pp. xvii-xxi; Hales, *Statica dei Vegetabili*, pp. 9-46, 57, 82-88, 102, 116, 133, 255-57.

[84]For the importance of Hales' Analysis of Air see Guerlac, " The Continental Reputation...", pp. 393-404; Guerlac, " Hales...", p. 40; Nash, pp. 338-40, 351-52; Leicester, pp. 132-33; Sandra Tugnoli Pattaro, *La teoria del flogisto . Alle origini della rivoluzione chimica*, (Bologna: Clueb, 1983), pp. 173-80; Abbri, pp. 124-35; Beretta, p. 167.

[85]Hales, *Vegetable Staticks*, p. 89; Hales, *Statica dei Vegetabili*, p. 4.

[86]In this chapter, Hales also introduced two apparati, which he had used, and which later were to be perfected and used by natural philosophers like Cavendish, Priestley, and Lavoisier in their experiments on gases. These were the pneumatic trough, which Hales had used to collect his " airs " over water, and the pedestal apparatus for measuring the volume of air given off, or absorbed in chemical processes within a closed system; see Hales, *Vegetable Staticks*, p. 177; Nash, p. 357; Leicester, p. 132; Guerlac, " The Continental Reputation...", p. 396.

[87]Hales, *Vegetable Staticks*, pp. 2-4; Hales, *Statica dei Vegetabili*, pp. 11-14.

[88]Guerlac, " Hales...", p. 39.

[89]For corrections see for instance Ardinghelli's table in Hales, *Statica dei Vegetabili*, p. 22; Hales, *Vegetable Staticks*, p. 11.

[90]Hales, *Statica dei Vegetabili*, p. 23.

[91]*Ibid.*, pp. 342-49; Guerlac, " Hales...", p. 44.

[92]Hales, *Vegetable Staticks*, p. 68; Hales, *Statica dei Vegetabili*, p. 102.

[93]Hales, *Vegetable Staticks*, pp. 69-70; Hales, *Statica dei Vegetabili*, pp. 105-06.

[94]Hales, *Vegetable Staticks*, p. 72; Hales, *Statica dei Vegetabili*, pp. 112-116.

[95]Hales had distilled different substances in an iron, or glass retort, which had been cemented to a bolthead open at the botton, and which had been placed in water. The water was raised up to its neck, by means of a syphon, to a point which was carefully marked. After distillation had occurred, and the whole apparatus had cooled down, Hales determined how much air had been fixed (absorbed), or released, depending whether the water level was higher than the original mark, or below it, respectively. To Ardinghelli, the water level in the bolthead could rise or fall not only because of the air absorbed, or released, but also due to variations in atmospheric heat and pressure. For the material and apparati Hales had used, as well as his experiments see chapter six in Hales, *Vegetable Staticks*, pp. 89-180; for Ardinghelli's notes see Hales, *Statica dei Vegetabili* pp. 13, 142, 170, 171, 194, 212, 223, 229.

[96]Hales, *Statica dei Vegetabili*, pp. 246-47; Nastasi, " I primi studi sull' elettricità...", pp. 238-39, 251-52; Vincenzo Ferrone, " Alcune riflessioni sulla cultura illuministica napoletana e l' eredità di Galilei ", *Giornale critico della filosofia italiana*, sesta serie, Vol. IV, (settembre-dicembre 1984), pp. 325-27; for Bassi's experiments see Berti Logan, pp. 791-792n, 803-11; for her physics cabinet see Cavazza, " Laura Bassi e il suo Gabinetto di Fisica...", pp. 739-45.

[97]Guerlac, " The Continental Reputation of Stephen Hales ", p. 398n; summaries of the dissertations given at Bologna are found in Tega ed., *Anatomie Accademiche*, Vol. I: *I Commentari*, pp. 162-63, 274, 277; Nadia Urbinati, " Physica ", *Anatomie Accademiche*, Vol. II: *L'Enciclopedia*, pp. 137-38, 146.

[98]Hales, *Statica dei Vegetabili*, p. 246-49.

[99]For Black see Guerlac, " Hales...", p. 42; Abbri, pp. 126-28; Leicester, pp. 131-34.

[100]The realization by Black and Cavendish that certain gases were soluble in water, led Priestley to modify Hales' pneumatic trough, and collect gases over mercury, rather than water; see Leicester, pp. 14-35; Schaffer, p. 287; Peter K. Knoefel, *Felice Fontana. Life and Works*, (Trento: Società di Studi Trentini di Scienze Storiche, 1984), pp. 166-68;

Priestley, " Observations on Different Kinds of Air ", pp. 210-24; Hales, *Vegetable Staticks*, p. 151.

[101] Priestley, " An Account of Further Discoveries in Air ", pp. 384-94; Hales, *Vegetable Staticks*, p. 163; Abbri, pp. 184-85.

[102]Abbri, pp. 114-15; Guerlac, " The Continental Reputation...", pp. 393-94, 403-04; Leicester, pp. 140-41; see experiments LIV, LXXVI, CIII in Hales, *Vegetable Staticks*, pp. 97, 104-05, 129-30.

[103]The books published by Felice Fontana were *Ricerche fisiche sopra l' aria fissa*, (Florence, 1775), and *Descrizione ed usi di alcuni stromenti per misurare la salubrità dell' aria*, (Florence, 1775); Marsilio Landriani's publication was *Ricerche fisiche intorno alla salubrità dell' aria*, (Milan, 1775); for the role in eudiometry and ideas on fixed air see Schaffer, pp. 292-305; Knoefel, pp. 164-69; Abbri, pp. 142-44, 175-76; for Bassi's experiments and her correspondence see Berti Logan, pp. 791-92, 804, 809-11; for Veratti's experiments see A.A.S.B.: *Catalogo de' lavori dell' Antica Accademia raccolti sotto i singoli autori*, Domenico Piani ed, under Giuseppe Veratti, pp. 136-38; Guerlac, " The Continental Reputation...", pp. 401-02.

[104]Vitrioli, pp. 59-60, note 6; Ferrone, " Alcune riflessioni...', pp. 325-27; see Alberto Fortis, " Trasunto del Giornale de' Letterati di Parigi ", *N.G.E.*, (agosto 1782), pp. 53-69.

[105]Vitrioli, p. 13; "Ardinghelli Crispo Maria Angela ", in *Poetesse e scritrici*, p. 43; Nastasi, " I primi studi sull" elettricità ", p. 242; Brigaglia e Nastasi, " Bologna e il Regno delle Due Sicilie...", *Giornale critico...*, p. 173 and in *Scienza e letteratura...*, p. 230; Findlen, " Translating the New Science...", p. 201; for De Lalande's remark on the book trade in Naples see Palladino, p. 386.

[106]Vitrioli, pp. 26-27; the theory of probability began to develop with some consistency in the eighteenth-century; for meaningful statistics applied to climatology one had to wait for Quêtelet, Caterina Scarpellini's correspondent; see E.T. Bell, *Development of Mathematics*, (New York: Dover Publications, 1972), pp. 583-89.

[107]Vitrioli, pp. 17-18; I assume her marriage and widowhood occurred between these two dates because in either the 1756 edition, or the 1776 edition of *Statica de' Vegetabili*, the surname Crispo did not appear.

[108]Nastasi, " I primi studi sull' elettricità ", pp. 251-52 and note.

[109]For a more detailed description of the letters see Heilbron, pp. 356-57.

[110]Abate Nollet, *Lettere intorno all' elettricità nelle quali si trovano esaminate le scoperte fatte in questa materia dall' anno in appresso, e le conseguenze che se ne possono dedurre. Del Sig. Abate Nollet dell' Accademia delle Scienze. Tradotto dal Francese*, (Naples: G. Raimondi, 1761), " A chi legge "; no work in electricity appeared

in Naples since Bammacaro's book in 1748, and Della Torre's studies in *Scienza della Natura* until Giuseppe Saverio Poli published in 1772 his treatise on *The Formation of Thunder, Lightning, and Various Other Meteors Explained According to the Ideas of Mr. Franklin*; Nastasi appears unaware of this work, and believes the first work since Della Torre did not appear until 1786, see Pace, pp. 37-38, 46-47, 415, 416; Nastasi, " I primi studi sull' elettricità ", p. 252.

[111]Nollet, *Lettere intorno all' elettricità*, Vol. I: A chi legge, and pp. 32-33, 48, 62, 82, 106, 190, Vol. II: pp. 79, 178-79.

[112]C. De Michelis, " Caminer, Elisabetta ", *D.B.I.*, Vol. 17, pp. 236-41.

[113]For a list of her publication, and her importance as a translator of plays see *Ibid.*, pp. 236-41.

[114]For a complete list of her books see "1796, 16 giugno Vicenza, nella solita casa d' abitazione del Ecc. S. Antonio Turra--Inventario " in B.N.C.F.: Ms. Tordi 542, 14: *Caminer Turra Elisabetta, lettere no. 2.*

[115]For a sketch as to what the Caminer journal contained see De Michelis, pp. 326-241; Elisabeth Ravoux-Rollo, *La femme à Venise au temps de Casanova*, (Paris: Stock/Laurence Pernod, 1984), pp. 225-35; for the French periodicals see Claude Belanger et al, *Histoire Générale de la presse française*, T. I: *Des origines à 1814*, (Paris: Presses Universitaires de France, 1969), pp. 124-36, 202, 219, 273-79, 314-15; for some information on Italian periodicals see Ciancio, pp. 120-30, 318-19, 312; Stefano Casati, " Giuseppe Toaldo: la luna, il saros e le meteore", *Nuncius*, V, fasc. 1, (1990), pp. 20-21; Giuseppe Ricuperati, " Giornali e società nell' Italia dell' Ancien Régime (1668-1789) " in *La stampa italiana dal Cinquecento al Settecento*, Valerio Castronovo, G. Ricuperati, Carlo Cagna eds. (Bari: Laterza, 1976), pp. 362-72.

[116]For where the periodical was distributed see " Introduction " of *G.E.*, (gennaio 1772), and (gennaio 1776); for requests of abstracts, dissertations, and letters see letter no. 393448 of Caminer Turra to unknown, Venice, June 6, 1770 in B.C.A.B.: Collez. aut. CVIII, pos. 24.111: *Caminer Turra Elisabetta letterata*; Caminer Turra's letter to unknown, Vicenza, July 5, 1780 in B.C.A.B.: Collez. aut. XII, no. 3827: *Caminer Turra Elisabetta letterata*; her letter no. 1 to unknown, no date in A.C.R.: Colez. aut. Ms. Conc. 376, lettere B, C: *Caminer Turra Elisabetta*; her letter no. 1, Vicenza, March 11, 1778 in B.N.C.F.: Tordi 542,14; see Francesco Albergati's letter to Caminer Turra, Bologna, September 24, 1771 in B.C.A.B.: Ms. Tognetti: *Notizie e scritti riguardanti Francesco Albergati*, Cartone III; " Lettera del P.D. Girolamo Barbarigo C.R. S.P.P. nell' Università di Padova sulla spiegazione d' un fenomeno osservato dal Cav. Sig. Franklin alla Sig.ra Elisabetta Caminer Turra compilatrice del Giornale di Vicenza (luglio 1779)", *Opuscoli scelti sulle scienze sulle arti*, T. III, (1779), pp. 313-15.

[117]See letter no. 2 of Fortis to Spallanzani, Venice, September 24, 1768 in *Lettere di vari illustri italiani del secolo XVIII e XIX ai lor amici, e di massimi scienziati e letterati*

nazionali e stranieri al celebre Abate Lazzaro Spallanzani, e molte sue risposte a' medesimi e per prima volta pubblicate, Vol. VI, (Reggio: Torreggiani e Compagni, 1842), p. 11.

[118]For changes in the Caminer journal see C. De Michelis, " Caminer Domenico" and " Caminer Elisabetta ", *D.B.I.*, Vol. 17, pp. 234-36 and 236-41 repectively; Vittorio Malamani, *Una giornalista Veneziana del secolo XVIII*, (Venice: Visentini, 1891), p. 18 states that Caminer married Antonio Turra in 1769; in fact the inventory by her husband, a far more accurate source, dated the marriage to September 1771 see B.N.C.F.: Tordi 542,14: " Inventario "; see Fortis letter in Ciancio, p. 201; Ricuperati, pp. 301-03.

[119]Fortis was quite critical of clerical abuse. This criticism and his rejection of the biblical deluge, insistence on the great age of the earth, belief in many cyclical translocations of the seas in the past and in the fact that living forms transformed themselves, due to environmental pressures, over an enormous extension of time--concepts which were not compatible with a scriptural interpretation of the earth's history--were to damage his career in the long run. He was never offered a chair of natural history at the University of Padua by the then conservative, and pro-church, government in Venice, in spite of his qualifications, and lobby in his favour by natural philosophers like Spallanzani, John Strange, Giuseppe Toaldo and Targioni-Tozzetti. For a superior intellectual biography of a much neglected naturalist, and a very complex man see Ciancio, pp. 21-27, 101-17, 171-97; for a contemporary biography see Carlo Amoretti, " Elogio letterario del Sig. Alberto Fortis ", *Memorie di matematica e di fisica della Società Italiana delle Scienze*, T. XIV, parte 1, (Venice 1809), pp. XVII-XXVI. The term minerology had a much broader definition in the eighteenth-century than at present. It referred to the third kingdom of nature, after animal and vegetable; in modern times it defines the earth sciences. The term geology and geologist, although known at the time, only became widespread in the nineteenth-century; Fortis and all geologists referred to themselves as naturalists, and this latter word is the one I will use; see Martin Rudwick, " Mineral Strata and Fossils ", in *Cultures in Natural History*, pp. 266-86.

[120]Fortis, Arduino and John Strange maintained that most transformations of the superficial crust of the earth could be attributed to the extremely diversified action of vulcanic fire, and of the waters; they believed also that rocks like granith, porphyry and basalt had igneous origins, unlike the neptunists who believed them to be sedimentary. Fortis extensive field experience in Italy, Dalmatia and France gained him considerable notariety in Paris amongst naturalists and others, and guaranteed him the position of prefect of the Istituto Nazionale Italiano at Bologna during the Directorate; for a bibliography of Fortis works and other matters see Ciancio, pp. 16, 32-37, 119-49, 162, 283, 288, 293-297; Kenneth Taylor, " The *Époques de la nature* and Geology during Buffon's Later Years ", *Buffon 88, Actes du colloque internationel pour le bicentenaire de la mort de Buffon*, Jean Gayon ed., (Paris: Vrin, 1992), pp. 382, 384; for Arduino, Moro and the neptunists in the English literature see Laudan, pp. 49, 58, 68, 131, 180-200; Guntau, pp. 222-23.

[121]Ciancio, pp. 26-28, 113 and note, 123 and note; for his mother's salon see also Amoretti, p. XVIII.

[122]De Michelis, " Caminer Elisabetta ", p. 237; Ciancio, Chapter I, pp. 174-184.

[123]See Fortis letters to Spallanzani: I: 1768, II: Venice, September 24, 1768, IV: Venice, December 24, 1768, V: Padua, February 6, 1769, VI: May 13, 1769 in *Lettere di vari illustri italiani del secolo XVIII e XIX...*, Vol. VI, pp. 7-8, 10-11, 14-15, 16-17, 19-21.; for Du Châtelet's knowledge in mechanics see Iltis, " Madame du Châtelet's Metaphysics and Mechanics ", pp. 29-48; Keiko Kawashima, " La participation de Madame du Châtelet à la querelle sur les forces vives ", *Historia scientiarum*, 40, (1990), pp. 9-28.

[124]Fortis was co-director of *Magazzino italiano*, which lasted from 1767-1768; *Nuovo Giornale d' Italia*, Venice 1778-1784--Fortis was editor from 1776-1777; *Notizie letterarie Cesaree*, 1791 to 1792 and *Il genio letterario d' Europa*, Padua 1793-1794; see Ciancio, pp. 234-35, 301, 312, 315, 318, 319.

[125]The inventory shows that Caminer Turra and husband had separate sleeping quarters, which might indicate a marriage of convenience, rather than affection; but perhaps, the separate quarters might have arisen during her last illness; see B.N.C.F.: Tordi 542, 14: " Inventario "; Fortis collaborated with several reviews when Elisabetta was seriously ill and dying with, what appears to have been cancer in 1796. De Michelis says she died with breast cancer, and her correspondence at Rovigo and, particularly at Bassano del Grappa seems to confirm it. For Fortis reviews see *N.G.E.I.*, months of January and February 1796; for her illness, gossip and salons see De Michelis, " Caminer Elisabetta ", pp. 236-41; " Lettera del Ab. Fortis alla compilatrice del giornale ", *G.E.*, (marzo 1781), pp. 33-38; see her letter no. 1 to unknown in A.C.R.: Collez. aut. Ms. Conc. 376, lettere B.C.: *Caminer Turra Elisabetta*; see the letter of Francesco Aglietti to Caminer with a description of the disease, Venice, July 1793 in B.C.B.G.: *Epistolario Gamba,* V.A.43.; for women journalists see Nina Rattner Gelbart, " Le donne giornaliste e la stampa nel XVII e XVIII secolo " in *Storia delle donne dal rinascimento all' età moderna*, Natalie Zemon Davies and Arlette Farge, (Bari: Laterza, 1991), pp. 453-54; for gossip associated with Bassi see Berti Logan, p. 795; for Sarrocchi see Baldini e Napoletani, " Per una Biografia di Luca Valerio ", pp. 143-44; for Borromeo see Cusani, pp. 60-65, 184-85.

[126]For the extracts on air quality prior to 1774 see, *E.L.*, T. IV, (aprile 1771), pp. 3-8; *E.L.*, T. V, (maggio 1771), pp. 3-12; Schaffer, pp. 281-318; " Osservazioni su differenti specie d' aria...", *G.E.*, T. IV, (aprile 1774), p. 35 and *G.E.*, T. V, (maggio 1774), p. 3; " Appendice sul' aria fissa ", *G.E.*, T, IV, (aprile 1774), p. 65; *G.E.*, (gennaio 1775), pp. 53-73; Abbri, p. 144.

[127]D. Caminer, " Raccolta di opuscoli fisico-medici....', *G.E.*, (febbraio 1775), pp. 24-28; " Osservazini in fisica...del Abate Rozier " and " Ricerche fisiche sopra l' aria fissa... ", *G.E.*, (maggio 1775), pp. 17-20, 122-23 respectively; " Ricerche fisiche intorno alla

salubrità dell' aria...", *G.E.*, T. VIII, (agosto 1775), pp. 65-69; Abbri, pp. 200-02; Schaffer, pp. 292-302; Leicester, p. 142.

[128]" Scelta di opuscoli interessanti ...volumi XVI, XVII, XVIII ...", *G.E.*, T. VIII, (agosto 1776), pp. 33-38; " Ricerche fisiche...del Ab. Felice Fontana...", *G.E.*, T. I, (gennaio 1777), 3-15; " Sperienze e osservazioni...del S. Priestley..", *G.E.*, T. III, (marzo 1777), pp. 48-53; Abbri, pp. 206-10.

[129]J. Senebier, " Memoria fisico-chimica sopra l' influenza della luce solare...", *N.G.E.*, (marzo 1783), pp. 3-12; J. Sennebier, " Ricerca sopra l' influenza della luce solare nella metamorfose dell' aria fissa...", *N.G.E.*, (gennaio 1784), pp. 53-57; Nash, pp. 388-91.

[130]" Osservazioni sopra la Fisica...del Ab. Rozier..maggio 1782 ", *N.G.E.*, (settembre 1782), pp. 39-42; G.d.B., " Metodo di nomenclatura chimica proposta da S. di Morveau...Parigi 1787 ", *N.G.E.*, (marzo 1788), pp. 54-63; Leicester, pp. 144-45; Beretta, pp. 147-57, 200-14.

[131]Abbri, 269-338.

[132]' De la Métherie osservò acqua...', " Giornale di Fisica...gennaio 1784", *N.G.E.*, (aprile 1784), pp. 44-52; 'Estratto di memoria letta da Lavoisier...', " Giornale enciclopedico di Buglione, gennaio, p. II, febbraio, marzo 1784", *N.G.E.*, (giugno 1784), pp. 76-102; Abbri, pp. 314-16.

[133]" Philosophical Transactions of the Royal Society of London, Vol. 73", *N.G.E.*, (aprile 1785), pp. 67-70; A. Fortis, " Lettere meteorologiche romane...Cavalli...Roma 1785", *N.G.E.*, (ottobre 1785), pp. 332-48.

[134]A. Fortis, " Saggio analitico sopra l' aria pura...De la Métherie, Parigi 1785 ", *N.G.E.*, (aprile 1786), pp. 28-32; A. Fortis, 'Saggi chimici di William Scheele'. "Trasunto del Giornale...di Buglione, agosto 1786", *N.G.E.*, (Ottobre 1786), pp. 64-92; Fortis, ' Dubbi sopra alcuni incovenienti...Giovanni Senebier', "Trasunto del Giornale...di Buglione, aprile 1787", *N.G.E.*, (luglio 1787), pp. 87-95; " Difesa del Sig. Ab. Felice Fontana...", *N.G.E.*, (Giugno 1786), pp. 26-36; the abstracts of Priestley works are found in " Philosophical Transactions...Vol. 75 , anno 1785...", *N.G.E.*, (luglio 1786), pp.45-49; "Trasunto del Giornale Enciclopedico di Buglione...novembre 1786, parte I", *N.G.E.*, (febbraio 1787), pp. 75-87; " Trasunto del Giornale Enciclopedico di Buglione...settembre 1788, parte II ", and "Trasunto del Giornale Enciclopedico di Buglione...novembre 1788, parte I," *N.G.E.*, (dicembre 1788), pp. 23-27, 72-73; " Philosophical Transactions...Vol. 78, anno 1788 ", *N.G.E.*, (ottobre 1789), p. 72; " Philosophical Transactions...anno 1789, parte I ", *N.G.E.I.*, (aprile 1791), pp. 32-36.

[135]" Sulla metachimica, su la nuova teoria e nomenclatura chimica lettera del P. Pini al Conte Carburi...Milano 1793", *N.G.E.I.*, (gennaio 1794), pp. 58-6; G.B. da San Martino, " Risultati di alcune sperienze del S. Fontana...", *N.G.E.I.*, (dicembre 1791), pp. 88-92; Beretta, pp. 314-15; Abbri, pp. 377-78.

[136]E. Caminer Turra, " Trattato elementare di chimica...pel S. Lavoisier ", *N.G.E.*, (settembre 1789), pp. 49-56; Giuseppe Olivi, " Trattato elementare di chimica...del S. Lavoisier...da Vincenzo Dandolo...Venezia, 1791,"*N.G.E.I.*, (settembre 1791), pp. 69-79; " Dell' atmosfera delle acque minerali...Memoria epistolare del Ab. Giuseppe Olivi...", *N.G.E.I.*, (maggio 1792), pp. 80-83; Gio: Battista da San Marino, " Trattato elementare di chimica del S. Lavoisier tradotto...e annotato da Vincenzo Dandolo...Venezia 1792 ", *N.G.E.I.* (agosto 1792), pp. 59-67, and (settembre 1792), pp. 10-27; Gio: Battista da San Martino, " Catalogo de nati e dei morti entro un decennio... ", *N.G.E.I.* (luglio 1991), pp. 69-75; G. Tommaselli, " Esame chimico dei pneumatisti...del S. Giobert...Torino 1793 ", *N.G.E.I.*, (maggio 1793), p. 65-75; Vincenzo Dandolo," Fondamenti della scienza chimico-fisica applicati alle formazioni dei corpi...Venezia 1795 ", *N.G.E.I.* (luglio 1795), pp. 62-75; Beretta, pp. 309, 311-315; Abbri, pp. 377-78.

[137]Francesco du Pré, " Riflessioni su alcuni punti di dottrina chimica ", *N.G.E.I.*, (aprile 1796), pp. 55-105; Beretta, p. 314; " Estratto di una memoria del Ab. Gio: Battista da San Martino...", *N.G.E.I.* (gennaio 1795), pp. 107-124; G. Tommaselli, " Esame imparziale della nuova dottrina dei chimici...de Machy...", *N.G.E.I.*, (agosto 1794), pp. 69-86; G. Tommaselli, " Sopra la natura del gas ", *N.G.E.I.*, (ottobre 1794), pp.47-53; Ciancio, pp. 209, 223, 234, 256-62.

[138]A. Fortis, " De Bononiensi Scientiarum Instituto...Commentarii, T. V...1767 ", *E.L.*, (marzo 1769), T.IV, pp. 15-22; " Miscellanee di filosofie e di matematiche della Società Reale di Torino..., Torino 1776 ", *G.E.*, (novembre 1776), pp. 105-117; " Ati della Accademia di Scienze di Siena", *G.E.*, (giugno 1781), pp. 124-26; ' Memorie di matematica e di fisica della Società Italiana, *N.G.E.*, (novembre 1786), pp. 27-38; " Saggi scientifici e letterari dell' Accademia di Padova ", *N.G.E.*, (settembre 1787), pp. 77-93; " Atti della Regia Accademia delle Scienze...di Napoli ", *N.G.E.*, (novembre 1788), pp. 50-60; for *Nuova raccolta di opuscoli scientifici* and *Opuscoli scelti* in the paper see *E.L.*, (settembre 1770), pp. 74-76; (aprile 1772), pp. 30-32; (aprile 1773), pp. 95-100; *G.E.* (settembre 1774), p. 81;. (marzo 1775), pp. 81-82; (marzo 1776), pp. 101-108; (maggio 1776), pp. 17-19; (giugno 1776), pp. 95-96; (agosto 1776), pp. 33-38; (dicembre 1776), pp. 35-46; (maggio 1777), pp. 33-41; (gennaio 1778), pp. 55-63; (dicembre 1780), pp. 81-87; (ottobre 1781), pp. 108-112; *N.G.E.*, (agosto 1784), pp. 40-42; (aprile 1786), pp. 37-40; A. Fortis, " Atti dell' Accademia Reale delle Scienze di Svezia..."*N.G.E.*, (ottobre 1784) , pp. 22-36. The *Commentarii* of the Bologna Academy of sciences were published other times during the life of the Caminer journal, but it was not reviewed. In addition, the activities of the members of the Bologna Academy was far more extensive than the *Commentarii* would indicate; many dissertations were never published; other academies if studied might give similar results; see Tega ed., *Anatomie Accademiche*, Vol. I, pp. 369, 413, Vol. II , pp. 503-04; Berti Logan , p. 808; Ciancio, pp. 305, 316, 318, 319.

[139]The appearance of abstracts of the *Philosophical Transactions* and the *History of the Berlin Academy of Sciences* are too numerous to indicate; for the first and last extracts

see *E.L.*, (dicembre 1768), pp. 36-43, (gennaio 1769), pp. 11-15, (settembre 1769), pp. 42-50, (ottobre 1769), pp. 12-24; *N.G.E.I.*, (gennaio 1793), p.. 15-23, (novembre 1793), pp. 30-34, (settembre 1793), p. 18-24, (febbraio 1796), pp. 15-31; for the Paris Acadamy of Sciences see *E.L.*, (maggio 1769), pp. 38-45, (febbraio 1773), pp. 32-36; *G.E.*, (agosto 1781), pp. 17-23; *N.G.E.*, (dicembre 1783), pp. 45-63, (giugno 1791), pp. 33-41; for the St. Petersburg Academy see *E.L.* (febbraio 1771), pp. 3-9, (marzo 1773), pp. 46-48; *N.G.E.*, (marzo 1786), pp. 66-85, (ottobre 1787), pp. 99-113, (gennaio 1788), pp. 82-95; for the Swedish Academy of Sciences see *N.G.E.* (ottobre 1784), pp. 22-36, (ottobre 1786), pp. 42-63; for the Dijon Academy see *N.G.E.*, (ottobre 1785), pp. 49-79, (ottobre 1786), pp. 64-92, (febbraio 1788), pp. 45-62; for abstracts of some articles in mathematics and physics at the Berlin Academy see *N.G.E.*, (febbraio 1787), pp. 53-74; *N.G.E.I.*, (gennaio 1793), pp. 15-23.

[140]For when the *Observations sur la physique* appeared in the journal before 1782 see *E.L.*, (febbraio 1773), pp. 67-73; *G.E.*, (giugno 1775), p. 72, (luglio 1775), pp. 106-08, (luglio 1781), pp. 129-31; for the frequency of the *Observations* and other French periodicals see the editions from *G.E.*, (maggio 1782), pp. 42-49 to *N.G.E.*, (settembre 1784), pp. 64-107; for the continuation of the *Journal de Bouillon* see *N.G.E.*, (ottobre 1784), pp. 76-92 to *N.G.E.I.*, (settembre 1790), pp. 3-27; the last *Nuova raccolta di opuscoli scientifici* for the period was to appear in October 1781, and it was to return only in August 1784; see *G.E.*, (ottobre 1781), pp. 108-12 to *N.G.E.*, (9 agosto 1784), pp. 40-42.

[141]Caminer Turra seemed to have become friends with Anton Maria Lorgna through Francesco Albergati; see B.C.A.B.: Ms. Tognetti, Cartone III: Albergati's leters dated, Verona November 5, 1768 and November 21, 1768; for biographical information on Lorgna see Teodoro Bonati, *Carteggio scientifico Lorgna, Canterzani, Frisi, Saladini, Calandrelli, Venturi*, M.T. Borgato et al. eds., (Florence: Olschki, 1992), pp. 43-46; for abstracts of his, Delanges', and other works in mechanics, see for Lorgna: *E.L.* (maggio 1770), pp. 30-40, (novembre 1770), pp. 3-8, (ottobre 1771), pp. 3-11; *G.E.*, (gennaio 1776), pp. 117-121, (giugno 1778), pp. 3-14, 33-40, (ottobre 1778), pp. 70-75; *N.G.E.*, (agosto 1786), pp. 111-15; for Delanges: *N.G.E.*, (gennaio 1783), pp. 31-37, (aprile 1784), pp. 11-18; for others: *G.E.*, (aprile 1774), p. 97; *N.G.E.*, (marzo 1783), pp. 38-48, (marzo 1784), pp. 25-35, (aprile 1786), pp. 3-14, (marzo 1787), pp. 30-40; for Toaldo's works and correspondence in astronomy see *G.E.*, (settembre 1777), pp. 118-24; *N.G.E.*, (gennaio 1785), pp. 97-127, (febbraio 1785), pp. 48-50, (marzo 1786), pp. 98-101, (novembre 1786), pp. 96-106; *N.G.E.I.*, (novembre 1792), pp. 115-18, (febbraio 1795), pp. 41-49; for Giambattista Beccaria's works see " Experimenta atque observations..." *E.L.*, (ottobre 1770), pp. 38-42; " Nuove sperienze elettriche...", *E.L.*(settembre 1771), pp. 7-76; " Dell' elettricità terrestre atmosferica...",*G.E.*, (dicembre 1775), pp. 122-25; for Carlo Barletti see " Dubbi e pensieri...",*G.E.*, (giugno 776), pp. 11-13; for Volta's letters see " Scelta di opuscoli...", *G.E.*, (settembre 1775), p. 53; for explanation on *vindex* electricity see Heilbron,, pp. 405-21. For mathematical works, see for Boscovich work *G.E.*, (aprile 1775) , pp. 12-28; for examples of letters see *G.E.*, (gennaio 1776), pp. 117-21; *N.G.E.* (giugno 1784), pp. 102-11, (agosto 1786), pp. 111-15, (agosto 1787), pp. 16-23; for problems : *G.E.*, (ottobre 1777), pp. pp. 49-51, (

maggio 1780), pp. 60-61, 73-74; for disputes: *N.G.E.*, (giugno 1783), pp. 3-20, (agosto 1783), pp. 1-15, (maggio 1784), pp. 107-11, (gennaio 1788), pp. 95-103, (marzo 1788), pp. 39-53; for dissertations: *G.E.*, (ottobre 1778), pp. 70-75; *N.G.E.I.*, (luglio 1793), pp. 34-50, (agosto 1793), pp. 25-45.

[142]It is difficult to know how close to the original text were Caminer Turra's translations for they have not been compared with the original abstracts. I have also assumed that all her abstracts of foreign works were translations; but it might have been otherwise in those occasions where the foreign journal was not mentioned. See Ravoux-Rollo, pp. 232-33; and *E.L.*, (gennaio 1769), pp. 77-78; *E.L.*, (febbraio 1769), pp. 3-8; *E.L.*, (marzo 1771), pp. 61-69; *E.L.*, (ottobre 1771), pp. 40-47; *E.L.*, (luglio 1772), pp. 71-77; for her review of the work in optics see *E.L.*, (settembre 1771), pp. 91-93.

[143]The collaborator was G.G.F., whom I cannot identify see his " Plantarum Romulea et Saturnia...", *E.L.*, (giugno 1772), p. 24n.

[144]For Caminer Turra's extracts in botany during the first years of her marriage see *E.L.*, (ottobre 1771, pp. 47-48, " Domenici Vandelli...Fasciculus plantarum...", *E.L.*, (aprile 1772), p. 35; *E.L.*, (aprile 1772), p. 86; for those of the later period see *N.G.E.*, (maggio 1784), pp. 93-95; *N.G.E.*, (aprile 1788), pp. 85-105; *N.G.E.* (agosto 1788), pp. 88-89; " Enciclopedia Botanica Metodica...Cav. de Lamarck...", *N.G.E.I.*, (marzo 1993), pp. 38-44; for Turra's extracts of the earlier period see *E.L.*, (maggio 1772), pp. 65-70; *E.L.*, (luglio 1772), pp. 59-70; *E.L.*, (agosto 1772), pp. 29-30; for Caminer Turra's lack of proficiency in Latin see A.C.R.: Ms. Conc. 376: lettere B.C., Caminer Turra Elisabetta, Vicenza 3 luglio 1782.

[145]For Turra's works in classification see *G.E.* (febbraio 1781), p. 113; *N.G.E.I.*, (marzo 1794), pp. 121-25; for a defence of the Linnean system see *E.L.* (giugno 1772), pp. 24-26; *N.G.E.I.*, (ottobre 1794), pp. 75-86; for the popularity of the Linnean system then see Koerner, pp. 144-62; Ann B. Shteir, *Cultivating Women, Cultivating Science. Flora's Daughters and Botany in England 1760 to 1860*, (Baltimore: The Johns Hopkins University Press, 1996), pp. 11-32; Gunnar Eriksson, " Linnaeus the Botanist " in *Linnaeus: The Man and His Work*, Tore Frangsmyr ed. (Berkeley: University of California Press, 1983), pp. 63-109; for Turra's works on plants' properties see *N.G.E.*, (giugno 1787), pp. 97-109; *G.E.*, (marzo 1780), pp. 54-58; *N.G.E.*, (luglio 1788), pp. 57-64; Caminer Turra also published a criticism of Turra's work on febrifuges in order to rebut it see *N.G.E.*, (settembre 1784), pp. 97-102.

[146]For examples of works of a teaching nature see *G.E.*, (marzo 1775), pp. 17-18, 25-28; *E.L.*, (luglio 1771), pp. 49-54; *G.E.*, (aprile 1777), pp. 25-28; *G.E.*, (giugno 1777), p. 16; *G.E.*, (gennaio 1778), pp. 119-21; *G.E.* (aprile 1778), pp. 89-91; *G.E.*, (agosto 1778), pp. 104-07; *G.E.*, (aprile 1781), pp. 53-62, 83-89, 97-108; *N.G.E.*, (agosto 1783), pp. 35-50; *N.G.E.*, (settembre 1783), pp. 67-82; *N.G.E.*, (maggio 1786), pp. 16-21, 79-98; *N.G.E.*, (agosto 1786), p. 19-39; *N.G.E.*, (giugno 1788), pp. 21-35; *N.G.E.I.*, (novembre 1792), p. 34; *N.G.E.I.*, (dicembre 1792), pp. 26-27, 100-04; *N.G.E.I.*, (luglio

1794), pp. 50-69; *N.G.E.I.*, (ottobre 1794), pp. 28-36; *N.G.E.I.*, (febbraio 1796), pp. 9-15; *N.G.E.I.*, (marzo 1796), pp. 7-17, 58-63, 116.

[147]Francis M. Lobo, " John Haygarth, Smallpox and Religious Dissent in Eighteenth-Century England " in *The Medical Enlightenment of the Eighteenth Century*, pp. 235-236.

[148]*Ibid.*, pp. 216-18; for attempts to stop contagion in France see *E.L.*, (otttobre 1768), pp. 30-33, (novembre 1768), pp. 3-10; *E.L.*, (maggio 1769), pp. 44-45; *G.E.* (maggio 1775), pp. 21-24; *G.E.*, (dicembre 1776), pp. 9-12; *G.E.*, (ottobre 1777), pp. 92-104; *G.E.*, (marzo 1781), pp. 81-84; *N.G.E.*, (settembre 1782), p. 67; *N.G.E.*, (aprile 1786), p. 83; in Prussia see *G.E.*, (novembre 1780), pp. 97-100; for England, *G.E.*, (giugno 1775), pp. 55-58; for Siberia see *G.E.*, (maggio 1780), p. 27; for Sweden, *N.G.E.*, (ottobre 1786), p. 50; for Spain see *N.G.E.I.*, (agosto 1793), pp. 45-53.

[149]" Innesto felice di vajuolo...Leopoldo Marcantonio Caldani", *E.L.*, (dicembre 1768), pp. 68-73; *E.L.*, (dicembre 1768), pp. 71-73; *E.L.*, (dicembre 1769), pp. 58-66; "...Contessa Marianna de' Bertolozzi de' Bettai", *E.L.*, (gennaio 1771), p. 97; *G.E.*, (luglio 1775), pp. 25-28; *N.G.E.*, (gennaio 1786), pp. 68-72; *N.G.E.I.*, (maggio 1790), pp. 71-73; *N.G.E.I.*, (luglio 1794), pp. 88-98; *N.G.E.I.*, (settembre 1794), pp. 86-96; for disclaimers see *G.E.*, (agosto 1774), pp. 121-22; *G.E.*, (marzo 1782), pp. 87-94; for Caldani see Loris Premuda, " Albrech von Haller a Padova " in *Da Fracastoro al novecento: mezzo millenio di medicine tra Padova, Trieste e Vienna*, Loris Premuda, 9 Padua : La garangola, 1996), pp. 212-21; Ciancio, pp. 27, 27n, 53, 224; Walter Bernardi, *I fluidi della vita. alle origini della controversia sull' elettricità animale*, (Florence: Olschki, 1992), pp. 181-88.

[150]" Discorso sopra a' mezzi impiegati in questi ultimi tempi...espezialmente nella seconda spedizione del Capitano Cook...", *G.E.*, (gennaio 1782), pp. 17-46.

[151]For pellagra see *G.E.*, (agosto 1781), pp. 102-09; *N.G.E.I.*, (maggio 1792), pp. 3-10. The disease was first named in 1735 by Gaspar Casal (1691-1754) of Spain. It is caused by vitamin B defficiency; see Ackernecht, pp. 132, 230.

[152]See " Memorie della Società letteraria e filosofica di Manchester...', *N.G.E.I.*, (gennaio 1793), pp. 50-52. Linnaeus had classified albinos as *homo troglodytes*, and an amorphous group of human outcasts as *Homo monstrosus*; they provided with others the link between 'true' man, or *Homo sapiens* and 'true' ape (*simia simia*); see William F. Bynum, " The Great Chain of Being after Forty Years: An Appraisal ", *History of Science*, XIII (1975), pp. 2021; Gunnar Broberg, " *Homo sapiens*. Linnaeus Classification of Man" in *Linnaeus. The Man and His Work*, pp. 179-194; for endemic goitre in Italian history see Antonio Giampalmo, " Il gozzo endemico nelle raffigurazioni dell' arte ", *Medicina nei secoli. Arte e scienza*, 8, (1996), pp. 85-103.

[153]For works on hydrophobia see *G.E.*, (febbraio 1776), pp. 87-88 (Italy); *G.E.*, (aprile 1778), pp. 24-27 (Italy); *G.E.*, (settembre 1778), p. 109 (Austria); *N.G.E.*, (dicembre

1782), pp. 107-112 (England); *N.G.E.*, (agosto 1784), pp. 43-46 (Germany); Elisabetta Caminer Turra, " Un caso di idrofobia...riferito dal S. Babingham", *N.G.E.*, (settembre 1785), p. 82; *N.G.E.*, (ottobre 1785), pp. 53-54 (France); *N.G.E.*, (dicembre 1785), pp. 81-102 (Italian); *N.G.E.*, (aprile 1786), pp. 15-26; *N.G.E.I.*, (marzo 1792) , pp. 97-100 (Austria).

[154]For Veratti's part in electric therapy see Berti Logan, pp. 803-04; Pace, pp. 3-34; Heilbron, p. 354; Nadia Urbinati, " Physica ", *Anatomie Accademiche*, Vol. II, pp. 140-43; Elisabetta Caminer Turra, " Sopra all' utilità dell' elettricità per la guarigione di varie malattie...", *E.L.*, (febbraio 1772), pp. 93-95; for other extracts in electric therapy see *G.E.*, (gennaio 1774), pp. 94-96; *G.E.*, (agosto 1778), pp. 27-28; *N.G.E.*, (dicembre 1782), pp. 99-102; *N.G.E.*, (dicembre 1783), pp. 109-10; *N.G.E.*, (dicembre 1785), p. 78; *N.G.E.*, (aprile 1786), pp. 62-63.

[155]Lindsay Wilson, *Women and Medicine in the French Enlightenment. The Debate over Maladies des Femmes*, (Baltimore: The Johns Hopkins University Press, 1993), pp. 104-24; Mesmer believed that the magnetic fluid permeated celestial bodies, as well as inanimate and sensient bodies on earth. Disease was caused when this universal fluid could not freely circulate within the nervous system due to some obstruction. Health was restored through magnetization by means of wands, baths, and other devises, which encouraged convulsions, and evacuations, and thus enabled the magnetic fluid to circulate freely.

[156]*G.E.*, (gennaio 1776), pp. 42-45; *N.G.E.*, (novembre 1783), pp. 10-11; Elisabetta Caminer Turra, " Osservazioni sopra il magnetismo animale...' , *N.G.E.*, (agosto 1784), pp. 60-67; Fortis criticisms are in *N.G.E.*, (settembre 1784), p. 55; *N.G.E.*, (dicembre 1784), pp. 61-63; Ciancio, pp. 217-220; Bernardi, p. 326.

[157]*N.G.E.*, (gennaio 1785), pp. 25-47; Wilson, pp. 106-113. It may have been because Mesmerism arrived late in Italy, after the publication of the negative reports by both the Paris Academy, the Faculty of Medicine, and the Royal Society of Medicine; by then physicians would not touch such a system. In addition the *protomedicato* (medical courts) in various important towns were efficient in keeping tight control on healers of any sort than, say, a free enterprise system as in England; see *N.G.E.*(giugno 1785), pp. 50-68; for the *protomedicato* in Bologna see Pomata, pp. 15-60; for mesmerism in France see Wilson, pp. 104-24; in England Patricia Fara, " An Attractive Therapy: Animal Magnetism in Eighteenth-Century England ", *History Of Science*, Vol. 33, Part 2, (June 1995), pp. 127-77.

[158]Caminer, " Dizionario storico...", *E.L.*, (novembre 1769), pp. 79-94; Elisabetta Caminer Turra, " Disgrazia di Donna Urania...", *N.G.E.I.*, (agosto 1793), pp. 53-54; for Clelia Borromeo's and Laura Bassi's eulogies see respectively *G.E.*, (settembre 1777), p. 30; *G.E.*, (marzo 1778), pp. 39-41; for Amoretti's degree see *G.E.*, (luglio 1777), p. 63; for her death and extract of her publication see *N.G.E.*, (aprile 1788), pp. 38-45; for Cristina Roccati's lectures see *E.L.*, (dicembre 1770), pp. 104-05.

[159]For Bassi see Berti Logan, pp. 786-89; for Borromeo and Amoretti se respectively *G.E.*, (settembre 1777), p. 30 and *N.G.E.*, (aprile 1788), pp. 38-45; for Roccati see Grotto; for the physicians' and Rousseau's critique of culture, see Wilson, pp. 108-13; for extracts in the Caminer paper see *N.G.E.*, (febbraio 1783), pp. 33-39; *G.E.*, (febbraio 1775), pp. 58-59; *G.E.* (marzo 1776), pp. 3-4; *G.E.*, (marzo 1781), pp. 54-55; *N.G.E.I.*, (febbraio 1795), pp. 3-12; *G.E.*, (dicembre 1780), p. 97; *N.G.E.*, (ottobre 1784), pp. 17-21; *N.G.E.*, (giugno 1784), pp. 20-25.

[160]I have not looked at her defense of Rousseau, but Ricuperati has; see Ricuperati, p. 304; Malamani, pp. 23-24; Gita May, " Rousseau's 'Antifeminism' Reconsidered " in *French Women and the Age of Enlightenment*, Sonia I. Spencer ed., (Bloomington: Indiana University Press, 1984), pp. 309-17.

[161] *E.L.*, (luglio 1771), pp. 92-93 (Tuscany); Elisabetta Caminer Turra, " Dei conduttori per preservare gli edifici dai fulmini...memoria del Ab. Giuseppe Toaldo', *G.E.*, (agosto 1778), pp. 49-52 (Venetian Republic); *N.G.E.*, (giugno 1784), pp. 52-53 (Lombardy); *E.L.*, (aprile 1772), pp. 20-26; *E.L.*, (maggio 1773), pp. 13-19; *G.E.*, (giugno 1774), p. 65; for Turrini see *G.E.*, (gennaio 1781), pp. 22-27; *N.G.E.*, (luglio 1783), pp. 117-20; for Scaguller see *N.G.E.*, (marzo 1784) , pp. 96-106; *N.G.E.I.*, (marzo 1795), pp. 74-83; Pace, pp. 26-27.

[162]Some of Toaldo's extracts were already mentioned on note 136; for others see *E.L.*, (gennaio 1776), pp. 51-62, and (febbraio 1776), p. 96; *E.L.*, (giugno 1776), pp. 20-28; for summaries of his yearly observations for Padua and other locations see *E.L.*, (gennaio 1771), pp. 91-96; *N.G.E.*, (luglio 1781), pp. 97-116; *N.G.E.*, (gennaio 1785), pp. 78-108 (in this last yearly report he mentioned his female collaborators); *N.G.E.*, (febbraio 1783), pp. 94-101; *N.G.E.*, (febbraio 1784), pp. 82-124; his monthly observations are too extensive to mention all of them; they began in August 1782 see *N.G.E.*, (agosto 1782), pp. 97-107. San Martino's observations in December 1786 covered the whole year of 1786; see *N.G.E.*, (dicembre 1786), pp. 94-102; his observations again are too numerous to be indicated; the last observation carried in Vicenza was May 1793, see *N.G.E.I.*, (maggio 1793), p. 91; they began in Zara September 1793, see *N.G.E.I.*, (gennaio 1794), p. 110; they ended September 1795, see *N.G.E.I.*, (gennaio 1796), p. 125; the Zara observations were published several months after the event.

[163]For the Academy of Georgofili see Pasta, pp. 484-501; for Venice see Venturi, *Settecento riformatore*, V, Tomo secondo, pp. 64-70; Ciancio, p. 179.

[164]For Scola's article see *G.E.*, (maggio 1777), pp. 49-64 and (luglio 1777), pp. 81-97. Fortis wrote a book on a similar vein to Scola's article, as it pertained, however, farming in Dalmatia, which Caminer Turra summarized for the paper; but as a naturalist he presented environmental solutions to the problem; see Elisabetta Caminer Turra, " Della cultura del castagno da introdursi nella Dalmazia marittima ", *G.E.*, (agosto 1780), pp. 42-45; Ciancio, pp. 180-82.

[165]For works in veterinary from abroad see *G.E.*, (febbraio 1777), p. 113; *G.E.*, (novembre 1777), pp. 3-8; *G.E.*, (gennaio 1778), pp. 65-68; *G.E.*, (settembre 1778), pp. 117-26; *G.E.*, (giugno 1780), pp. 3-5; for other French works see *E.L.*, (agosto 1769), pp. 50-51, (extract translated by E. Caminer); *E.L.*, (settembre 1771), pp. 60-61. For Italian works on the subject see *E.L.*, (luglio 1770), pp. 51-55; *G.E.*, (maggio 1781), pp. 97-108; *N.G.E.*, (maggio 1787), pp. 34-39; *N.G.E.I.*, (gennaio 1790), pp. 64-75 and (febbraio 1790), pp. 83-88; *N.G.E.I.*, (ottobre 1793), pp. 90-92; *N.G.E.*, (1787), pp. 34-39; for cattle disease in France, Germany and Austria see *E.L.*, (ottobre 1769), pp. 41-44 (extract translated by E. Caminer); *G.E.*, (settembre 1775), pp. 69-76, 81-82 and (dicembre 1775), pp. 33-42 (Paulet's); *G.E.*, (ottobre 1775), pp. 43-44 (French); *G.E.*, (aprile 1776), pp. 58-60 (Vicq d' Azyr's); *G.E.*, (dicembre 1776), pp. 104-06 (Vicq d' Azyr's); *N.G.E.*, (ottobre 1782), p. 85 (French); *N.G.E.*, (novembre 1784), pp. 88-93 (German); for Italian epidemics see *N.G.E.*, (novembre 1784), pp. 66-72; *N.G.E.I.*, (dicembre 1795), pp. 72-81; *N.G.E.I.*, (gennaio 1776), pp. 7-11. For improvements in agriculture see *G.E.*, (agosto 1781), pp. 23-27 (Bath Agronomic Society); for Italian works see *N.G.E.*, (aprile 1788), pp. 105-16 (G.B. da San Martino's letter); *N.G.E.*, (maggio 1788), p. 3-37 (wheat planting); *N.G.E.I.*, (agosto 1792), pp. 28-33 (forestation); *N.G.E.I*, (gennaio 1791), pp. 31-39 (rice); *N.G.E.I.*, (maggio 1791), pp. 29-44 (hemp); *N.G.E.*, (settembre 1786), pp. 72-86 (wheat); *N.G.E.I.*, (maggio 1790), pp. 73-75 (silkworms); " Elementary Instructions in Agriculture by Adamo Fabbroni ", *N.G.E.*, (settembre 1787), pp. 14-23. For plant diseases see: for smut see *E.L.*, (ottobre 1770), pp. 38-42; *E.L.*, (ottobre 1771), p. 92; *G.E.*, (ottobre 1781), pp. 67-70; for rust see *N.G.E.*, (dicembre 1785), pp. 29-38; *N.G.E.*, (dicembre 1787), pp. 103-10; for the mulberry epidemics see *G.E.*, (novembre 1778), pp. 49-57; *N.G.E.*, (maggio 1786), pp. 102-04; for olive tree diseases see *N.G.E.I.*, (aprile 1790), pp. 43-47; *N.G.E.I.*, (luglio 1790), pp. 30-37; for tree diseases see *N.G.E.I.*, (agosto 1793), pp. 11-14. For new crops see *G.E.*, (maggio 1775), pp. 88-90; *G.E.*, (maggio 1780), pp. 102-04; *N.G.E.*, (novembre 1782), pp. 103-05; *N.G.E.*, (aprile 1783), pp. 108-10; *G.E.*, (agosto 1780), pp. 42-45; *N.G.E.*, (marzo 1786), pp. 110-12.

[166]Renato Pasta, " Fabbroni, Adamo ", *D.B.I.*, Vol.32, pp. 669-73; E. Caminer Turra, " Memoria che ha ricevuto il premio dall Società di Agricoltura di Vicenza ", *G.E.*, (aprile 1774), pp. 33-36. For other works on wine fermentation see *N.G.E.*, (marzo 1783), pp. 13-18; *N.G.E.*, (settembre 1787), p. 121; *N.G.E.*, (novembre 1787), pp. 56-73 (Fabbroni's dissertation); *N.G.E.*, (dicembre 1787), pp. 3-13 (San Martino's dissertation); *N.G.E.I.*, (giugno 1795), pp. 92-106 and (agosto 1795), pp. 3-20 (San Martino's later work).

[167]Ciancio, 183-84, 197; see Caminer Turra's introduction to " Elementi di agricoltura...", *G.E.*, (settembre 1780), pp. 97-98 and " Istruzioni teorico-pratiche di agricoltura...", *N.G.E.I.*, (febbraio 1792), pp. 76-78.

[168]For natural history's popularity in the eighteenth-century see Guntau, pp. 227-28; Ciancio, pp. 129-30, 233-34.

[169]*E.L.*, (luglio 1769), pp. 37-40; *G.E.*, (novembre 1776), pp. 17-19; for abstracts of Buffon's works see *E.L.*, (agosto 1771), pp. 3-15 and (november 1771), pp. 26-33; *E.L.*, (maggio 1772), pp. 46-52 and (luglio 1772), pp. 16-23; *G.E.*, (novembre 1774), pp. 33-34; *G.E.*(dicembre 1775), pp. 49-57 and (gennaio 1776), pp. 18-24; Hamilton: *G.E.*, (giugno 1776), p. 132; Romé de l' Isle: *E.L.*, (marzo 1772), pp. 61-62; Haüy: *N.G.E.*, (settembre 1782), pp. 32-39; Bonnet: *E.L.*, (gennaio 1770), pp. 3-21; Pallas: *G.E.*, (marzo 1780), pp. 11-14; Dolomieu: *N.G.E.*, (luglio 1788), pp. 39-43 and (novembre 1788), pp. 27-38; St. Fond : *N.G.E.*, (luglio 1785); Daubenton: *N.G.E.*, (giugno 1784), pp. 65-74; Kirwan: *N.G.E.*, (aprile 1786), pp. 28-32; Bergman, De la Métherie:*N.G.E.I.*, (maggio 1794), pp. 76-85; for Italian works see Volta : *N.G.E.*, (ottobre 1787), pp. 3-6; Breislak: *N.G.E.*, (giugno 1786), pp. 5-14; Pini: *G.E.*, (aprile 1778), pp. 97-101; Dondi Orologio: *G.E.*, (luglio 1780), pp. 14-15.

[170]For Fortis summary see *E.L.*, (settembre 1768), pp. 81-90; *E.L.*, (ottobre 1768), pp. 87-88; *E.L.*, (dicembre 1768), pp. 48-54 and 91-92; *E.L.*, (settembre 1768), pp. 79-80. For Spallanzani's translation of Bonnet and correspondence see *E.L.*, (aprile 1771), pp. 42-49 and (giugno 1771), pp. 96-103; *E.L.*, (gennaio 1769), pp. 59-63; *E.L.*, (aprile 1770), p. 71; circulation: *E.L.*, (aprile 1773), pp. 31-39 and (settembre 1773), pp. 47-49; opuscoli: *E.L.*, (settembre 1776), pp. 76-89 and (dicembre 1776), pp. 12-23; fertilization: *G.E.*, (ottobre 1781), p. 5; *N.G.E.I.*, (novembre 1791), pp. 56-63; Critera: *N.G.E.*, (gennaio 1787), pp. 3-8; for his defense: *N.G.E.* (luglio 1787), pp. 118-20 and (novembre 1787), pp. 30-40; for secondary sources which cover some of the topics above see Giuliano Pancaldi, " La generazione spontanea fra sistema ed esperimento: Spanllanzani e la generazione degli infusori (1761-1765)", Shirley A. Roe, " Needham's Controversy with Spallanzani: Can Animals be Produced from Plants?", Antonello La Vergata, " Spallanzani e i 'muletti' ", Maria Franca Spallanzani, " La collezione naturalistica di Spallanzani ", all in *Spallanzani e la biologia del settecento*, pp. 283-294, 295-303, 255-269, 585-590 repectively.

[171]For the trip to the Two Sicilies see *N.G.E.I.*, (gennaio 1795), pp. 3-11, (maggio 1795), pp. 3-18 and (luglio 1795), pp. 83-96; See Spallanzani's answer to Caminer Turra of February 1795 in B.C.B.G.: *Epistolario Gamba*, IV. C. 17. 613; for Fortis' supposed attack on Spallanzani's latest work see Daniela Silvestri, " I rapporti tra Lazzaro Spallanzani ed Alberto Fortis" in *Lazzaro Spallanzani e la biologia del settecento*, p. 316.

[172]Ciancio, pp. 119-66; *N.G.E.*, (agosto 1782), pp. 59-63; *N.G.E.*, (aprile 1783), pp. 96-102; *N.G.E.*, (dicembre 1783), pp. 178-208; *N.G.E.*, (agosto 1784), pp. 18-22; Guntau, pp. 222-26. For other examples see *E.L.*, (luglio 1769), pp. 3-12; *E.L.*, (settembre 1769), pp. 3-7; *G.E.*, (giugno 1782), pp. 3-20; for another attack on the biblical deluge see *N.G.E.*, (settembre 1782), pp. 3-7; for Robinet see *E.L.*, (ottobre 1768), pp. 34-49; *N.G.E.*, (aprile 1784), pp. 3-11; for a detailed account of Fortis mining troubles see Ciancio, pp. 201-14; *N.G.E.*, (ottobre 1785), pp. 13-31; *N.G.E.*, (gennaio 1786), pp. 96-102; *N.G.E.*, (dicembre 1786), pp. 3-14; *N.G.E.*, (aprile 1787), pp. 84-98; " Lettera del S.Ab. Fortis alla Sig. Elisabetta Caminer Turra ", *N.G.E.*, (aprile 1787), pp. 101-11; "Lettera del S. Ab. Fortis alla Sig. Elisabetta Caminer...", *N.G.E.*, (gennaio 1787), pp.

66-80; *N.G.E.*, (agosto 1787), pp. 55-62; *N.G.E.*, (febbraio 1788), pp. 86-90; *N.G.E.I.*, (febbraio 1790), pp. 22-41.

[173]Carlo Villani, *Stelle femminili*, (1915), p. 305; Alic, pp. 133-34.

[174]Mary Somerville, *Geografia fisica*, (Florence: Barbera, Bianchi, 1856), see " Gli editori ".

Chapter VI

Women in Traditional Scientific Fields: Astronomy

Italian women of the Renaissance and early Baroque periods had shown considerable interest in Aristotelean-Ptolemaic cosmology, astronomy and astrology. Christine de Pizan, Moderata Fonte, Veronica Gambara, to name a few, used their knowledge of the constellations and of the movements of the heavens, and their belief that celestial bodies influenced bodies in the sublunar region in their poetry and in other works of literature. Male humanists like A. Piccolomini and P. Danti adapted, and translated into Italian Sacrobosco's *Sphere* in order to instruct women. In turn, a woman, Sister Frescobaldi, adapted Piccolomini's own *Sphere of the Universe* for the benefit of the sisters in her convent. Frescobaldi herself enjoyed observing the heavens, and recorded a very rare observation of sunspots prior to the discovery of the telescope. Laura Cereta, Teodora Danti and Laudomia Forteguerri were practicing astronomers. Margherita Sarrocchi and Sister Maria Celeste had shown keen interest in Galileo's astronomical discoveries with the telescope.[1] However, the Vatican's interdict on the Copernican system in 1616, and Galileo's condemnation in 1633 put a damper on women's public enthusiasm for astronomy, cosmology and astrology.

The anticopernican edict did much to reduce the number of male amateur astronomers in Italy, and thus of women who might have been traditionally associated with them. Most of the important Italian male astronomers of the late 1600s and early 1700s appear to have been associated with institutions of higher learning, which did not usually welcome women. The anticopernican edict was revoked in 1757; however, the

need for more sophisticated instrumentation, and extensive mathematical knowledge, which tied astronomy even more to institutions of higher learning, conspired to keep most women away from the field in the late 1700s and early 1800s. That is not to say that some women's interest in astrology, and/or astronomy, and cosmology did not persist in spite of the condemnation of the Copernican system by the Church, the papal bulls of 1586 and 1631 against astrology, and astronomy's association with universities and public observatories in the 1700s. Ideas and methodologies pertaining to the Copernican system filtered through to women via books which had escaped censorship, such as Descartes' *Principles of Philosophy* and Book III of Newton's *Principia*, if they knew Latin and had studied geometry, and via their use of Kepler's *Rudolphine Tables*, founded on the heliocentric system. A woman, Eleonora Barbapicccola aided the diffusion of the Copernican system with her Italian translation of Descartes' *Principles of Philosophy*. Another woman, Maria Vigilante encouraged young women and men to study elementary astronomy with her translation in 1789 of Isaac Watts' *First Principles of Geography and Astronomy*, which expounded the Copernican system, by then acceptable to the Church in new publications.[2] In spite of living in an environment which was not really conducive to the systematic study and practice of astronomy, a few women were introduced to astronomy beyond the elementary level by men who believed they had the ability to learn the subject, and/ or who needed them as assistants. One of these women, Elena Cornaro Piscopia, studied astronomy as part of her curriculum in preparation for a degree in philosophy. Teresa and Maddalena Manfredi, and Caterina Scarpellini were taught astronomy because their male relatives needed assistants in the field. The Manfredi sisters, active in the early 1700s, remained on the margins of

institutional activity, whereas Scarpellini was able to become a career astronomer at a time--the mid 1800s--when the field was highly institutionalized.

The papal bulls against astrology were intent on eradicating judicial astrology. The Church still allowed natural astrology geared towards meteorological, agricultural and medical prognostics. The subject itself continued to be taught at University of Bologna into the seventeenth-century. As Ann Geneva states in *Astrology and the Seventeenth-Century Mind*, astrology disappeared from intellectual circles by 1700, while it continued among ordinary people, with almanacs being printed in many Italian towns throughout the eighteenth century.[3] But by the second half of the seventeenth-century it was still alive among the intellectual elite, and continued to be associated with astronomy, through the study of celestial motion. There were several works on the subject by Italian men, and, it appears, one by a woman, Maria Mancini Colonna's *Discorso astrosofico della mutatione dei tempi* for the years 1670, 1671 and 1672. Mancini appeared to have been knowledgeable, and essentially self-taught, not only in astrology, but also in astronomy at a time when the subject was increasing rapidly in complexity. [4]

I. *Maria Mancini Colonna: The Last Elite Woman Astrologer*

Maria Mancini (1639-1715), one of the nieces of Cardinal Mazarin, chief minister to the young Louis XIV, was born in Rome, and from seven to nine years old received her education at the Roman Benedictine convent of Campo Marzio. After her arrival in France (1653), at her uncle's request, she spent eighteen months at the Parisian couvent de la Visitation of faubourg Saint Jacques, where she learned French.

By 1659, Mancini had apparently mastered enough Latin and Greek to handle philosophers like Seneca, Plutarch, Philostrates, and have Antoine Baudeau, Sieur de Somaize, say in his *Dictionnaire des precieuses* that she knew Greek like the best of Athenians. Baudeau might have been exaggerating her knowledge of Greek, but she appeared to have known enough Latin to have understood many of the astronomical, and astrological tracts, written in that language, quoted in her work. Furthermore, in France Mancini was known as an avid reader of the books in her uncle's extensive library, and to have been a quick study.[5] While in Paris, Marie belonged to the group of the *precieuses*, and also held a salon, attended by men of letters. She continued to hold a salon, or academy, after her move to Rome in 1661. In this she followed in the footsteps of learned women like Sarrocchi, and others.[6]

Mancini's interest in astrology might have predated her stay in France. According to Perey, Mancini's father was an astrologer, although he appeared not to have published on the subject. Her mother was a believer in the art; therefore Maria might have begun her readings in astrology at an early age.[7] During her stay with her sisters at La Rochelle in 1659, Mancini appeared engaged in the study of astrology under the guidance of an Arab physician, who was an expert in physiognomy. Marie had her horoscope cast by her teacher, which indicates that, at least at that time, she was not at Laura Cereta's level, who in the fifteenth century could cast horoscopes from her own observations, and tables. Her teacher then might have been the Christian Arab, Franciscus Allaeus, who had published a book on a new astrological method, *Astrologia Nova Methodes* (Rennes, 1654), which was derived from the ancients.[8]

While in Rome, in the late 1660s, and early 1670s, Maria again dedicated herself to the study of astronomy, metaposcopy, and chiromancy, under the supervision of a Giuseppe de Terzi, who at the time had yet to publish. De Terzi was to continue to be associated with the Mancini family in France. In 1686, Terzi was in charge of the horses of Marie's brother Filippo, the Duke de Nevers. In 1690, De Terzi published at Paris *De gradu horoscopante*. a book which provided tables to save " astrologers labor in determining the ascendant, drawing up a *figura coeli* (horoscope), determining the positions of the planets in the mansions of the moon ", and finding their aspects. Most importantly, it appear that De Terzi provided Mancini with similar tables, years prior to his 1690 publication, for in the Vatican there is one of his manuscript treatises on astrological necromancy, dedicated to Mancini. The treatise contains astronomical tables from October 1670 to December 1671, a *figura coeli* for the vernal equinox of 1671, sixty two pages of astrological tables from the first of January to the twenty-ninth of December, fifteen pages of *figurae coeli*, or horoscopes, at a rate of six per page. There is also a brief text on how to use the tables he provided; it gave astronomical and astrological directions, such as how to observe the ascendant, the disposer of the hour, and the *figura coeli* at whatever time of the year, not only with respect to the hour, but also to the minutes of the hour.[9]

Ettore Janni in *Lo scandalo della moglie inconciliabile* (1955) feels that Mancini's *Discorso* should be really attributed to her teacher De Terzi, and not to her; but as Lucia Traversi appropriately points out, he fails to produce documentation to back his statement.[10] Perhaps Janni is led to this conclusion, in part, by the fact that Mancini only published on astrology during the period she was under De Terzi's tutorship. What Janni

forgets, and Ann Geneva points out, is that one could be an astrologer without training in astronomy, mathematics, or having an interest in observational astronomy.[11] It is possible that Mancini had no help whatsoever from De Terzi in writing her discourse, but it is more likely, that he provided her similar tables to those found in the Vatican, for the year of 1672, discussed in the book which has been traced. In fact Mancini used "we", instead of "I" in reference to the tables adopted in order to be able to find the best aspects of Saturn and Mercury, an indication that perhaps she had some help with them; thus, " According to our style, because we are following Hecher's calculations, taken from the Rudolphine tables, and Riccioli's tables..." [12]

Mancini's *Discorso* did not contain tables of any kind, unlike say , the almanacs which were published in Rome, with the Pope's permission, in the late 1600s, such as the *Diario romano,* the *Calendario romano,*and the *Notizie per l' anno* or an English almanac such as, for an example, John Gadbury's *The Diary Astronomical, Astrological, Meteorological for the Year of Grace 1671.* In them there were tables for the planets' daily motion, of the lunar aspects for every month of the year, and several *figurae coeli,* for instance. Planets, signs of the Zodiac, and aspects were represented symbolically; weather predictions were found in the tables dealing with planetary daily motion.[13] Symbols were absent from Mancini's work; her discourse, as the name implied remained throughout descriptive, making it more accessible to the reader not coached in such symbolism. Nevertheless, the book gave dates for all the eclipses that were expected during the year, and where they would be visible, dates and times for the arrival of the four seasons, the times of sunrise and sunset, length of day, and phases of the moon for each quarter of each month.[14]

Mancini provided information on the rising and setting of stars and constellations She then proceeded to define what was meant by terms such as acronycal, heliacal, and/or cosmic settings, or risings.[15] There were references to the rising and setting of Zodiacal signs, such as the appearance of the first degree of Sagittarius in the orient, as well as to the position of the planets in the houses of the Zodiac.[16] As far as planetary aspects were concerned, (the geometrical angle planets formed with one another) Mancini used the classical ones, which conformed to Pythagorean norms, such as conjunction (0^0), sextile (60^0), quadrate (90^0), trine (120^0), and opposition (180^0). The sextile, and trine aspects were considered harmonious, and the quartile and opposition ones disharmonious. Mancini also adopted, particularly in weather predictions, the " new aspects " that Kepler attempted to introduce to astrology as prognostically important, such as the bisquintile (144^0), quintile (72^0), quincunx (150^0), and semisextile (30^0). De Terzi used similar terms in his 1690 publication, *De gradu horoscopante.*[17]

Once the positions of heavenly bodies were established for each day of a particular year (thus the importance of ephemerides), then the astrologer could proceed in predicting how these would affect events, people's health, and the weather of the sublunar region. This was the path followed by Mancini. For each quarter of every month, she predicted what events, diseases, and weather patterns were most likely to occur. In these sections dealing with events, Mancini made use of interpretations from the bastions of Arab astrology, such as Abü Masher, Haly Abenragel (Ahmed in Yusuf), Zahel, and Almansor, and from more modern astrologers, as Francesco Giuntini (1523-1590). But these sections also contained many of Mancini's own predictions, which at the end, she emphasized were meant to be taken in jest. These predictions appear to

have been often specific, and perhaps were related to what concerned her most when the book was written, such as the breakdown of her marriage, and her desire to be called back to France by the king.[18]

Mancini made very few references to authors in her predictions of the illnesses which would affect people due to the dispositions of heavenly bodies. Alcabitius, Galen, Hermes. and the Jesuit Father Casper Schott were referred to once. and Haly Abenragel and Hippocrates twice. Frequently enough, it appears that Mancini was comparing two sources, one source, which she called the Latin doctrine, and the other, which was defined as the Arab doctrine. In the sections where the Arab doctrine was not singled out, one may assume that it did not conflict with the Latin doctrine.[19]

The section dealing with ailments ended with the " Discorso astrosofico medico " whereby Mancini advised, on a daily basis, for the whole year, when certain medical treatments could, or could not, take place. The advice was founded, according to her, on a study of the course of the Moon, and observation of its motion. Thus from a reading of the discourse, one could learn the critical days to avoid surgery, phlebotomy, purgation, or medication of any kind. The reader would also learn when emetics, baths were to be taken, as well as when medications against fever, or purgation of the liver would be effective. Although not directly quoted by Mancini in this section, Giovanni Antonio Magini (1555-1617), professor of astronomy at the University of Bologna, and his student Andrea Argoli (1568-1651) might have been the authors used for information on critical days; both wrote works, which dealt with the precepts to be observed in medicine in relation to the course of the Moon.[20]

It is in the sections dealing with weather predictions that Mancini made the greatest obvious use of the works of other astrologers. The sections are perhaps indicative of her extensive readings, of her great interest in astrology, and of the fact that most of her education in astrology may have been self-acquired. Depending on the positions of the celestial bodies, Mancini made use of statements on the weather by earlier writers such as Hermes, Haly, and Abü Masher, and thirteenth-century astrologers, like Guido Bonetti, and Leopold of Austria, but mostly, she referred to the sayings made by sixteenth and seventeenth centuries authors. Amongst the authors of this later period she mentioned Regiomontanus (1436-1470), Johann Stoefler (1452-1531), Pietro Pilati, Joseph Moletius, and his Gregorian Tables, Girolamo Cardano, Giovanni Battista Corello, and Nicolò Simi. The most quoted of this group of sixteenth-century astronomers/astrologers were Giovanni Antonio Magini, who published Ephemerides for the years 1581 to 1620,and his student Andrea Argoli, whose Ephemerides, covered the years 1631 to 1700. However, it is only in association with her own predictions, and with the predictions of seventeenth-century astrologers, such as the Capuchin monk Antonius Maria Schryrleaus de Rheita (1597-1660), the author of the mystical *Oculus Enoch et Elice* (1645), that the new planetary aspects, introduced by Kepler and used by her, are to be found.[21]

As seen, the list of references to astrologers, and/or astronomers is extensive in the sections dealing with the influences of celestial bodies on events, health, and weather; but it increases considerably in length, once the "Preamble", and the "General Astrological Discourse", which precede the main body of the work, are taken into account. It is in this latter section which dealt with astronomy that Mancini was at her most technical.

The "Preamble" appears to have been drawn straight out of Sacrobosco's *Sphere.* The *primum mobile*, called the ninth sphere, with its rapid motion, would transport along, every twenty-four hours, all the other heavens from East to West , including fire, air and water.

By attributing circular motion to the sublunar elements of fire, air and water, Mancini had already broken with Aristotelean tradition. As far as Aristotelean dogma was concerned, sublunar elements had finite, linear motion; circular, complete motion was reserved for celestial bodies alone. Mancini had launched three out of the four sublunar elements into space, by attributing circular motion to them. Nevertheless, she stopped short of attributing circular motion to the fourth element, earth, and thus kept it, by default, immobile at the centre; as such, she hoped perhaps to avoid censorship from the Church.[22] One cannot learn from the *Discorso*, whether Mancini supported the Copernican system. Still the work illustrates how Copernican concepts had filtered through, and affected the standard Aristotelean-Ptolemaic dogma.

Besides, making use of Kepler's *Rudolphine Tables*, Mancini appeared to have read, at least in part, Kepler's most important works. She referred to them in her "Preamble", when she stated that celestial bodies observed amongst themselves an harmonic motion, and determined consonance. This concept was found in Kepler's *Mysterium Cosmographicum*, chapters 14, 20, and 21, *Harmonice mundi*, book 5, and E*pitome astronomiae Copernicanae*, book 6. This latter work, found in the *Index librorum prohibitorum*, expounded correctly, for the first time the structure of the solar system. The book was the first complete manual of astronomy constructed after new principles, and, according to Kepler, was an explanation to the Rudolphine Tables.

The Rudolphine Tables were based on the elliptical planetary theories found in the *Epitome;* consequently, by making use of these tables, Mancini also accepted the methodology that sprung out from the adoption of the Copernican system.[23] The Jesuit Father Giovanni Battista Riccioli, a defender of the Ptolemaic system, had two of his works, the *Almagestum novum* (1651), and the *Systemata mundi harmonice*, mentioned by Mancini in relation to what caused harmonic motion among celestial bodies. Like Mancini, he was also affected by the methodology of the Copernican system. In the *Almagestum novum*, Riccioli came to accept the corruptibility of the heavens; and based on measurements, he had also expanded the universe considerably.[24]

In the "General Astrological Discourse" which followed the "Preamble", Mancini discussed the uncertainties associated with all astronomical measurements, and consequently, the disagreement that existed among the various authors' tables. As Thorndike points out, the failure of these tables to predict an exact time for the conjunction of two planets, also cast doubt on any forecasting associated with such conjunctions. The conjunction of Saturn and Jupiter on October 16, 1663, was six days ahead of Argoli's tables, five ahead of those of Eichstad, three in advance of those of Kepler and Riccioli, used by Mancini, and a day behind Lansberg's Tables.[25]

Mancini was well aware of these differences. As she remarked, the position of the Sun on degree 20.5 of Libra considered in Kepler and Argoli's tables, occurred half an hour earlier in Henricus Renerius' tables, three hours later in Domenico Cassini's *Cornelius Malvasia Novissimae Motuum Solis Ephemerides* (1662); Cornelio Malvasia, himself, antecipated the position by three hours, Montebruni by two hours, and Riccioli in his *Astronomia reformata* (1665) by 37 minutes.[26]

The position was dependent on the observed altitude, measured with any appropriate instrument, such as the quadrant. To obtain the true altitude one needed to correct for parallax and refraction; the latter lowered the apparent position of a celestial body, the former raised it. Both corrections were not without problems, as Mancini pointed out. There was a connection between refraction and solar parallax to which astronomers became increasingly aware in the seventeenth-century. Some, like Remus, Kepler's correspondent, were aware that a very small solar parallax went a long way towards erasing the differences Tycho saw between solar and stellar refractions.[27] Referring to Tycho Brahe's *Progymnasmata*, book I, Mancini explained how to obtain the horizontal parallax , and how to form tables to correct it. [28]

According to Mancini, distances to celestial bodies were measured in earth radius. This radius was obtained from the earth's circumference, which in itself was an approximation. In addition, different authors had different values for the earth's circumference anyway, making the earth radius not an accurate measurement. Varied was also the distance from the earth's centre to a celestial body, such as the sun . At apogee, Tycho gave such a distance to be 1182 earth radii, Kepler, 3469, Lansberg, 1552 and Longomontanus, 1333, caused by variations in measurement of the sun's horizontal parallax.[29]

Refraction, like the parallax, also varied according to Mancini, for it was dependent on the pole, and maximum declination, measurements which were different in different authors. Ultimately, Mancini concluded that if there were such variations in solar measurements, there would be greater variations in the measurements of other planets.

As A.Van Helden points out, small errors in parameters of the sun's model, or rather of the earth's motion, would cause errors in the theories of all planets.

Mancini was not surprised that there were discrepancies among the different authors, as it pertained to astrology, for it was a most difficult science. Besides, differences existed in other sciences, such as medicine. Even using the latest tables, as she had done, Mancini was well aware that there would still be variations for aspects, conjunctions, ingresses of the sun, and so on. Therefore nothing that was predicted in the work could be taken strictly, and ultimately, all depended on the divine will.[30]

Other important works consulted by the author, and not mentioned earlier, were Regiomontanus' *De Triangulis planis et sphaericis libri quinque* (1561), Ptolemy's *Almagest*, Aristotle's *De generatione et corruptione*, Hippocrates' *De aeris, aquis et locis*, Francesco Redi's *Osservazione intorno alle vipere* (1664), to name a few. As seen above, it appears that Mancini consulted an impressive list of authors in astronomy and astrology to write, what turned out to be, eighty pages of printed work. The fact that she was supposed to have consulted so many works by so many authors, some of them in the Index of Restricted Books, and others of considerable technical difficulty, may be the reason why Janni has cast doubt on Mancini's authorship, and attributed it to Terzi, her teacher. But three factors favour her authorship of the work: firstly, her interest in astrology was of long duration; thus she may have read the works over several years. Secondly, as Cardinal Mazarin's niece, living in his palace in Paris, and then as wife of the Viceroy of Aragon, and Constable of Naples in Rome, Mancini was more likely to get access to such books than her teacher, who was only part of her family's household staff. Furthermore, she could have taken most of the specialized astronomical information

found in her "General Astrological Discourse", not from all the different authors mentioned in it, but from Riccioli's *Almagestum novum*, which, according to Van Helden, contained a complete review of the problems of sizes, and distances.[31]

Mancini's *Discorso* could have been placed in the Index of Restricted Books, in spite of her warning that it was meant to entertain. Almanacs, to which the *Discorso* belonged, in spite of its descriptive nature, were strictly controlled in Rome, as compared to other areas in Italy. Very few were printed legally, and they dealt exclusively with natural astrology. The sections of Mancini's book, which dealt with weather, and medical prognostications were perfectly acceptable; but, those which dealt with predictions involving people and events were not. They would have been prohibited by the Papal bulls of 1586 and 1631. [32] However, if one considers, that only a few copies must have been printed, or the book would not be so rare nowadays; and that the printing was probably done privately, for the printer is not mentioned, the work might have escaped detection. Still Mancini's *Discorso* is an important book, as far as Italian women in science are concerned, since it served as a bridge between the exclusively scientific writings of women like Laura Cereta, Isabella Cortese, Teodora Dante, and Sister Frescobaldi, active in the fifteenth and sixteenth centuries and those of women active in the eighteenth and nineteenth century.

In the "Preamble" and "General Astrological Discourse" of her *Discorso*, Mancini demonstrated to have been knowledgeable with all the uncertainties associated with up-to-date astronomical measurements. She might have acquired this astronomical knowledge from De Terzi, or, possibly, she might have been self-taught on the subject. As astronomical studies increased in complexity the self-taught woman would tend to

disappear, no matter how well informed she was on the subject. Thus, Mancini's style of learning represented the end of an era in astronomy, rather than the beginning of a new one.

A contemporary of Maria Mancini Colonna, Elena Cornaro Piscopia (1646-1684) represented the future, for she was systematically educated in astronomy, mathematics, and natural philosophy, and was awarded a degree for her studies. Piscopia could have become an astronomer, and a natural philosopher with her education. And yet, one does not find in Piscopia's surviving works, consisting of letters, poems, epigrams, and discourses, references to contemporary writers in astronomy one can find in Mancini's *Discorso*, leading to the conjecture that in spite of her education, Piscopia was not as interested in astronomy as the self-taught Mancini had shown herself to be. It is important to be aware, however, that many of Piscopia's writings were destroyed at her death, at her request, by her music teacher, and companion, Maddalena Cappelli; therefore it is impossible to know whether she ever wrote on exclusively scientific subjects. None of her surviving works dealt exclusively with astronomy, cosmology, mathematics, and/or natural philosophy, subjects on which she had received considerable instruction.[33] It prompts O.Kristeller to define Piscopia as belonging to the same line of women humanists as Cassandra Fedele and Laura Cereta, who, in addition, was also a student of theology, and Aristotelean philosophy. However, Piscopia lived at the end of the seventeenth century and not in Quattrocento Italy, and from surving documents, one can gather that Piscopia had been exposed to many new scientific concepts.[34]

II. *Elena Cornaro Piscopia: From Humanist to Natural Philosopher*

Elena Lucrezia Cornaro Piscopia was born out of wedlock in Venice to the aristocratic Giovanni Battista Cornaro Piscopia and Zanella Giovanna Bonni, who, apparently, being his mistress, enjoyed neither a good personal reputation, nor an elevated family background. Later, Elena's father tried to overcome this unfortunate liaison and then marriage, and redeem his, and his family's honour in the eyes of his peers through several attempts to purchase the office of Procurator of San Marco. He succeeded in his efforts in 1664. Giovanni Battista's efforts on behalf of his daughter's education, and her subsequent degree, has to be viewed as another attempt to rescue, what was perceived as tarnished family honour.

Even Elena's theological studies, and her father's failed efforts that she graduate in theology, must be viewed in this light. Elena's interest in theology was most likely genuine; still it was important that a girl, born out of wedlock, prove her piety, chastity, and religious learning in order to enhance the honour of her family. Elena was quite conscious of this fact, and there are no indications that she disapproved of any of her father's schemes. In her surviving letters to her father, written from Padua in 1680, where she resided with Maddalena Cappelli after her degree, Piscopia used phrases like " I hope that in the future I may resume my studies (she had been ill) so that I might claim the honour of our house from the destruction of time " or " the glory of the children is also that of the fathers ".[35]

Elena was one of three daughters, but she was the only one singled out for such an extensive education. She was singled out as exceptional by Monsignor Giovanni Battista Fabris, doctor in theology, and a friend of the family, because of her quiet and studious nature. At his urging, and under his supervision, Piscopia began a course of studies

which included the standard humanist languages, such as Greek and Latin. Piscopia undertook also the study of Hebrew, to complement her studies in theology. But the other languages she learned, Spanish and French, represented a departure from humanist studies, and reflected the political and cultural changes which had occurred in the Italian peninsula from the 1500s onwards. By 1600, Spain was in control of more than half of the peninsula. In addition, French culture, and thus language, became increasingly dominant by the second half of the seventeenth-century. Earlier in the century, men like Galileo and Cavalieri had little knowledge of the French language. Towards the end of the century, there were many attempts on the part of the intellectual elite to organize institutions, such as scientific academies, in the French model of the Paris Academy of Sciences.[36]

Even the fact that Piscopia received a degree in philosophy was a step forward from the Renaissance, as far as the University of Padua was concerned. As discussed earlier, Cassandra Fedele was only able to deliver one confirmed oration at the university. Again, quite possibly, Bitizia Gozzadini had received a degree in law from the University of Bologna, as Costanza Calende received one in medicine (1422) from Medical School of Salerno, but these degrees are difficult to confirm with any certainty. There are no doubts as to Piscopia's degree.[37]

To use Piscopia's own words, her first teacher " in the mathematical sciences and some foreign languages ", and, one assumes, natural philosophy was a Jesuit father, whom she left unnamed. Maschietto believes him to have been Father Carlo Maurizio Vota, from Turin, and who had spent at least ten years of his life at various Jesuit colleges in the South of France, first as a student in philosophy, then as a teacher. He

arrived in Venice in 1661, after a sojourn of three years in Rome. Only by late 1667, or early 1668, would Carlo Renaldini come to the fore as Piscopia's teacher in natural philosophy and mathematics.[38]

From one of the discourses she gave at the Academy of Pacifici, one of several literary and philosophical academies operating in Venice at the time, of which Piscopia was a member, it appears that her Jesuit teacher was not well informed on recent physiological discoveries. In the discourse Piscopia made reference to Galen's theory of blood movement, whereby veins departed from the liver, and arteries from the heart. She appeared to have been ignorant of Harvey's *De motu cordis* (1628), which propounded the circulation of the blood, and of Marcello Malpighi's *De pulmonibus observationes anatomicae* (1661) that announced the discovery of the capillaries, that helped confirm such a circulation.[39]

But Piscopia's Jesuit teacher, in addition to her family's library, informed her better on other subjects. In the same discourse, Piscopia came down in favour of the Aristotelean four primary elements of fire, water, air, and earth. However, she also was aware of the chemical principles Paracelsus and followers had added to Aristotle's four basic elements. According to Piscopia, the chemists believed that all bodies resolved themselves into sulfur, salt, spirit, earth, and water. Neither the chemical principle, mercury, nor the element fire appeared in the equation. Perhaps, spirit stood for both in Piscopia's eyes, for Paracelcus equated mercury with pure fire.[40]

The mathematics taught to Piscopia, first by Vota, and then by Renaldini, had undergone changes from the Renaissance. From Renaldini we learn that Piscopia was familiar, like Sarrocchi, with the mathematical works of Archimedes. She discoursed

very effectively on the Archimedean lemma, which dealt with the application of a straight line drawn between the convex (arc) of a circumference and the diameter (of a circle). Some of Archimedes' works were known in the Middle Ages, but until the end of the sixteenth-century, very few were really familiar with the geometry of Archimedes, Apolonius. and Pappus. From then on Archimedean mathematics were to influence mathematicians like Clavius, Valerio, Galileo, Marino Ghetaldi and others. By the second half of the seventeenth-century, Archimedes' mathematical works became part of the curriculum of those, as Piscopia, studying geometry to a more advanced level.[41]

Most certainly, Piscopia progressed even further in her mathematical studies when she came under the supervision of Carlo Renaldini, one of the few mathematicians in Italy at the time, who was familiar with the innovative *Géométrie* of Descartes, which dealt with analytical geometry.[42] Renaldini, although still remaining attached to the geometrical constructions of the ancients, applied some algebraic procedures to, for example, variations on the Archimedean lemma discussed above by Piscopia. A believer in the unity of mathematics, Renaldini had no problems in applying either geometric, algebraic, and/or trigonometric methods to the study of geometry.[43]

Maschietto informs us that Piscopia's great grandfather was a close friend of Galileo, and that the family library contained many scientific works of a Galilean stamp. Most likely, the family received a copy of the *Dialogue*. Galileo had sent copies to various Venetian state officials; it might be assumed he sent one to his friend.[44] However, there is no surviving evidence that Piscopia had ever read this work, although she was aware of several discoveries made with the telescope.

But there is some evidence that Piscopia might have studied, Galileo's already discussed, *Discourse on Bodies in Water*, partly due to her knowledge of Archimedes' works, which would include *On Floating Bodies*, on which Galileo's discourse was founded, and partly due to the interests of her own teacher, Renaldini. In a letter to Robert Boyle, he stated that one matter worthy of study was that of the ascent of bodies. A concern which also occupied him in *De Resolutione et Compositione Mathematica*, a work Renaldini had written for Piscopia's instruction, in which he praised for the first time, in print, her exceptional ability. In either the letter, and in the book section dealing with the ascent of bodies, Renaldini seemed to have accepted, as confirmed by experiments, that a body with a specific weight (specific gravity) which was less than the surrounding medium would ascend through the medium, with the former being pushed up by the latter. This was essentially Archimedes' position in *Floating Bodies*, and Galileo's in his *Discourse*. This ascent was not like the Aristoteleans who believed it to be due to some contrasting intrinsic quality of light and heavy.[45]

Concerning Piscopia's studies of cosmology and astronomy, her discourse on the sphere seemed to imply an acceptance of the Aristotelean-Ptolemaic system on her part. But as we know a Jesuit was her teacher on the subject, and the Jesuits by Piscopia's time, unable to adopt the Copernican system, at least in print, had adopted to a great extent the Tychonic system. Under Tycho Brahe's system, the earth remained immobile at the centre of the world, the planets circled the sun, while the sun circled the immobile earth. Tycho also maintained the twenty-four hour revolution of the fixed stars. By accepting Tycho's system, Jesuits had accepted the celestial origins of new stars and comets, and thus also accepted the corruptibility of the heavens.[46]

There is some evidence that Piscopia was introduced to this system. For instance, there was her awareness, motivated by telescopic discoveries, that although some astronomers believed celestial matter to be rare and transparent, others accepted it to be dense and opaque. Although in this occasion she expressed no opinion as to whom was right, in another discourse Piscopia referred to the universe being composed of what Aristotle had described as being sublunar, and corruptible elements: earth, water, air and fire. In doing so, Piscopia had made Aristotle's incorruptible ether disappear, and had accepted the corruptibility of the heavens. The Jesuit Riccioli in his influential *Almagestum novum* had done as much, motivated not only by ideas from the Church fathers, but also by the telescopic discoveries of sunspots, and by the presence of comets above the lunar region. To Riccioli, the two terrestrial elements found in the heavens were water, and fire. Possibly by accident, but may be not, Piscopia had gone further than Riccioli when she failed to identify which Aristotelean elements constituted the heavens, and which the earth. From the discourse, it could be assumed that not only water and fire might form the heavens, but also air and earth. It seemed to imply on her part a belief in the mobility of the earth.[47]

Renaldini in his *Geometris Promotus* stated that Piscopia had studied astronomy so that she might be able to visit the starry heavens, at least with her thought. Such statement seems to imply that Piscopia never dealt with the practical side of astronomy, in spite of all her mathematical knowledge. Although not a practicing astronomers, she would still be introduced to astronomical tables, and taught how they would have been calculated. These would, most likely, have been Kepler's *Rudolphine Tables*, or some variation thereof, which as Mancini pointed out, had the Jesuit Riccioli's blessing in his

Astronomia reformata, as being the most accurate. As seen, these were based on Tycho's observations, and Kepler's own elliptical planetary theories, that better represented the phenomena of planetary motion than had the eccentrics and epycicles of the Ptolemaic system.[48]

It appears that Piscopia had dispensed with epycicles and eccentrics. In a discourse she referred to the contrary motion (retrograde) of the erratics (planets), and concluded that, in fact, there was among the planets a proportionally disposed order, and constant harmony. From such a statement, one might assume that Piscopia was familiar with Kepler's *Harmonice mundi*, in which he produced planetary velocities at aphelion (the point in the orbit of a planet where it is farthest from the sun) and perihelion (the point in the orbit of a planet where it is nearest the sun) from harmony. From these velocities Kepler finally calculated the greatest and least distances from the Sun. It appears that this work, unlike the *Epitome* was not in the list of interdicted books. But Riccioli in his *Almagestum novum* had accepted such an harmonic motion.[49] Having considered Piscopia's divergences from Aristotelean-Ptolemaic cosmology, and the fact that her teacher was a Jesuit, it seems reasonable to conclude that Riccioli's works, perfectly acceptable to the Church, loomed large in her education in cosmology and astronomy. Thus, in spite of her complaint to Cardinal Emmanuel Bouillon, that many were neglecting Aristotle, Piscopia herself, had departed, at least in part, from his cosmology, and under the influence of Renaldini, from some aspects of his physics, including his concept of matter, if Democritus statue at her mausoleum can be used as a guide.[50]

The discourses, from which one can infer her studies in natural philosophy and astronomy, were not scientific in nature; one was in praise of the city of Venice, and the

Venetian Republic, the other two dealt with political problems. Nevertheless, they still contain a considerable amount of material in natural philosophy, something which was practically absent from the surviving orations of Cassandra Fedele, and Olimpia Morati, both philosophy students in their times. This was in part due to Piscopia's education, but also due to the fact that lay interest in the sciences increased throughout the period, brought about by the publicity associated with Galileo's trial, by the discoveries achieved by the telescope and microscope, and by increased publications on scientific subjects, particularly in the vernacular.[51]

If Piscopia diverged from many Aristotelean scientific concepts in the course of her studies, she was nevertheless introduced to Aristotelean philosophy as it was required in order to obtain a degree in philosophy in 1678 from the University of Padua, an institution, which had a long Aristotelean tradition, however enlightened it might have become after a century of debate.[52] For her examination Piscopia was told to prepare on two passages, or *puncta*, as they were called, by Aristotle. The first passage was in logic; it came from the first book of *Posterior Analytic*, and dealt with the nature of scientific knowledge; the second was based on the first book of *Physics*, on the fact that principles were contraries. Both passages illustrated the teaching of philosophy at the university, which emphasized logic and natural philosophy.[53] Already in 1670, Piscopia had been able to display her knowledge of the same first book of *Physics* in a discourse given by her at the Academy of Pacifici, where for a period she was not only a member, but also its president. On that occasion, Piscopia had accepted Aristotle's premise of three first principles, while rejecting the premises of other philosophies, such as Democritus' atomism.

Her rejection of Democritus' atomism was also evident in another discourse given in the same period , at the same academy. Still her mausoleum contained the sculptures of Aristotle, Plato, Seneca, and Democritus, which appears to indicate that perhaps Piscopia had changed her mind as to atomism. This change might have occurred through the influence of one of her last teachers, and friend, Carlo Renaldini (1615-1698), member of the Academy of Cimento, professor of philosophy at the University of Pisa until 1667, and then at the University of Padua, mathematician to Prince Cosimo de' Medici, and a supporter of Pierre Gassendi, and atomism.[54]

One can gather from Piscopia's correspondence, that her interest, and studies in natural philosophy, and mathematics increased when she moved to Padua after her graduation, and Carlo Renaldini became her only teacher. Although she published nothing of a scientific nature; even the discourses, which have survived were published by others from manuscripts found in the academies concerned. Therefore one has to agree with Maschietto, that it was never Piscopia's intent to contribute to the world of letters, and sciences through publications. Her studies were motivated by her desire to know, and by her father's ambition for his daughter, and his family.

If one considers Piscopia's apparent conversion to atomism, it is also possible that the manuscripts she ordered destroyed, contained material, which might have been viewed unfavourably by the Church, if ever published, and thus their destruction. Atomism, often associated with materialism, by the Church, had been repressed at the University of Pisa in 1670, and came increasingly under attack in the 1680s. Piscopia, being associated with Renaldini, a former professor at Pisa University, was well aware of such pressures and condemnation by the Church. As a religious person, she might not have

been able to face condemnation by the Church, even after death. One should also add, that there was no real extensive tradition of Italian women publishing exclusively in the sciences, and it was not in Piscopia' nature to break the mold. It was in her mold, however, to encourage her teacher, Renaldini in his research, and publishing efforts; in fact Piscopia used her fame to promote Renaldini's work, even abroad.[55]

Piscopia's education, public appearances, degree, and her move to Padua were carried out at her father's instigation, and were his responsibility. At Padua where she resided until her death, Piscopia remained a woman on the margin of academic life. There are no indications that Piscopia ever taught, but there is a record of her attendance at a meeting at Padua's Academy of Ricovrati, of which she had been a member since 1669, while she was still in Venice. This special meeting was held because of Cardinal d' Estres' visit, and presented an opportunity for Piscopia to offer an eulogy to the cardinal. The fact that her presence at the meeting was recorded by one of her biographers seems to indicate its exceptionality.

Her biographers at the time, all emphasized her piety, modesty, and faith. Piscopia appears to have been a deeply religious person. Such religious feelings were well represented in one of her poems dating from 1680 published by Luisa Bergalli in 1726.[56] Still, throughout her life, her love of scientific studies appeared genuine. Therefore, one cannot say with any certainty whether, had Piscopia survived her father, she would have retired to a convent, or would have continued to live in Padua, studying under Renaldini's supervision to whom she was attached by friendship. One suspects she might have continued as she was.

Piscopia had the education and qualification (a degree) to become a full fledged astronomer. As a woman she was unlikely to receive a teaching position in astronomy at any institution of higher learning. But she might have tried to practice astronomy on her own, as an amateur in the field. However, by then, astronomy had advanced not only theoretically, but also technologically, and to practice astronomy at high level increasingly required group effort. None of her teachers were practicing astronomers, therefore neither was Piscopia.

Schiebinger informs us that in Germany, between 1650 and 1720, over thirteen percent of astronomers were women. They received their apprenticeship within a family, of usually self-taught practicing astronomers, just as Cereta, and Danti had done; with a few exceptions, they served as editors of the husband's writings, or performed astronomical calculations.[57] In Italy, the ban on the Copernican system, and subsequent problems with censorship discouraged the formation of many self-taught amateur astronomers as in Germany. Most of the best known astronomers of the period such as G. D. Cassini, G. Montanari. D. Guglielmini, and G. A. Borelli, were associated with universities, were Jesuits, like Riccioli or G. Grimaldi, or abbots, associated with the Roman court, like F. Bianchini; women were much less likely to be apprentices to these men in their official roles, than to the self-taught amateur astronomers of Germany.[58] Still there were a few male amateur astronomers in the Italian peninsula, such as Eustachio Manfredi and his brothers, and as in Germany, there were women relatives associated with them, such as the Manfredi sisters, Maddalena and Teresa.

III. *Maddalena and Teresa Manfredi, Astronomers for the Sake of the Family*

The Manfredi sisters, Maddalena (1672-1744), and Teresa (1683-1767) came to astronomy because of their brother Eustachio's (1674-1739) interest in the subject. Their father, a notary, abandoned the family, making Eustachio, as the eldest brother, the head of a family which was financially strapped, in spite of the initial assistance the family had received from a fraternal uncle.[59]

Eustachio had studied natural philosophy when very young with Lelio Triofetti, and later, mathematics with Domenico Guglielmini. However, his degree was in civil law, a subject he never practiced. Manfredi and his friend, Francesco Vittorio Stancari, expert mathematicians, began to teach themselves astronomy around 1689. By then, Domenico Guglielmini, the leading astronomer in Bologna at the time, had left the university for the much higher paying chair of mathematics at the University of Padua.

In fact, it appears that astronomy at Bologna had been at a low ebb since Montanari's departure for the freer atmosphere of Padua in 1678. Although very able, Guglielmini had other interests, besides astronomy, such as mathematics, for instance. He was also considered an expert in hydraulics, with several publications to his name, in addition to being a practicing physician; thus, astronomy was low in his priorities. To make matters worse, the university lacked an observatory; the meridian erected by Cassini before he had departed for Paris, was the most important astronomical tool possessed by the town. In 1695, there was a burst of astronomical activity when Cassini in a visit to Italy, stopped at Bologna to examine, and then repair his meridian with Guglielmini's assistance with instruments brought for that purpose from Paris. There appeared to have been very little activity after that.[60]

Guglielmini's departure left the field open for Manfredi and his friend Stancari. In addition to studying astronomy, they also engaged in observations from either Manfredi's or Stancari's home. For such observations they made use of Cassini's meridian, quadrants, telescopes, and, what perhaps was, the first Italian-made cycloid clock on Huygens' model; it was owned jointly by Manfredi and Stancari. Manfredi also made sure that at least two of his younger brothers, Eraclito and Gabriele, as well as his sisters became involved in the observations. The two brothers were mathematicians in their own right, and were to teach on the subject at the university, following in Manfredi's footsteps, who became lecturer in mathematics in 1699. Gabriele, along with Stancari also took up the study of infinitesimal analysis, becoming pioneers on the subject in Italy.[61]

The learning of mathematics was also extended to the sisters. Teresa's and Maddalena's mathematics appeared to have been very much geared for their role as assistants to Manfredi. The greatest expert on the subject was Maddalena, whom Manfredi had instructed in astronomical calculations, and trigonometry so that she could spare him from having to do all the calculations himself. Fontanelle described the sisters as veritable *calculatrices*. In fact, the sisters were very much like most other women astronomers in other countries, who were either their contemporaries, or were to follow them in the field. It was usually as computers that women were able to participate in astronomy, even after they were able to obtain degrees from universities. As seen, the Manfredis' German counterparts were usually relegated to astronomical calculations; very few of them directed or published their own works. The same could be said for

most of the British and American women astronomers of the nineteenth and early twentieth centuries.[62]

The father's desertion limited the prospects of all the Manfredi children. Only one brother was to marry, with a woman ten years his senior, and probably the possessor of some income. One brother became a Jesuit; Eustachio and Eraclito remained single all their lives, living, whenever possible, with their sisters. Maddalena, the eldest was supposedly engaged to Stancari, however by 1709, the time of his early death, they were still unmarried; lack of a dowry on her part, and of a position on his, might have prevented such a marriage. Teresa's prospective marriage in 1718 came to naught; the bridegroom's demand of a 3000 lire dowry could not be found at the time. But if the Manfredi males were all to find positions for themselves, the sisters had no such means at their disposal, and remained totally dependent on their brothers, particularly on Eustachio, who took responsibility for the family's financial support. Eustachio had made astronomy, and later in 1704, the superintendence of waters, not only his business, but the family's business. Maddalena and Teresa, being part of the family were expected to contribute; it was not required that they love either astronomy, or mathematics, but only that they be competent at their tasks.[63]

The surviving correspondence shows no indication that the sisters desired to make a name for themselves as astronomers. They did not engage in observations, or calculations unless they were requested to do so, and seemed happy in this secondary roles. In answer to a song about ignorant female doctors, Maddalena defended the abilities of women, but also pointed out that not all women, including herself, wanted to go so far in their achievements as to become doctors. In spite of their reluctance to

become known as something more than assistants to their brothers in his activities, the sisters, particularly Teresa, became famous in Italy for their translations of satires into Bolognese, and for their own compositions of comical, satirical Bolognese poetry. As seen, such activities were well within the bounds of what was expected of women for several centuries.[64]

In 1690, while not yet sixteen years old, Eustachio Manfredi began a discussion group in his home. Such a group was, most likely, to have an impact on the education of the eldest sister, Maddalena, very close in age to him. She appeared more knowledgeable than her younger sister in both mathematics, and in the Latin language. Teresa was never referred to knowing Latin. The academy remained in Manfredi's home until 1694, when it transferred for the next ten years to the residence of physician Giacomo Sardi, took a more experimental turn, and by 1704 was given regulations similar to those of the Paris Academy of Sciences. In 1711, through the efforts of Count Luigi Ferdinando Marsili, it became the Academy of Sciences, within the publicly-funded Institute of Sciences of Bologna. Eustachio Manfredi, the founder of the original academy, became, as one might expect, the Institute's official astronomer, and would eventually be in charge of a publicly-funded observatory tower (1726) from which he and his group could carry on their observations.[65]

After Guglielmini's departure in 1698, Manfredi was to inherit the former's correspondence with Giandomenico Cassini of the Paris Observatory, and with Count Marsili; such correspondence turned out to be pivotal for his career, and consequently, for the activities of his sisters. His correspondence with Cassini began in 1699, and continued to about 1710 (Cassini died in 1712). He also corresponded with Cassini's

nephew, Giacomo Filippo Maraldi, at the same observatory, before and after Cassini's death. Manfredi and Stancari intended to imitate the observational program of the Paris Observatory, as far as local conditions would allow. Some of Manfredi's group earliest observations were not published in Italy, but in the *Memoires de l' Academie des Sciences* of 1701.

But it was his correspondence with Marsili which was to have the most immediate impact on his future, and on the one of his sisters. In 1701, Marsili, a general in the Imperial army, and a man with a great interest in the sciences, appointed both Manfredi and Stancari to supervise his collection of scientific materials. He was also to provide an observatory for them at the residence of his family in Bologna. The observatory was equipped according to Manfredi's instructions, based on the Paris observatory. It was to contain two mobile quadrants, and a wall semicircle, telescopes and cycloidal clocks. Manfredi was to live on location; however, as he needed his family for observations and calculations, he asked Marsili permission for them to join him. Thus for the sake of astronomy, they all shared--including the mother-- what turned out to be very cramped quarters.[66]

From the books Manfredi asked Marsili to acquire for the observatory, and from his correspondence with Mon. Leprotti, it appears that Manfredi accepted the motion of the earth, and thus the Copernican system. This is confirmed by his own later findings on the aberration of starlight. Nevertheless, Manfredi was always careful not to express such beliefs in print, or in his public lectures, where he treated the question of the motion of the earth as a hypothesis. He and his family were too dependent on the good will of the

papal government for their livelihood to risk antagonizing it. Thus the program of the observatory from its outset was designed to cause the least trouble with censorship.[67]

The program they intended to carry out was to be geared towards the reform of geographical knowledge of the Italian peninsula. The geographical coordinates (longitude and latitude) of the most important Italian locations were to be determined pretty much as Cassini had done for France. Thanks to the patronage of Cardinal Davia, Legate to Romagna, the group determined a series of longitudes with a method devised by Manfredi which used the occultation of the stars by the moon. These were published in the *Memoires* of the Paris Academy of Sciences. However, Italy was not a unified country like France, which had a central government; the project turned out to be too ambitious for the times, and was never completed. But as an offshoot of such activities, Manfredi was able to publish in 1715 the *Ephemerides motuum celestium*, which had very wide diffusion in Europe, and abroad. The *Ephemerides* were based on Cassini astronomical tables, and contained detailed synopses of the ephemerides of the moon and planets, all possible information on the eclipses of the moon, and of the Jovian satellites, as well as on the occultation of the stars by the moon. Apparently, the Manfredi sisters contributed a great deal to the making of the *Ephemerides* in terms of observations and calculations, but like many women assistants, failed to receive any credit in the final printed work.[68]

Fontanelle in his " Eloge de E. Manfredi " pointed out that the sisters not only engaged in observations, but also made the greatest part of the calculations of the two volumes. He reproached Manfredi for failing to mention their extensive help in print. However, the ommission was to no avail since he himself, and others knew who had

helped him. Giampietro Zanotti, a close friend of the family, also said the sisters helped in the observations and calculations. To do some justice to Manfredi, he gave credit for his sisters' assistance in a postscript at the end of the *Ephemerides* manuscript. In it he stated that the Ephemerides took many years to complete for they had suffered many interruptions, but through the years he had received assistance from his two sisters, Maddalena and Teresa, Giuseppe Nadi, and occasional help from Parisi, and others like Balbi, and Guglielmini, when the latter visited Bologna. The table of longitudes and latitudes was calculated in its entirety by his sister Maddalena towards the years 1702 and 1703. It is possible that the printer Pisarri chose to ignore the acknowledgement; but it was most likely Manfredi 's decision not to print it, for, as shall be seen later, there were other times when he again failed to credit his sisters for their efforts.[69]

The data gathered, and to be gathered for the ephemerides from the different observations were assigned to different notebooks. Thus, the data, properly calculated and corrected, from observations of each planet was recorded in its individual notebook. There were notebooks assigned respectively to the fixed stars, the satellites of Jupiter's eclipses and conjunction of stars, for observations of elements of calculation such as, obliquity of ecliptic, altitude of the pole, longitude, refraction, and so on, and for extraordinary celestial appearances such as, comets and sunspots for example.

The expanded table was to contain the longitude and latitude of all points of the zodiac, given their declination and right ascension. From Manfredi one gathers that this table and all the calculations it entailed were solely Maddalena's responsibility. This table, which was number XX in the printed work, actually consisted of thirty-six subtables. Each of these subtables contained five degrees of right ascension, and on the

average twenty two degrees of declination, divided by degree, from which to calculate the respective longitudes and latitudes. Thus, to construct each such table, Maddalena had to do, as the barest minimum, at least two hundred and twenty calculations, which totaled a minimum of seven thousand nine hundred and twenty calculations for the thirty six subtables, not an indifferent task before the age of computers. Volume one of the Ephemerides contained thirty tables, many of them divided into subtables; if Fontanelle and Zanotti are to be believed, the sisters had a hand calculating many of these also.[70]

Circumstances eventually dictated that for the completion of the *Ephemerides*, the sisters engage far less in observations, than in calculations. Manfredi's mother died on April 9, 1703; it was her dying wish that Manfredi find his sisters a place of abode within one of Bologna's convents. The mother made this request perhaps out of concern for her daughters' reputation, surrounded as they were by men. Conditions at the Marsili's residence were very crowded; Marsili's brothers, who also lived there, did not view the astronomers with favour, and matters were made worse by the decision to move the Academy of Inquieti's headquarters to the palace in 1705. Manfredi had no desire to place his sisters in a convent, as such a move deprived him of their valuable assistance in observations. Nevertheless, by 1704, having amassed income after his nominations as protector of the Collego Montalto, and superintendent of waters, he placed his sisters as boarders at the Convent of San Ludovico. Regardless of where the sisters resided, Manfredi still continued to send them data, as well as instructions so that they could proceed with the calculations required for the completion of the *Ephemerides.* In 1709, Manfredi, the instruments, and the academy were expelled from Marsili's palace by the general's family. Thus, Manfredi and his instruments had to take up residence at the

Collegio Montalto, a place which was even more unsuitable for his sisters, for it was a seminary. The family had to wait until 1715, when they were offered a suitable residence by the administrative body of the recently opened Institute of Sciences to be reunited.[71]

In 1725, Manfredi published a new set of ephemerides, as the original ephemerides of 1715 were only valid for ten years. Since the family was back together, one might assume the sisters collaborated on this new set of ephemerides, as they had done on the first; but credit was not given to them, and there are no indications of their collaboration in their surviving letters. Still, one suspects they may have still carried out part of the calculations, since these were too many to be carried out by the official staff of the observatory.[72] It is also possible the sisters might have participated in the observations of the apparent motions of the fixed stars. In 1707 and 1708, Manfredi and Stancari had repeated Maraldi's Paris observations on the difference in the times of transit over the meridian of two stars, Sirius and Arturus. The sisters could not have participated on these early observations as they were boarding at the Convent of San Ludovico at the time.

In 1727, when Manfredi retook the observations of the same stars, and extended it to fourteen stars in 1728, the sisters were back, living with him in the apartments of the new observatory tower of the Institute of Sciences. Again there are no indications from the correspondence that the sisters participated in any way in these observations; since they lived right on the place where observations took place, one expects they took part in them at some level. However, it appears less likely that the sisters would be neeeded for observations, or perhaps, even calculations at that time. By then, the Institute of

Sciences, and the observatory tower were fully operational; Manfredi as the Institute's professor of astronomy would have had more manpower at his disposal than ever before in the form of his brother Eraclito, his official assistant, Eustachio Zanotti, and students of astronomy at the Institute.

The results of Manfredi's observations, published in 1729 and 1731, remained Manfredi's most important work. The 1731 publication remained for many years the only work which confirmed by a different method from James Bradley's the aberration of starlight, or the apparent displacement of a star on the celestial sphere due to the speed of light and the rotation of the earth. To have the 1731 publication pass the censors, Manfredi was forced to refer to Bradley's explanation--that the aberration was due to the earth's rotation--as " improbable and marvelous ", while we know from his correspondence that he believed in it in private.[73]

If Maddalena and Teresa may have assisted their brother less in astronomical matters, after the foundation of the Institute, they still assisted him in matters pertaining to his position as superintendent of waters. In 1735, Manfredi published *Compendiosa informazione di fatto sopra i confini della communità Ferrarese d' Ariano con lo stato Veneto.* The work dealt with a region in the Pò delta which once was under the control of the extinct Duchy of Ferrara, which bordered the Venetian Republic. However, by Manfredi's time, the region was disputed by both the papal government and the Venetian Republic because of the continuously changing delta landscape caused by the changing courses of the Pò river and its affluents. It was Manfredi's job to prove papal ownership of the territory through the use of ancient and modern documents, actual measurements, and the construction of maps.

The book contained copies of thirty documents, many of them in Latin, dating from 944 to modern times, which indicated how the land might have been at various periods due to the changing courses of the Pò river and its affluents. The documents also showed who had administered, owned, and donated the various locations of the territory from the Middle Ages to the time of the dispute. From the documents, and from measurements taken on location, Manfredi provided descriptions and drew three maps on the same scale, one ancient, one from the 1600s, and one recent, which illustrated the changes caused by the changing courses of the Pò river and its affluents.[74]

The sisters with the help of Giampietro Zanotti began work on the project in 1726. Zanotti appears to have assisted them with the translation of many Latin documents. For although Maddalena was familiar with Latin, it appears her skills in the language were not sufficient to allow her to read manuscript documents, often from the Middle Ages. The sisters also provided summaries of the documents' contents, might have assisted in the mapmaking, and took down his dictations. When the work was printed, once again Manfredi failed to acknowledge his sisters' collaboration.[75]

Manfredi should not be judged too harshly for failing to acknowledge his sisters in print; his brother Eraclito, and his friend Zanotti often received the same treatment. The sisters might not have wished any official recognition anyway; and, if her poem can serve as a guide, Maddalena apparently did not wish to be known as a learned lady. Besides, for all of Manfredi's bossy tendencies, there was real affection and good humour between the brother and the sisters, and their friend in common, Zanotti. In addition, there is also plenty of evidence of his respect for his sisters' abilities, as well as for the abilities of other women, such as Laura Bassi, whom he felt was not only deserving of her degree,

but also a lectureship at the university.[76] Astronomy, and the superintendency of waters was a family business, initiated by the head of the family, Eustachio Manfredi; the sisters appeared quite happy to ensure that the business ran smoothly. Even if no official credit was given them, their efforts on behalf of that business was generally acknowledged as far as Paris.

Another woman, Caterina Scarpellini (Foligno 1800-Rome 1873) began her studies in astronomy in a similar fashion to the Manfredi sisters. Her teacher on the subject was her uncle, Abbot Feliciano Scarpellini (Foligno 1762-Rome 1840) responsible together with D. Francesco Caetani and G. Pessuti for the resurrection of the Academy of the Lincei, Prince Cesi's old Rome academy, of which Galileo was a member. C. Scarpellini learned astronomy because her uncle, like Eustachio Manfredi, was in need of an assistant in the publicly-funded observatory, of which he was director. However, unlike the Manfredi sisters, C. Scarpellini was able to have a career as an astronomer and meteorologist, attached to the same public observatory, after her uncle's death. She was able achieve this at a time when astronomy was highly institutionalized, by choosing topics which did not interest the observatory's director, and by ensuring that her research would be published at any cost.[77]

IV. *Caterina Scarpellini: Professional Astronomer and Meteorologist*

Caterina Scarpellini was born in Foligno, in the Papal States, in 1800. Since no eulogies were written at the time of her death, little is known of her early education and private life. It is assumed she transferred to Rome around 1825, when her uncle Feliciano Scarpellini was made director of the newly founded Capitoline Observatory of

the Roman University (La Sapienza). Prior to that time, her uncle resided at a Roman residential college, the Collegio Umbro-Fuccioli, where he was rector, and where C. Scarpellini, as a woman, was unlikely to reside. C. Scarpellini also married either at Foligno, or in Rome, a cousin, Erasmo Fabri Scarpellini, who also acted as assistant at the same observatory. Husband and wife were partners in their publishing enterprise, the *Corrispondenza scientifica*, a scientific journal which provided her with the means to publish her research, and to make contact with scientists from home and abroad.[78]

Prior to becoming director of the Campidoglio observatory, Feliciano Scarpellini had been one of the directors of the Caetani observatory belonging to the Dukes of Sermoneta, where his abilities as a meteorologist, astronomer, and instrument maker became well known, and led to the publication of a series of Roman ephemerides. Many of the instruments made and/ or improved, and owned by F. Scarpellini, such as Reichenbach repeater circle, wall and portable quadrants, a catodioptric telescope, eliptic, and parallactic instruments, which were housed at the Caetani Observatory, eventually furnished the new publicly-funded Capitoline Observatory. In 1816, F. Scarpellini was also nominated by Pius VII professor of sacred physics, and astronomy at the Roman University (La Sapienza), a chair which was created especially for him with the deliberate intent to make scientific thought an instrument of the faith. Since the Capitoline Observatory was associated with the Roman University, its directors were also professors of astronomy at the university. The observatory and the instruments were meant to be teaching tools in optics and astronomy for the students at the Roman University, who met ten times a year, under Scarpellini's supervision. They were shown the main experiments on reflection and refraction, and how to use the instruments in

optics, and astronomy available at the observatory. The fact that F. Scarpellini owned many of the astronomical instruments housed in the Capitoline Observatory might explain why Caterina Scarpellini, who was one of her uncle's heirs together with Erasmo Fabri Scarpellini, was able to keep her position of assistant after her uncle's death, even after the government bought the instruments from her. She might have agreed to sell the instruments only after the government had agreed to keep her as assistant astronomer of the observatory. Women tended to lose their often unofficial positions at public observatories once their male relatives, holders of official positions at the institutions, had died. For instance, the German astronomer, Maria Winkelmann, who had assisted her husband, Gottfried Kirch, while he was the official astronomer of Berlin's Societas Regia Scientiarum, lost her position at the observatory when he died in 1710.[79]

According to Ignazio Calandrelli, who became director of the Capitoline Observatory, after the several years of dispute which followed F.Scarpellini's death in 1840, the observatory had not been used for the purpose of research in Scarpellini's time; at least, Scarpellini's heirs, Caterina Scarpellini, and Erasmo Fabri Scarpellini had failed to give any proofs of observations carried our by the uncle. This fact was disputed by both C. Scarpellini, and her uncle's biographer, who stated that F. Scarpellini had presented several dissertations on the topic of astronomy at the Academy of Lincei, including one on the new reflecting mirrors made in Rome for use on large telescopes. He had also determined very accurately the observatory's latitude, as Callendrelli did find out, when he, himself, determined the latitude. It appears that F.Scarpellini was a good practical astronomer, with a talent for improving, and making instruments in astronomy. Nevertheless, he appeared to have lacked the extensive knowledge in celestial mechanics

which his successor Calandrelli had, and which would eventually take the observatory in a different direction.[80]

Caterina Scarpellini's education reflected her uncle's interests and teachings. As a practical astronomer, she appeared to have had excellent knowledge of the solar system. This knowledge is apparent in her detailed description of lunar geography, as well as in her descriptions of the solar eclipse of July 18, 1860, the appearance of comets, of Saturn's rings, and of the asteroids in the asteroid belt. The motions of the asteroids were of particular interest to the observatory's director Calandrelli.[81] Caterina had also considerable knowledge of the constellations, and the stars they contained, which is evident in the catalogues of meteor showers, or swarms, she published from 1861 to 1869. The meteor swarm's location in relation to a constellation and its stars determined the swarm's radiant point (the area of the sky from which meteors radiate); this latter point then could be used to compute the position and orbit of the swarm.[82]

Like her uncle, and mostly because of him, C. Scarpellini had an interest, as well as an understanding of how instruments in physics and astronomy operated, and how modifications on their design might have improved them. This is apparent in her discussion on how Prof. Cecchi of Florence brought improvements to the induction machine of Ruhmkerff, or in her description of a new hygrometer by Prof. Baumhauver. Her interest in instrumentation, in this case in astronomy, is never more obvious than in the dissertation Scarpellini presented to the Roman Academy of Quiriti--a private academy whose members were interested in science, literature and the arts--of which she was made a member perhaps at the time of her presentation, on December 18, 1854. The dissertation dealt with " Science in the Papal States ". In it, Scarpellini not only

described the latest optical instruments in Russia and England, which allowed many discoveries, such as the previously unknown satellites of Venus, Saturn and Uranus, but also those instruments recently acquired by the main Roman observatories, the Roman College's, and the Capitoline, respectively. The Roman College had acquired a Merz equatorial, thanks to the efforts of its director, Father Secchi; while Pope Pius IX had donated to the Capitoline a meridian circle, a special form of transit with a large telescope, and with considerable refinements for reading angles. Since this latter instrument was donated to her observatory, she not only described it, but also explained how to operate it, and what could be seen with it. Scarpellini, herself, was given the opportunity to operate the circle, but as she pointed out, always accompanied by her director, Calandrelli.[83]

Scarpellini could find and determine the positions of celestial bodies at any time of the year. But there is no evidence that she had the advanced knowledge in celestial mechanics that Calandrelli had, and therefore could not have engaged in the type of astronomical research he was carrying out at the observatory. If there are plenty of indications that Scarpellini assisted her director in observations, there are none that she assisted him in any way in calculations, such as those needed to determine the elements of the orbits of small asteroids.[84] Considering how ready Scarpellini was to publicize and publish her work, as shall be seen, even to the detriment of her funds, and in spite of considerable obstacles, had she assisted Calandrelli in his calculations, she would have informed her readers of it.

If women in former centuries had been shy to publish their scientific expertise, Scarpellini did not suffer from such scruples, after her uncle's death. Thus, when a

previously unknown comet appeared into view, she followed it for three days, and published her findings in two journals, the *Giornale di Roma*, on the third day of its appearance, and in hers and her husband's journal, the *Corrispondenza scientifica*. At the time Scarpellini believed to have discovered the comet. Later she became aware that she was not the first astronomer to discover it, that honour belonged to S. Brersen of Senftenberg, who had viewed the comet a fortnight earlier than she had. Credit for the discovery of the 1854 comet continued to be given to her by later historians of astronomy, such as E. Lagrange among others, in spite of the fact that she had disclaimed all credit of such an honour. [85]

C. Scarpellini might not have discovered a comet, but she ensured that her work in astronomy and meteorology would be known, far and wide, in Italy, and abroad. However, it is important to stress that her publications began only several years after her uncle's death. In fact, very little is known of her activities in the observatory while Feliciano Scarpellini was its director, except that she would have assisted him as he required.

Neither she, nor Erasmo were professors at the Roman University; thus, they were in need of someone who belonged to that institution to ensure that teaching and research programs, as well as their own jobs as assistants, would continue to be funded by the government after their uncle's death. Therefore the appointment of Calandrelli, professor of astronomy at the university, as director of the observatory, was essential to their survival. In fact, the couple's editorial and research activities began after Calandrelli's return from Bologna in 1847, following years of disputes over the observatory. To be precise, their activities began on September 15, 1847, with their first

publication of *Corrispondenza scientifica*, a journal designed to divulge scientific and technical works from Italy and abroad to readers at large. Caterina's own autographed contributions to the journal began on March 14, 1849, although, she might have been anonymously contributing to it before that date.[86]

Taking part in the editing of the *Corrispondenza scientifica* did much to expand C. Scarpellini's scientific horizons. The journal offered local scientists, other than herself, a possibility to expose their works. For instance, the chemist Paolo Peretti, with whom C.Scarpellini would later cooperate in the editing of *Carte grafico-medico- metereologica* (1873), was given the opportunity to dispute the findings of F. Schoenbein (the discoverer of ozone), presented to the Royal Academy of Sciences of Bavaria, which stated that the reaction of phosphorus with water and air would gave rise to ozonized oxygen. To Peretti, what might have passed for ozone in reactions where there were uncertainties as to the purity of the reagents, might have actually been some other chemical.[87]

The fact that the botanist Elisabetta Fiorini Mazzanti of Rome read her findings on the collema lichen relationship with nostoc (algae) to the Florentine Academy of Georgofili was duly recorded by Scarpellini. She also provided an abstract of Fiorini Mazzanti's findings on the relationship between nostoc and collema.[88] Her own director, Calandrelli, published a long article on the solar eclipse of July 28, 1851, and received the occasional reference, such as how precisely he had determined the beginning and end of the great solar eclipse of July, 1860, observed by C. Scarpellini at the Campidoglio. Normally, he preferred to publish in the *Acts of the Academy of Lincei*, a more technical journal, where he was able to report his research in full.[89]

References to, and the contributions of Father Pietro Angelo Secchi, director of the Roman College observatory, were more frequent. Secchi, whose work on star spectra, was to achieve him considerable fame, seemed to have had good relationship with both Scarpellini and Erasmo, due to an interest in meteorology, which they shared in common. The three collaborated in *Pontificia meteorologica telegrafia in Roma e Mezzodì*, which used meteorological data gathered from the main towns in the Papal States from July to December 1855. The results were plotted in graphs which represented the barometric oscillations for the period, as well as variations in temperature, humidity, wind direction and speed for each town. Scarpellini herself was responsible for the graphs which illustrated variations in wind direction.

Scarpellini duly recorded and explained Father Secchi's acquisition of a meteorograph for the Collegio Romano in 1859. She also mentioned his observations on Saturn and its rings, whereby through the measurements of the rings he demonstrated there were variations in their dimension, but they were not enough to cause their progressive tightening, and eventual collapse as Otto Struve believed. In 1854, Secchi had the use of two of Scarpellini's journals to expound his thoughts on periodical variations of terrestrial magnetism, again a topic of interest to her and husband.[90]

Usually the articles published did not occupy a whole journal, but tended to be shorter, and were the result of communications received from various parts of Italy and Europe. To maintain such lines of communication open must have been a difficult task for both Scarpellinis. The Italian peninsula was experiencing considerable upheaval during the period of the journal's existence (1847 to 1863) due to the struggle for unification. Rome itself came under the control of a republican government from

November 1848 to April 1850.[91] In spite of political instability, the journal continued to be printed. Their intention to have it appear on a weekly basis, could not always be carried out, and there could be considerable gaps between publications. For instance, the journal was not published between October 2, 1850 and February 26, 1851. It appears that only considerable debts on the couple's part put an end to their publication in 1863.

Whatever difficulties the Scarpellinis faced throughout the paper's existence their goals remained constant, which were to inform Italians of scientific activities abroad, to encourage similar activities in Rome, and elsewhere in the Italian peninsula, and to promote unity in Italian science. To encourage such unity her husband had initiated the *Corrispondenza meteorologica telegrafica*, which compiled meteorological data from the various observatories of the Italian peninsula. In 1860 Caterina had the same intent in mind when she congratulated Vincenzo Antinori, the director of Florence's Museum of Physics and Natural History for founding the *Archivio meteorologico italiano*. As far as she was concerned, there was need to coordinate and organize the scattered data that was being gathered in various parts of the peninsula, as was done in other countries, so as to get a uniform and informed picture of Italian meteorology.[92]

To understand the environment better, and how it might affect all living things was Scarpellini's reason for publishing Padua's Prof. Zantedeschi's observations of the earthquakes that hit the area in 1859, and again in 1860, the latter of which having occurred twenty four hours after the 1860 solar eclipse. He hoped she would also publish the observations of others on the phenomenon, which seemed to strongly indicate a correlation between oscillatory movements of the earth's crust with solar and lunar attractions. For similar reasons, Scarpellini presented to the readers the work of the

Venetian Antonio Berti on the relation between barometric pressure and the cholera epidemic, and on the effect of atmospheric variations of ozone with catarrh illnesses.[93]

Several pages of each journal were dedicated to reporting the activities of scientific societies and individuals from outside the Italian peninsula. These activities could deal with chemistry, medicine, technical advancements, and areas of particular interest to the Scarpellinis, astronomy and meteorology. These activities could be summarized in a few short paragraphs in a section, often edited by Caterina, and called "Scientific Week", or have a longer format and belong to the main body of the paper. The Scientific Week's paragraphs could range from the extraction of nickel or cobalt to what was discussed at a meeting of the Astronomical Society of London, or a cure for cholera by the use of tobacco as published by the Journal of Medicine of Boston.[94]

The longer format items in the journal could be either translations, or summaries of communications from secretaries of various European academies, or associations, of papers presented in these institutions, or of information directed exclusively to the *Corrispondenza scientifica*. Thus, the astronomers at the Berlin observatory had sent to the Scarpellinis the elements of comet Pons' orbit (quantities which are used to compute the size, shape and orientation of an orbit). The comet's small orbit, 3½ years, had been calculated, and its return predicted, by one of the astronomers at the Berlin observatory, J.F.Encke. Since the comet was expected to return in 1855, Caterina passed on the information received to her readers. She also explained that the comet's orbit was getting smaller, and that Encke, to predict its orbit more accurately, had to take into account the resistance of the medium, a most tenuous fluid, which filled the spaces in between the planets. Perhaps to counterbalance this concept of ether, Scarpellini also

published that same year (1855) the University of Upsala's astronomy professor, A. J. Angström's objections to Encke's assumption that resistance to the medium might have caused changes in comet Pons' orbit.[95]

The editors presented summaries, or translations of what was presented at the various meetings of the British Association for the Advancement of the Sciences, the Biological Society of Paris, the Imperial Society of Natural Sciences of Cherbourg, the Pharmaceutical Society of Anvers, and the Society of Physics and Natural History of Geneva, to name some of the most obvious institutions.[96] However, the foreign institutions, which were reported most often, were the Paris Academy of Sciences, and the Royal Academy of Sciences of Brussels. Contact with the Paris Academy of Sciences and other French institutions was, no doubt, made easy by the presence of the French military in Rome for much of the journal's existence. The papers presented to the Paris Academy, and translated, or summarized by Scarpellini, could range from research on the atmosphere of comets to research on the physical, chemical properties of aluminum, its test in the Voltaic series, and its extraction.[97]

Undoubtedly, the correspondence reported in the journal, which was to affect Scarpellini's career most deeply, was that which she maintained with the Royal Academy of Sciences of Brussels, and its permanent secretary, Alphonse Quetelet (1796-1874). The Belgian scientist, although an astronomer, had an absorbing interest in meteorology and physical phenomena, especially their periodicity. He studied the temperature of the earth, the intensity of atmospheric electricity, variations in barometric pressure, and the periodic phenomena of the life of plants and animals. His study of atmospheric electricity, and its annual and diurnal variations, established the law of variation of

intensity with height. His observations of barometric pressures led to the discovery of atmospheric waves. He believed it served meteorology well to set up simultaneous observations in various locations, and he worked hard to achieve this goal. Due to his efforts, some progress in international cooperation, and uniformity was achieved by the Sea Conference held in Brussels in 1853.[98]

In 1850, Quetelet sent to *Corrispondenza scientifica* his observations on atmospheric electricity for 1849, which according to Quetelet, was at its lowest point, and could explain cholera epidemics. In 1851, Scarpellini presented a paper by Quetelet on the influence of atmospheric electricity on barometric height, which to her was of great importance, because it was little studied at the time. In 1852, she summarized a note he had sent her on atmospheric waves. He also communicated to her what was discussed on nautical meteorology at the Sea Conference of 1853. In 1855 Scarpellini printed his observations on the Aurora Borealis' effects on telegraph wires, as well as his important communications on the influence of temperature on the development of vegetation. To Quetelet, the influence of heat on plants could be expressed as the sum of the squares of the diurnal temperatures.[99]

As demonstrated above, through her editing work at the *Corrispondenza*, Scarpellini was well aware of the activities of Quetelet and other European scientists in the field of meteorology. An opportunity to join such fields of research was offered her when the Roman magistrature organized the meteorological chamber at the Capitoline Observatory in 1853, and furnished it with the latest instruments. Such opportunity was further enhanced by the fact that Calandrelli, her director, had no interest in meteorology.[100]

The first results of her meteorological studies appeared in 1856, not in the *Corrispondenza*, but in the *Giornale arcadico*, the most important journal for scientific matters in Rome until the foundation of the *Atti dell' Accademia Pontificia dei Nuovi Lincei* in 1847. The article dealt with the ozonometric observations carried out at the Campidoglio during August 1856. As can be concluded from some of the articles mentioned above, ozone, identified by C.F. Schönbein in 1839, was considered a purifying agent of the atmosphere. Many scientists believed that higher levels of atmospheric electricity produced higher levels of ozone. In turn, this ozone had the recognized capacity to purify the air, which made it particularly efficacious against epidemics, particularly of cholera. High levels of ozone were indicative of salubrious air. The importance of ozone levels to the nineteenth-century mind, ensured that methods for measuring it would be devised, and that meteorologists would be responsible for such measurements. Schönbein devised a method for measuring ozone, which became widespread at the time, and it was the one used by Scarpellini. It consisted of a strip of special absorbing paper in a solution of starch and potassium iodide, which when exposed to the air, but protected from light and rain, could turn violet because of the formation of iodine. Colour intensity was then assessed by a colorimetric scale, after the strip had been immersed in distilled water.[101]

In her 1856 article, Scarpelini explained the difficulties in understanding the ozone formula. According to her, the last studies seemed to indicate an isomeric allotropic state of oxygen. She then described the method used for measuring ozone, and the location of the instruments. According to Scarpellini, she had asked to start such measurements in Rome, and she was inspired to undertake them for their eminent

usefulness. Before publishing her August 1856 readings, she had made trials runs from March to July; from these trials Scarpellini concluded that Schönbein appeared to have been correct in finding increased ozone levels during electrical storms. The tables she provided contained ozone measurements, relative humidity, temperature, barometric pressure, and the state of sky, all taken at 7 a.m. and 7 p.m., every day of the month. Scarpellini also gave average daily ozone measurements, as well as monthly averages for all the measurements. She had desired to measure diurnal variations in atmospheric electricity, and wind direction and speed, but lacked the equipment to do so. Having eventually acquired an anemoscope, Scarpellini was able to provide wind direction for all the later measurements, but not wind force. These later measurements also contained a column which indicated iodoform odour, and a section called meteor, which, besides containing detailed, descriptive, information on the weather, also recorded earth tremors, aurora boreales, meteor observations, and other unusual atmospheric phenomena. These later measurements began August 1857, and continued on a daily basis until April 1860. They were published as tables by either the *Giornale delle strade ferrate* from 1857 to June 1859, when the journal ceased publication, or by the *Corrispondenza.*[102]

Scarpellini seemed to have interrupted ozone measurements between March 1860 and January 1862; at least none survived. In 1862 she issued the new series of ozonometric measurements; of these, the January 1862 to April 1862, and December 1862 to January 1863 measurements survived, printed in the *Corrispondenza.* To the old measurements, Scarpellini added others, such as rainfall for the month, diurnal atmospheric electricity, and Abbot Marucchi's hydrometric observations of the Tiber. For the January 1863 tables, she added a section called the physiology of the seasons, which described how

one's physiology, such as breathing, food intake, and heat generation, could vary according to the seasons.[103]

There is evidence that Scarpellini continued to measure ozone levels up to her death in 1873, and issued them as bulletins. One such bulletin survived for the years 1870 to 1872, and there was also a bulletin for August 1869. A related bulletin called *Medical Meteorology* for the years 1871 and 1872 also survived, and was sent to the *Società medico chirurgica di Bologna*. The bulletin was done at the request of Prof. C. Maggiorani, from Rome University, so that he and others could study the influence of barometric pressure on the phenomena of life. The bulletin had a graph which displayed variations in barometric pressure for the months measured, as well as tables which contained the usual measurements of her ozonometric tables, except that in them the ozone level was ignored.[104]

Scarpellini was certainly measuring ozone levels in 1864-1865, because Paolo Volpicelli, the Secretary of the Academy of Lincei, referred to her doing so at the time in the Academy's Acts. He also added that she was the only person carrying out ozonometric measurements in Rome, in spite of their importance. The format of the bulletins, a few pages only, and the fact that they might have been sent to individuals, rather than to institutions, contributed to their dispersal. But the members of the Academy of Lincei (the academy refounded by her uncle) should share in the blame. Once the two journals in which she published her tables folded, they simply failed to offer their journal as a substitute. Undoubtedly, they did not publish her results because she was not a member of the academy, which begs the question: why was she not made a member, when Elisabetta Fiorini Mazzanti, her contemporary and also a woman, was?

One suspects, her political views (in favour of Italian unity) might have interfered with her membership in a pontifical academy.

When Italy and Rome were finally united in 1870, and the Royal Academy of Lincei was created, all the members of the old academy were automatically made members of the new academy, Fiorini Mazzanti included. Scarpellini, who was not a member of the old academy, was left out of the new one, thereby she again missed out on the opportunity to publish in the Acts. Nevertheless, she had the honour of receiving a medal from the Italian government in 1872 for her scientific efforts. Scarpellini was to have better luck elsewhere, because she was made honorary, or corresponding member of various academies in Italy and abroad, such as the Academy of Georgofili of Florence, Accademia fisico-medica e statistica dell' Ateneo di Scienze of Milan, the Imperial Geological Institute of Vienna, the Academy of Natural Sciences of Dresden, and the Imperial Society of Naturalists of Moscow, to name a few.[105]

Scarpellini's astronomical observations were also connected, somehow with meteorology, since they usually dealt with the effect of celestial phenomena on the earth. In the total solar eclipse of 1860, Scarpellini provided the readers with a description of the sun, as it appeared to her at the observatory. She also included the photographs which were taken during the eclipse's different phases. If Calandrelli had calculated its beginning and end, her job had been to monitor meteorological changes during the event. Thus, she recorded light, temperature, barometric pressure and humidity before, during, and after the eclipse. These measurements were organized in a table, with the changes, which had been detected suitably explained to the readers.[106]

The astronomer also recorded earth tremors, for which she provided tables from 1858 to 1861. These tables recorded the type of tremor (vibrational, or ondulatory), and its direction, the phases of the moon, and whether it was at apogee or perigee, the usual meteorological measurements , and whether there were barometric oscillations during the quake. These tables had their origin in her belief of the moon's influence on earthquakes. From her observation of tremors for a period of at least four years, Scarpellini concluded that these were more likely to occur when the moon was at perigee, and its attraction was at its strongest, and also when it was full or new and at syzygy (when the moon, sun, and earth are lined up). In fact, as there was a connection between tides and lunar attraction, there was also a connection between tremors and lunar attraction. Tremors were most likely caused by the effect of the moon, which raised and lowered subterranean water congregating at specific places. Tides were at their highest at syzygy; it would then be logical to conclude that during this period tremors were most likely to occur. This theory was not original to Scarpellini, as she pointed out; it had been suggested by Giorgio Baglivi in 1703, Giuseppe Toaldo in 1770, by Zantedeschi of Padua in 1854 and by Prof. Alexandre Perrey of Dijon in 1856. In fact, the effect of subterranean water, if not the moon, on seismic and volcanic activities had been widespread in the seventeenth and eighteenth centuries.[107]

During the 1860s, Scarpellini occupied herself with observing, and cataloguing those shooting stars, or meteor showers, which intersected the earth's orbit in August (the Perseids), and/or November (the Leonids). For many centuries shooting stars were considered some kind of lightning, and, thus, ignored by astronomers. Only in 1790, two astronomers discovered that these occurred even above what is today called the

stratosphere. In 1833, astronomers witnessed a magnificent meteor shower during the night of November 12-13. Further studies indicated that these showers had occurred in the past, at approximately the same time of the year at 33 years intervals. Another such shower was expected for 1866, and it occurred, with repeated displays in 1867 and 1868. These showers were named Leonids because they appeared to radiate from the head of the constellation Leo. At the same time, astronomers witnessed yearly displays of meteor showers around August 10, which were named Perseids, because their common radiant point was the northern part of Perseus.[108]

Scarpellini was aware that to determine the height of the meteor shower, there was a need for simultaneous observations at two stations. Her second station was at Civitavecchia, manned by another astronomer, either Captain Alessandrini or Prof. Pinelli. Her first surviving publication, which dealt exclusively with meteor swarms dated from 1866. It took the form of a letter to her uncle's biographer, Benedetto Trompeo of Turin, and described the meteor shower of the night of August 10, 1866 (the Perseids). The article gave in a descriptive manner (it contained no tables) the number of meteors observed, the time they appeared in the greatest number, their direction in relation to the stars, and their relative sizes. Scarpellini also described in the same manner the findings of the second station's observer.[109]

In 1868, Scarpellini published her most important work on meteor swarms: it consisted of a catalogue of the meteor showers she had observed at the Campidoglio from 1861 to 1867. E. Lagrange referred to it as the first of such catalogues in Italy. In it, the author presented the history of the study of meteor swarms, pretty much as can be found in any modern history of astronomy work. This was followed by the actual catalogue

based on a method of observation that followed the precepts of the Neapolitan astronomer Antonio Nobile. Scarpellini attempted to observe the August sky for the Perseids, and the November sky for the Leonids. From 1861 to 1865 inclusive, and then for 1867, she provided tables for the Perseid which included for each meteor observed, the time of observation , apparent position in relation to the stars and its direction and apparent size. She began her observations of the Perseids around 8 p.m., and ended them around 1.30 a.m. of the following morning; only in 1867 did her observation time stretch to 3. 50 a.m. The meteors were also classified according to colour, such as bluish, green, orange, and so on, with a reminder of the Doppler's law on the variation in colour of a moving luminous point. In 1864, the need to be precise on the radiant point forced Scarpellini to catalogue the meteors observed on the five nights which preceded August 10, the night in which the swarm would be at its peak.

Scarpellini also attempted to observe the November meteors, or Leonids, which were expected in the greatest numbers only in 1866, because they had an orbit of 33.25 years, intersecting, with each occurrence, the earth's orbit at later dates in November, as calculated by H. A. Newton of New Haven. Her attempts to observe them from 1861 to 1864 failed because of overcast conditions in Rome. In 1865, Scarpellini was able to observe fifty of them on the morning of November 13. In 1866, in the morning of November 14, between 0.25 a.m. and 2.40 p.m., before the clouds moved in, she was treated to the full spectacle of the meteor shower. The shooting stars were only 10 between 0.25 a.m. to 0.30 a.m., but from 2.15 a.m. to 2.30 a.m. the shower was so intense from the general direction of Western Leo, that the meteors could no longer be counted.[110]

The catalogue was dedicated to Prof. Giovanni Schiaparelli, director of the Milan Astronomical Observatory, who in 1866 had discovered that the Perseids and comet 1862 III shared the same orbit. He had come to that conclusion after he had determined that the Perseids moved in a nearly parabolic orbit; a fact that Schiaparelli had ascertained from knowing the ratio of the number of shooting stars in the first and in the second half of the night. After computing the Perseids' orbit elements from the radiant, he found these elements to coincide with these of comet 1862 III.[111]

Scarpellini's catalogue for the Perseids was of no utility to Schiaparelli, except to help him confirm what he already knew. He had derived their orbit in 1866, and the catalogue was only published in January 1868. Certainly, it would help others confirm Schiaparelli's findings. The same could be said of the 1869 bulletin on the Perseids, in which Scarpellini provided detailed information from two stations, on the time, number, position and direction of individual meteors.[112] But the information the catalogue contained on the Leonids may have proven of some utility. It contained the number of shooting stars at different times of the night and their direction, from which a ratio of their numbers in the first half, and in the second half of the night might have been derived. No doubt, Scarpellini had utility in mind when she also published the bulletin of the 1868 Leonids from two stations, from which again a ratio of their numbers, as well as their radiant could be derived. Whether he made use of her catalogue and bulletins, or not, after November 1868 Schiaparelli was able to compute the Leonids' orbit and found it to be nearly identical to Temple's comet 1866 I.[113]

Pannekoek points out that observation of shooting stars during the entire nineteenth-century was a regular field work for amateur astronomers. It is difficult to qualify

Scarpellini as an amateur astronomer, since for many years she acted as assistant to Calandrelli at the Capitoline Observatory. One assumes she had chosen meteor observation initially because of Calandrelli's lack of interest in the subject. However, as a woman, who could not attend university, and had been dependent on her uncle for her education, Scarpellini had failed to receive much of the advanced theoretical training, which would have made her a more complete astronomer. Consequently, with a limited knowledge in celestial mechanics, Scarpellini could never had made use of meteor observations, as Schiaparelli, a university trained astronomer, had done. Still, with limited material, education, and opportunities at her disposal, she was able to carve a position for herself , and to achieve recognition in Italy, and abroad in the world of nineteenth-century astronomy and meteorology. Scarpellini achieved this recognition by understanding where her opportunities lay, making the most use of them, and by making sure that others knew of her activities through extensive publications.

If Scarpellini's science differed in any way from that of men like Calandrelli, it was because, as a woman, her opportunities were limited, and not because of any belief on her part that science had to be humane, and not be used for competition and warfare, as writer on gender and science, as E. Fox-Keller and others have attempted to demonstrate of women scientists in general.[114] Scarpellini believed in the importance of technological advancements to a country, whether it came in the form of better instruments, new machines, or more efficient exploitation of natural resources; she constantly promoted such advancements in her journal. Positivism underlay many of her writings, for in them we find a belief on her part of the unlimited capacity of men and women (she included women in the equation) to achieve results, and progress in science; the nineteenth

century provided the needed proof of this ability. In the best Baconian tradition, she also believed that to achieve such results, to arrive at a law or principle, both men and women needed to be prepared to conquer and dominate nature.[115]

We cannot discuss the history of women in astronomy and/or cosmology in Italy after Galileo's trial and before 1757, without taking into consideration the Catholic Church's interdictions of the Copernican system, and other subjects that smacked of materialism. Such interdictions affected their education, what they published, and even how many women entered the field of astronomy. Mancini, Piscopia, a translator like Barbapiccola, and the Manfredi family were all affected by these interdictions, as their publications clearly reflect. Mancini, in spite of being familiar with several Copernican works, was careful never to refer to a moving earth. Had not her book been privately printed, and therefore relatively rare, Mancini might have been censured for the use of judicial astrology, also condemned by the Church. As such Mancini's work remained one of the last, if not the last publication, by an Italian learned woman, which made reference to astrology. It is illustrative of the decline of astrology among the learned women. A subject, which was once so popular, seems to disappear from sight amongst their publications by the eighteenth-century. Piscopia practically a contemporary of Mancini, apparently frowned on the subject, and the other women who followed in her footsteps, made no reference to it at all. Of course, as discussed, almanacs continued to be published throughout the eighteenth century, and elite women probably continued to be interested in the subject, but they no longer publicized it as they had done in the past.

Like Mancini's, Piscopia 's education in astronomy was also affected by the Copernican system, and the interdiction it suffered. Fear of censorship by the Church

might have been behind her orders to destroy her manuscripts after her death. Undoubtedly, she had been aware that any writing on atomism, a philosophy Piscopia had apparently been converted to by her last teacher, Renaldini, could be accused of materialism, and thus, be censored by the Church. This might have been deeply troubling to a religious person like Piscopia. Even the Manfredi sisters were affected by such a censorship, not directly, for they published nothing in astronomy and natural philosophy, but through their brother's publications. Eustachio Manfredi's living, and that of the whole family depended on him keeping peace with the institution which employed him, while, at the same time, he attempted to be an effective astronomer in the European stage. Only Scarpellini, and translator Maria Vigilante who wrote on astronomy after 1757 were not affected by this censorship to any extent.

The Church's interdiction also affected the number of women who were to practice astronomy. It did this by discouraging men who might have practiced astronomy at the amateur level. As Schiebinger demonstrates for Germany, women trained in astronomy were most likely found in this environment than attached to institutions. As shown in chapter three, these women were more common in the Italian Renaissance and early Baroque periods than later on. Women like Cereta, Forteguerri, Danti, Frescobaldi and others had the advantage that they could carry out observations on their own. However, by the second half of the seventeenth century, the practice of astronomy became increasingly a group effort, because of the instrumentation and methodology required.. A self-taught astronomer and astrologer like Mancini, or even a theoretically qualified astronomer like Piscopia, would have found it difficult to practice astronomy on their own. By then an astronomer was increasingly in need of friends, families, and/or

institutions, technical, and mathematical expertise to contribute to the field of astronomy. This type of environment should have allowed for women's limited participation in the field, in the role of assistants. The Manfredi sisters, like German female astronomers, were trained because their male relatives were in need of assistants. Like their German counterparts, they carried out tasks male astronomers cared not to perform. But the environment which fostered the Manfredi sisters was in short supply in Italy after 1633.

The Manfredi sisters might have escaped training in astronomy altogether, had not their brother begun the practice of astronomy, independently of any institution. There is evidence that their role as assistants in the field of astronomy was greatly reduced after the Bologna observatory was officially opened, and their brother had assistants and students at his disposal. One might generally say that observatories ran by institutions did not generally welcome women. But there was one notable exception in Scarpellini's case found right in the capital of the Papal States. Scarpellini had been called from Foligno, trained by her uncle, to act as his assistant at an observatory founded by the papacy for the purpose of teaching astronomy to students at the Roman University. She remained as assistant at the observatory, after her uncle's death. Then she was able to carve a career for herself in astronomy and meteorology within the institution by performing deliberately the tasks her observatory director had no desire to perform. It serves to illustrate that the relationship between women, and male run institutions in Italy was far from simple. Had the Manfredi sisters desired to have been more active in astronomy later in their lives, they might have succeeded.

From 1633 to 1874 Italian female astronomers were very few in number when compared with their counterparts in Germany. Nevertheless, they were present

throughout, and provided a link between female astronomers of the past and those who received degrees in astronomy after the universities opened to women. Most importantly, throughout the period there were men who believed that some women were capable of handling the theory and practice of astronomy.

[1]De Pizan, *Livre du Chemin*, pp. 76-95; Fonte, *Il Merito...*, pp. 81-83; Gambara, *Le rime*, pp. 81,104,123, 166; Sacrobosco, *La sfera*, Piccolomini, *Sfera del mondo*; Pierattini, Vol. 58, pp. 263-66; A.S.M.N.F. : *Diario dall'anno...*, February 25, 1578; Cereta, *Epistolae*, pp. 29-30, 128, 142-43; E. Danti, " Proemio ", Piccolomini, *Lettura...*; Sarrocchi's, letter 574 of August 27, 1611 in Galilei, *Opere*, Ediz. Naz., p. 177-78; Rosa, " The Nun ", pp. 198-200.

[2]Pope Benedict XIV revoked the anticopernican decree for newly printed works in 1757; Galileo's *Dialogue* remained in the index of restricted book until 1833, see Baldini, " L' attività scientifica nel primo settecento", p. 529; . Pannekoek, p. 234; Cottingham, pp. 126-30; Hatfield, p. 266; Ferrone, pp. 34-42; Van Helden, pp. 94-105, 113-117, 129-31; Cavazza, *Settecento inquieto*, pp. 419-87; Descartes, *I principi della filosofia*; Watts, *Elementi di goegrafia*.

[3]Thorndike, *The History of Magic*, Vol. VI: *The Seventeenth-Century*, p. 89; Ann Geneva, *Astrology and the Seventeenth Century Mind. William Lilly and the Language of the Stars*, (Manchester: Manchester University Press, 1995), p. 282; Marina Formica, " Tra cielo e terra. Gli almanacchi romani del XVII e XVIII secolo ", *Studi settecenteschi*, Vol. 15, (1995), pp 115-62.

[4]Lucien Perey, *Une princesse romaine au XVIIIe siècle: Marie Mancini Colonna après des documents inédits* (Paris: C. Lévy, 1896), p. 103; Claude Dulong, *Marie Mancini, la première passion de Louis XIV*, (Paris, 1993), p. 182. Although the latter biography was written almost one hundred years after Perey's, it adds no new information, as far as Mancini's astrological studies are concerned. Her interest in astrology is dealt only in passing. Perey's work is better documented; it contains many original letters; see also his *Le roman du grand Roi Louis XIV et Marie Mancini*, (Paris: C. Lévy, 1894). I have been able to trace only one of her books, found in the Biblioteca Nazionale di Roma. It was published in 1671, and deals with the year 1672. It seems to be the same copy used by Traversi, see Traversi, pp.30-31. Thorndike lists works by her teacher, Josephus de Tertiis, but not hers, see Thorndike, *The History of Magic*, Vol. VIII, pp. 346-347; Maria Mancini Colonna, *Discorso astrosofico delle mutationi dei tempi ed altri accidenti mondani dell' anno MDCLXXII di Madama Maria Mancini Colonna: Principessa Romana, Duchessa di Paliano, di Tagliacozzo, di Marino ecc. e Gran Contestabilessa del Regno di Napoli*, (Modena, 1671).

[5]Mazarin's library was inherited by the Bibliothèque Nationale de Paris, see Delong, pp. 17, 23-24; Perey, *Le roman...*, pp. 23, 38-42, 52-53, 70, 189; Mancini Colonna; " Mancini Colonna, Maria " in *Poetesse e scrittrici*, Vol. I, pp. 369-370.

[6]Perey, *Une princesse...*, pp. 91-92; Perey, *Le roman...*, pp. 70-71, 369-370, 460-466; Traversi, p. 30.

[7]Perey, *Une princesse...*, p. 103; Michele Lorenzo Mancini's name does not appear in the lists of publications on the subject found in Thorndike, *The History of Magic*, Volumes VII, VIII; *Poetesse e scrittrici*, Vol. I, p.369.

[8]See letters to Cardinal Mazarin from Marianna, July 1659, of Mme. De Venel. July 1659, and July 20, 1659, and Maria of July 1659 in Perey, *Le roman...*, pp. 189, 192, 196-97, 199-200.; for Cereta's ability to cast horoscopes see letters nos. 42 to Michael Baetus, July 6, 1486, 38 to John Oliverio, June 6, 1486, 24 to Alberto de Albertis, October 31, 1485 in Rabil, *Cereta*, pp. 64-65, 73, 75; for the Arab astrologer see Thorndike, *The History of Magic*, Vol. VIII, pp. 310-11.

[9]Perey, *Une princesse...*, pp. 77-80, 103; Thorndike, *The History of Magic*, Vol. VIII, pp. 298-99, 346-47; B.A.V.: Barb. Lat. 245, *Don Joseph de Triplici Figura Demonis, Cacodemonis et Coelesti autore Don Joseph de Tertiis ad Illustrissimam et Eccellentissimam Madama Colonnam*, pp. 1r-57v, 64r-77v, 9r, 84r; B.C.A.B.: B. 317, " Memorie di Madama Colonna ", cartaccio in fol. della seconda metà del sec. XVIII diff. 28 non numerati.

[10]Traversi, p. 31.

[11]Geneva, p. 9.

[12]Mancini Colonna, p. 57; Kepler's *Tabulae Rudolphinae* (1627) based on Tycho Brahe observations and his own elliptical planetary theory made all previous tables obsolete; she referred to Johannes Hecker's ephemerides from 1660 to 1680 for the Uraniborg meridian, and based on the Rudolphine Tables see Johannes Hecker, *Motuum Coelestium Ephemerides Ab Anno 1666 ad 1680. Ex observationibus correctis nobilissim. Tychonis Braheri & Joh. Kepleri hypothesibus Physicis Tabulisque Rudolphinis. Ad Meridianum Uraniburgiam...* (Gedoni: Pliniger, 1662); she referred also to Giovanni Battista Riccioli (1593-1671), whose *Almagestum novum* (1651) contained a complete account of sizes and distances of planets; as Thorndike points out there was much discrepancy among various ephemerides, see Thorndike, *The History of Magic*, Vol VII, pp. 446, Vol. VIII, pp. 326, 336; Van Helden, pp. 94-105, 114-115; Grant, pp. 240-43, 263.

[13]See John Gadbury, *A Diary Astronomical, Astrological, Metereological for the Year of Grace 1671*, (London: Company of Stationers, 1670); for the symbolism present in astrological tables see Geneva, pp. 151-3; for the Roman almanacs see Formica, pp. 120, 122-24.

[14]For examples see Mancini, pp. 28-30, 36, 38, 41, 42.

[15]*Ibid.*, pp. 31-32.

[16]*Ibid.*, pp. 36, 33.

[17]*Ibid.*, pp. 36, 45, 50, 71, 78; Geneva, pp. 152-54, 193-94; Thorndike, *The History of Magic*, Vol. VIII, pp. 346-47.

[18]Mancini, pp. 34, 30, 33, 74, 49; for Haly, Abu Masher, Hermes see Geneva, pp. 9-13, 122-37, 208-10, 181, 216, 177, 191; for the others see Thorndike, *The History of Magic*, Vol. V, pp. 220-269, Vol. VI, pp. 129-33, 180, 512; for problems with her marriage, and her desire to be recalled to France see Perey, *Une princesse...*, Chapter IV.

[19]For references to Alcabitius, Galen, Hippocrates, Haly and Schott see Mancini, pp.36, 40, 50, 54, 58, 79; for references to the Latin and Arab doctrines see Mancini, pp. 30, 31, 37, 38, 46, 60, 63, 65, 66, 70, 75; for Alcabitius and Schott see Thorndike, *The History of Magic*, Vols. V, pp. 292, 308, VI, p. 471, VII, Chapter XXI.

[20]Mancini, pp. 79-80; Thorndike, *The History of Magic*, Vols. V, pp. 250-51, VII, pp. 121-23.

[21]Mancini, pp. 32-33, 37, 40, 42-46, 50-51, 53, 55, 58-59, 63, 68, 70, 72-74, 76, 79; for many of these authors see Thorndike, *The History of Magic*, Vol. II, pp. 830-33, Vol. V, pp.7, 222-25, 250-51, 264-65, 366, Vol. VI, p. 57, Vol. VII, pp. 122-23; for others see Van Helden, pp. 34-35, 52, 71-75.

[22]Mancini, " Preludio "; Grant, p. 244.

[23]Mancini, " Preludio ", Pannekoek, pp. 235-245; Van Helden, p. 105.

[24]Mancini, " Preludio "; Van Helden, pp. 27, 115-16; Grant, p. 668; Lattis, p. 154; Thorndike, *The History of Magic*, Vol. VII, pp. 138, 426-27.

[25]Thorndike, *The History of Magic*, Vol. VIII, p. 325.

[26]Mancini, p. 7; Van Helden, pp. 130-31; Lattis, pp. 210-11.

[27]Van Helden, pp.91-93.

[28]Mancini, pp. 8-9.

[29]*Ibid.*, p. 9; Van Helden, pp. 92-94; 102-115.

[30]Mancini appears not to separate astrology from astronomy see Mancini, pp. 10-11; Van Helden, p. 106.

[31]Mancini, pp. 9-11; Van Helden, p. 114; Thorndike, *The History of Magic,* Vol. V, p. 357, Vol. VII, pp. 664-70, Vol. VIII, pp. 20-30.

[32]Thorndike, *The History of Magic,* Vol. V, pp. 156-58, Vol. VII, pp. 99-100, Vol. VIII, p. 334; Formica, pp. 120-27.

[33]Helena Cornaro Piscopia, " Discorso terzo: introduttione ad altro problema politico" in Benedetto Bacchini. *Helenae Lucretiae (Quae & Scholastica) Cornelae Piscopiae...Opera,* (Parma: H. Rosati, 1688), pp. 95, 6, 43; Francesco Maschietto, *Elena Cornaro Piscopia (1646-1684). Prima donna laureata del mondo,* (Padua: Antenore, 1978), pp. 98-99, 153.

[34]Kristeller, p. 98.

[35]See Piscopia's letters of August 14, and July 9, 1680 to her father in Venice in Bacchini, pp. 151-52, 155-56; for her father's relationship and marriage, and his attempts to get her a degree in theology see Machietto, pp. 23, 37, 90-93, 112-19; Nicola Fusco, *Elena Lucrezia Cornaro Piscopia (1664-1684)*, (Pittsburgh: The United States Committee for the Elena Lucrezia Cornaro Piscopia Tercentenary, 1975), pp. 25-29, 35-36.

[36]For Piscopia's education in the languages and theology, see Massimiliano Desa, *Vita di Helena Lucretia Cornara Piscopia*, (Venice: Casamara, 1687), pp. 9-13; Bacchini, pp. 7-9, 13; Maschietto disputed that Marcelli was her theology teacher, see Maschietto, pp. 75-101; for the Spanish dominance of the Italian peninsula see the excellent map provided by Paula Findlen in *Possessing Nature* on the page facing the introduction; for attempts to found academies in the French model see Cavazza, *Settecento inquieto*, pp. 149, 178; for Galileo's inability to speak French see Luigi Pepe, " Note sulla diffusione della *Géométrie* di Descartes in Italia nel secolo XVII ", *Bollettino di storia delle scienze matematiche*, Anno II, no. 2 (dicembre 1982), p. 263.

[37]Kristeller, pp. 101-103; Berti Logan, pp. 790-91.

[38]See Piscopia's letter to Father Oliva, General of the Company of Jesus in Bacchini, pp. 182-83; Maschietto, pp. 82-83, 86-87.

[39]Piscopia, " Discorso terzo " in Bacchini, p. 91; Erwin H. Ackerknecht, *A Short History of Medicine,* (Baltimore: The Johns Hopkins University Press, 1982), pp. 74-75, 113, 118, 253.

[40]Piscopia, " Discorso terzo " in Bacchini, p. 92; Boas Hall, pp. 178-79; Leicester, p. 97.

[41]Carlo Renaldini, *Geometria Promotus*, (Padua: Frambotti, 1670), pp. 59-60; Boyer, pp. 261, 283, 301; Rose, pp. 43, 152-53, 166-67, 200-02; Baldini, "Archimede nel seicento italiano ", pp. 237-273; Silvio Moracchia, " Luca Valerio Matematico Linceo " in *La matematizzazione dell' universo. Momenti della cultura matematica tra 500 e 600,* Lino Conti ed. (Perugia: Perziuncola, 1992), pp. 253-311.

[42]Boyer, pp. 339, 343.

[43]Renaldini, p. 60; Pepe, " Note sulla diffusione...", pp. 275-77.

[44]Such a work would not likely appear in an official inventory of the period since it was an interdicted book, see Robert S. Westmann, " The reception of Galileo's " Dialogue '. A Partial World Census of Extant Copies " in *Novità celesti...*, p. 333; Maschietto, p.84.

[45]See Renaldini's 1668 letter to Boyle in Clelia Pighetti, *Influsso scientifico di Roberto Boyle nel tardo '600 italiano,* (Milan: F. Angeli, 1988), p. 66; Carlo Renaldini, *De Resolutione et Compositione Mathematica*, (Padua: Frambotti, 1668), p. 157; Drake, *Galileo at Work,* pp. 177-88; Galilei, " Discorso intorno alle cose...", pp. 73-74; for the Aristotelean position, Grant, pp. 196-98; Aristotle, *De caelo,* book I: 3. 269b, Book IV, chapter 1-4.

[46]Grant, pp. 668-69.

[47]Piscopia, " Discorso primo ", and " Discorso terzo " in Bacchini, pp. 59, 95; Grant, pp. 264-65.

[48]Renaldini, *Geometria promotus,*, p. 59; Mancini, p. 57; Van Helden, pp. 105-06.

[49]Piscopia, " Discorso terzo " in Bacchini, p. 95; Van Helden, pp. 82-83; Mancini, " Preludio ".

[50]Piscopia's letter to Cardinal Bouillon of September 9, 1681 in Bacchini, pp. 143-44.

[51]The seventeenth-century saw the development of at least six important instruments in science, the telescope, pendulum clock, air pump, barometer, thermometer, and microscope see D. Halliday & R. Resnick, *Physics*, (New York: John Wiley & Sons, 1978), p. 378; Ferrone, pp. 6-10.

[52]For Aristotelean philosophy at the University of Padua at an earlier period see for example Charles B. Schmitt, " Aristotelean Textual Studies at Padua: The Case of Francesco Cavalli " in *Scienza e filosofia all' Università di Padova nel quattrocento*, Antonio Poppi ed., (Padua: Lint, 1983), pp. 287-314; for Aristotelean philosophy at the university in the early seventeenth-century see Stillman Drake, *Galileo at Work. His Scientific Biography,* (New York: Dover Publications, 1995), pp. 47-49; Maschietto, pp. 88-89; Kristelller, p. 103; Spini, pp. 146-50.

[53]Kristeller, pp. 103, 115n; Maschietto, pp. 120-21; Aristotle, *Posterior Analytic*, Book I: 189.71b; Aristotle, *Physics*, Book I: 189a.

[54]Piscopia, " Discorso terzo ", " Discorso primo " in Bacchini, pp. 59, 90; Aristotle, *Physics*, Book I, particularly 5, 189a, 190b-191a; Maschietto, pp. 87-88; Fusco, p. 42; Luigi Tenca, " Lettere di Carlo Rinaldini "*Atti della Accademia delle Scienze dell' Istituto di Bologna Classe di Scienze Fisiche. Rendiconti*, serie XI, T. III, pp. 1-12; Desa, pp. 34-35.

[55]Piscopia's letter to Cardinal Bouillon of September 9, 1681 in Bacchini, pp, 143-44; Maschietto, pp. 148-49, 152-53.

[56]Desa, pp. 36-39; Bergalli, p. 169.

[57]Londa Schiebinger, " Maria Winkelmann at the Berlin Academy: A Turning Point for Women in Science ", *Isis*, Vol. 78, (1987), pp. 177-78; Schiebinger, *The Mind Has No Sex?*, pp. 79-90.

[58] Baldini, " La scuola Galileiana ", pp. 456-57; Cavazza, *Il settecento inquieto*, p. 57-78; Marta Cavazza, " Giandomenico Cassini e la progettazione dell' Istituto delle Scienze di Bologna " in *Scienza e letteratura nella cultura italiana del settecento*, pp. 109-132; Ferrone, pp. 57-65; Pannekoek, pp. 249-50.

[59]For the genealogy of the Manfredi family B.C.A.B.: B.709, Vol.XII: *Alberi genealogici delle famiglie di Bologna compilati dal G.B. Carrati*, no. 72: Manfredi; B.C.A.B.: B. 728, Vol. 32: *Alberi genealogici delle famiglie di Bologna compilati dal G.B. Carrati*, no. 92: Manfredi; from many of the letters that survived of the family to Giampietro Zanotti one becomes aware of the close friendship that existed between him, his daughters, and the Manfredis, therefore it is his biography that will be used as the one closest to the truth, see Giampietro Cavazzoni Zanotti, *Vita di Eustachio Manfredi*, (Bologna: Cremona, 1745), p.15; the fact that Manfredi's father had abandoned the family was even known to Fontanelle in Paris, see B. de Fontanelle, "Eloge de E. Manfredi ", *Histoire de l' Academie Royale des Sciences Année MDCCXXIX*, Paris, pp. 64-65.

[60]Zanotti, pp. 5-10; Fontanelle, pp. 61-63; Cavazza, *Il settecento inquieto*, pp.154-60;. Maffioli, pp. 68-69.

[61]Enrica Baiada, " Geographica et Astronomica " in *Anatomie Accademiche*, Vol. II: *L' Enciclopedia*,, p. 227; see letter no. 60 of May 1, 1703 in B.U.B.: Ms. 80 B: *Libro di moltissime lettere scritte l'año 1702 al G. Marsili da più sogetti*; B.U.B.: Ms. 4183, Caps LVIII, no. 2: *Notizie biografiche scritte da F.M. Zanotti*; Cavazza, *Il settecento inquieto* p.. 68-69; Livia Orlandi Frattolo, *Un astronomo in biblioteca*, (Bologna: Biblioteca Universitaria, 1990), pp. 7-8.

[62]For Maddalena and Teresa's education in mathematics see Eustachio Manfredi's letter to General Marsili of December 12, 1701 in B.U.B.: Ms. 79, Vol. I: *Eruditorum epistolae*

ad Marsilium, XII, p. 119; Fontanelle, pp. 67-68; G. Zanotti, p. 3; for the role of women in astronomy in other places see Schiebinger, " Maria Winkelmann...", p. 177; Schiebinger, *The Mind Has No Sex?*, pp. 79-90; Peggy Kidwell, " Women Astronomers in Britain, 1780-1930 ", *Isis*, Vol. 75, (1984), pp. 534-46; J. Lankford and R.L. Slavings, " Gender and Science: Women in American Astronomy, 1859-1940 ", *Physics Today*, Vol. 43, no. 3, (March 1990), pp. 58-65.

[63]For Manfredi's appointment to the superintendence of waters of the Bolognese see B.U.B.: Ms. 4183, Caps. LVIII, no. 2; for the brothers and sisters failed attempts to marry see G. Zanotti, pp. 3, 13, 15, 25; see also letter no. 7 of E. Manfredi to G. Zanotti, Rome, February 23, 1718 in B.C.A.B.: B. 198: *Lettere di Eustachio Manfredi a Giampietro Zanotti;* for the household compositions of Gabriele's and Eustachio's families see A.P.S.M.M.: *Status animarum dal anno 1724 al 1751*, Box 4, year 1726, Strada San Donato, Ca' Regimento; for Stancari's appointment to a chair of analysis at the university see Cavazza, *Il settecento inquieto*, p. 67.

[64]For the Manfredi sisters literary output, and their friendship and collaboration with G. Zanotti and his daughters see Campanacci, who also translates some of their work into Italian; Bolognese is very different from Italian, see Ilaria Magnani Campanacci, " La cultura extraccademica: le Manfredi e le Zanotti " in *Alma Mater Studiorum*, pp. 39-67; see also G. Fantuzzi, *Notizie degli scrittori bolognesi*, (Bologna, 1786-89), Vol. V, pp. 201-02; for Maddalena's original poetry see B.C.A.B.: B. 170: *Poesie di diversi in lingua bolognese*, cc. 1-3; for the correspondence which informs us of their daily life see B.C.A.B.: B. 159: *Lettere a Giampietro Zanotti;* B.C.A.B.: B.178 I: *Lettere di Eustachio Manfredi a diversi e alcune rime*; B.C.A.B.: B. 163: *Lettere famigliari e a diversi di Giampietro Zanotti*, particularly letter no. 210 of February 10, 1726; B.C.A.B.: B. 198.

[65]B.U.B.: Ms. 4183 Caps LVIII, no. 2; G. Zanotti, p.3; for the Academy of the Inquieti and the foundation of the Institute see Cavazza, *Il settecento inquieto*, pp. 57-78; Rosen, , pp. 26-34; Marta Cavazza, " La 'Casa di Salomone' realizata?" *I materiali dell' Istituto delle Scienze*, (Bologna: CLUEB, 1979), pp. 46-54.

[66]For Manfredi's correspondence with Cassini and Maraldi see B.O.P.: Lettres autografes A B 4-11; for Cassini's answers see B.C.A.B.: Collez. autogr. XVI, 4705-4722; Cavazza, *Il settecento inquieto*, p. 168n, 61, 165; Baiada, pp. 226-27; Manfredi's letters to Marsili of December 12, 1701 and of January 27, 1702 in B.U.B: Ms. 79 A, Vol. I and Ms. 80 A Vol. II respectively.

[67]The books asked were Newton's *Principia*, Copernicus's *De revolutionibus*, and Kepler's, Descartes', Cassini's, Borelli's and De la Hire's works see Manfredi's letter to Marsili of May 3, 1702 in B.U.B.: Ms. 80 a, Vol. II; for a list of books in astronomy in his possession see Marina Zuccoli, " Il fondo Eustachio Manfredi ' in *Un astronomo in biblioteca*, pp. 31-66; for his Copernican tendencies in private see Baiada, pp. 231-33; A. Braccesi e E. Baiada, " Proseguendo sulla specola di Bologna: dagli studi del Manfredi sull' aberrazione, al catalogo di stelle dello Zanotti ", *Giornale d' Astronomia*, Vol. 6, no.1, (March 1980), pp. 10-17.

[68]Braccesi e Baiada, " Proseguendo sulla specola...", pp. 6-7; Cavazza, *Il settecento inquieto*, pp. 166-67; Eustachio Manfredi, *Ephemerides motuum coelestium Ex Anno MDCCXV. In Annum MDCCXXV e Cassinianis Tabulis*, T. I (Bologna: Pisari, 1715), pp. 2r-4r; Bruno Morando, " Three Centuries of Lunar and Planetary Ephemerides and Tables " in *Planetary Astronomy from the Renaissance to the Rise of Astrophysics*, Vol. 2, Part B: *The Eighteenth and Nineteenth Centuries*, René Taton and Curtis Wilson eds. (Cambridge: Cambridge University Press,1995), p.255.

[69]Fontanelle, pp. 67-68; G. Zanotti, pp. 18, 20, 28; A.S.I.A.U.B.: *Eustachio Manfredi: Introductio in Ephemerides*, Cartone VI.

[70]See letter no. 60 of Manfredi to Marsili of May 1, 1703 in B.U.B.: Ms. 80 B; the calculations most likely involved several steps, and Maddalena might have had to correct each right ascension, and declination see Manfredi, *Ephemerides...*, Vol. I, Tab XX, pp. 58-93, 3-103.

[71]G. Zanotti, pp. 18-20, 28-32; Cavazza, *Il settecento inquieto*, pp. 65-66; Baiada, " Geographica ...", p. 230; for the Collegio Montalto see Berti Logan, p. 788; Giuseppe Cagni, " Il Pontificio Collegio Montalto in Bologna (1585-1797)", *Barbaniti studi*, 5 (1988), pp. 7-194; for Manfredi's residence after his sisters moved back with him, see letters 1 to 26 of Eustachio Manfredi to Giampietro Zanotti in B.C.A.B.: B. 198.

[72]Zuccoli, p. 54.

[73]For their move to the Institute see A.P.S.M.M.: *Status animarum del anno 1724 al 1751*, Box no. 4, year 1727; Manfredi measured star aberration from variations in the right ascension, rather than from variations in declination, thus making the phenomenon relatively independent of observations, see Baiada, p. 231-234; Braccesi e Baiada, pp. 10-17; for a modern explanation of aberration see Huffer, Trinklein, Bunge, pp. 355, 137; for the sisters cooperation when required see letters n. 59: July 27, 1720, no. 60: July 6, 1720, no. 79: December 14, 1720 of Manfredi to sisters in B.C.A.B.: B. 178 I; see also letters no. 209; February 10, 1726 of G. Zanotti to Maddalena and Teresa Manfredi , and no. 210 of the sisters to Eustachio in B.C.A.B: B. 163.

[74]Eustachio Manfredi, *Compendiosa informazione di fatto sopra i confini della communità Ferrarese di Ariano con lo Stato Veneto*, (1735), pp. 2-119.

[75]G. Zanotti, pp. 50-52; see letter no. 210 of Maddalena to Eustachio of February 10, 1726, and no. 209 of G. Zanotti to Manfredi in B.C.A.B.: B. 163; see also letters nos. 99 and 100 of February 13, 1726 and March 3, 1726 of Manfredi to G. Zanotti in B.C.A.B.: B. 198.

[76]See letters of Manfredi to G. Zanotti nos. 106, 111, 112, 114, 115 of July 2, 1732, September 6, 1732, September 20, 1732, November 29, 1732 respectively all in

B.C.A.B.: B. 198; for his relationship with his sisters and G. Zanotti see letters in B.C.A.B.: B. 178 I, B. 163, B. 198.

[77]For the survival of the Academy of Lincei see Michele Maylender, " Accademia dei Lincei-Roma ' in *Storia delle Accademie...*, Vol. III, pp. 481-90; see also Pietro Redondi, " Cultura e scienza dall' Illuminismo al Positivismo " in *Storia d' Italia*, Annali 3, pp. 786-89.

[78]Oscar Greco's biography of C. Scarpellini provides little information on her private life and education, see Oscar Greco, *Bibliografia femminile italiana del XIX secolo*, (Venice, 1875). pp. 446-47; it is unlikely that the Collegio Umbro-Fuccioli, a residential college associated with the university would have a place for a woman to stay. Therefore it might be plausible that Caterina moved to Rome from Foligno only in 1825, after her uncle took up rooms at the Campidoglio, see Ignazio Calandrelli, " Pontificio nuovo osservatorio della Romana Università", *A.A.P.N.L.*, Vol. 6-7, (1852-1854), p.268; Caterina Scarpellini and Erasmo Fabbri Scarpellini were never made members of the Academy of Lincei, or had any teaching post; for a list of the members see Maylender, " Academia dei Lincei...", Vol. III, pp. 489-90; for Caterina's and Erasmo's relationship see Caterina Scarpellini, " Biografia dell' astronomo Don Ignazio Calandrelli", *Giornale arcadico di scienze, lettere e arti*, CXCII, (1864), p. 205, and her letters to her cousin, Carlo Sanzi Petroselli of Foligno found in B.C.F.: M 21/11: *Lettere di Caterina Scarpellini 1865-1867*, I would like tho thank the staff of the Foligno library for sending me the letters.

[79]For a biography of Feliciano Scarpellini see Benedetto Trompeo, *Intorno alla vita e alle opere del Professore Cavaliere D. Feliciano Scarpellini*, (Rome: Salviucci, 1841), pp. 3, 6-8, 13, 25-26; see also Calandrelli, " Pontificio Nuovo Osservatorio ", pp. 267-71; Redondi, pp. 787-96; Feliciano Scarpellini had wished that his instruments be acquired by the government, which was done. Caterina Scarpellini in her biography of Ignazio Calandrelli referred to the fact that after her uncle's death the observatory became the centre of envy, argument, and controversy. She and her cousin tried to appease matters so that observations could continue, and that students would be able to use the facilities, see Scarpellini, " Biografia dell' astronomo ", pp. 204-05, 211, 217. According to Caterina, Calandrelli had studied at the Gregorian University the works of Newton, the celestial mechanics of Laplace, and Lagrange's analytical mechanics. Many of his works had to do with some aspect of celestial mechanics such as Elements of Partenope's Orbit and Observations of that Asteroid; Formulas to Calculate the Perturbations of Small Asteroids and Comets with Applications; New Research on Proper Motion of the Stars with Applications; On the Proper Motion of Syrius, to name a few, see Scarpellini, pp. 211-17; see also Pietro Secchi, " Necrologico cenno del Prof. Ignazio Calandrelli dal prof. Paolo Secchi ", *A.A.P.N.L.*, Tomo XIX (1865-66), pp. 200-01; Schiebinger, *The Mind Has No Sex*, pp. 82-94.

[80]Calandrelli, " Pontificio Nuovo Osservatorio ", pp. 267-71; Trompeo, pp. 3, 6-8, 13, 25-26; Scarpellini, " Biografia dell' astronomo ", pp. 204-05, 211-217; Secchi, pp. 200-01.

[81]Caterina Scarpellini, " La luna osservata in Roma nel 1° giugno 1863. rapporto fisico-astronomico di Caterina Scarpellini", *C.S.*, Vol. VI, no. 47, (5 luglio 1863), pp. 469-471; C. Scarpellini, " Il grande eclisse solare del 18 luglio 1860 osservato da Caterina Scarpellini", *C.S.*, Vol VI, no. 25, (15 agosto 1860), pp. 229-31; for her observation of the 1854 comet in *C.S.*, Vol. VII, no. 10-11, (18 marzo 1854), p. 85; C. Scarpellini, " Sul ritorno del Cometa Pons", *C.S.*, Vo. VII, , no. 49 (marzo 1855), pp. 405-06; for her summary of important observation of Saturn and its rings, *C.S.*, Vol. IV, no. 30, (7 marzo 1856); C. Scarpellini, " Scienza nello stato papale ", *C.S.*, Vol. V, no. 6-7, (26 giugno 1857), pp. 44-55; C. Scarpellini, " Biografia...", pp. 211-17; C. Scarpellini, " Settimana scientifica", *C.S.*, Vol. II, no. 41 (26 dicembre 1852), pp. 346-47.

[82]C. Scarpellini, *Gli uranatmi ossia stelle cadenti del periodo di novembre 1868 osservati in Roma e Civitavecchia. Stazione meteorologica di privita istituzione in Roma Anno IX;* C. Scarpellini, *Uranatmi o stelle cadenti visti in Roma ed in Civitavecchia nel periodo di agosto del 1869. Privata stazione,* (Rome: Tipografia delle Belle Arti, 1869); C. Scarpellini, *Catalogo degli uranatmi (o sia stelle cadenti) osservati alla privata stazione meteorologica di Roma (sul Campidoglio) negli anni 1861, 1862, 1863, 1864, 1865, 1866, 1867,* (Rome: Tipografia delle Belle Arti, 1868); for a history of meteor swarms see Pannekoek, pp. 419-22; see also Huffer, Trinklein, Bunge, pp. 225-26.

[83]See her discussion of the induction machine of prof. Cecchi in *C.S.*, Vol. II, no. 38, (30 ottobre 1854), pp. 313-16; for her description of the Baunhauver hygrometer see *C.S.*, Vol. IV, no. 16, (16 settembre 1855), p. 136; C. Scarpellini, " Nuovo barometro a due liquidi ", *C.S.*, Vol. IV, no. 21 (2 novembre 1855); C. Scarpellini, " Scienza nello stato papale ", pp. 44-55; for a description of the quadrant see Huffer, Trinklein, Bunge, p. 58.

[84]Notice of the new comet in *C.S.*, Vol. III, no. 10-11, (18 marzo 1854), p. 85; Scarpellini, " Biografia dell' astronomo...", 215-225; Scarpellini, " Scienza nello stato...", *C.S.*, Vol. V, no. 6-7, (26 giugno 1857), pp. 44-55.

[85]See notice of the comet in " Notizie diverse: nuovo cometa ", *Giornale di Roma*, (Lunedi 3 aprile 1854), no. 76, p. 513; see also *C.S.*, Vol. II no. 10-11, (18 marzo 1854), p. 85 and no. 17-18, (6 maggio 1854). It is obvious that the *Corrispondenza* was published with, perhaps, a month's delay, because the March number contained facts that occurred after the date of publication, such as the comet's date of April. For the credit given to her see E.Lagrange, " Les femmes astronomes", *Ciel et terre*, vol. 5, (1885), p. 525; Carlo Villani, *Stelle femminili*, (1915), p. 306; Alic, pp. 133-34.

[86]Scarpellini, " Biografia dell' astronomo ", p. 205-11; for the beginning of the *Corrispondenza scientifica* and her signed contributions to it, see respectively *C.S.* (15 settembre 1847) and Anno II, no. 2, (14 marzo, 1849).

[87]See " Memoria di Paolo Peretti sopra un lavoro chimico presentato...da C.F. Schönbein", *C.S.*, Vol. V, no. 12, (3 novembre 1857), pp. 97-100; Greco, pp. 446-47.

[88]Scarpellini, " Sul nostoc e sul collema ", *C.S.*, Vol. II, no. 41, (22 dicembre 1852), p. 347; for Calandrelli's article on the solar eclipse of July 28, 1851, see *C.S.* , no. 38, (13 ottobre 1852).

[89]C. Scarpellini, " Il grande eclisse solare del 18 luglio 1860 osservato da Caterina Scarpellini sul Campidoglio ", *C.S.*, Vol. VI, no. 25, (13 agosto 1860), pp. 229-31; see also her " Scienza nello stato...', pp. 44-55; for Calandrelli publications in the Acts see Secchi, " Necrologico cenno...", pp. 200-01.

[90]Pannaekoek, pp. 450-51; see " Pontificia meteorologica telegrafica in Roma e Mezzodì diretta da Padre P.A. Secchi istitute dal E. Fabri Scarpellini. Primo semestre luglio-dicembre 1855 ", *C.S.*, Vol. IV, no. 33-34-35, (2 aprile 1856), pp. 261-286; C. Scarpellini, " Il meteografo ossia registratore meteorologico universale. Teste eretto all' osservatorio del Collegio Romano del R.P. Secchi ", *C.S.*, Vol. V, no. 45, (30 aprile 1859), pp. 269-70; see her " Importante osservazioni sopra Saturno e i suoi anelli ", *C.S.*, Vol. IV, no. 30, (7 marzo 1856); P.A. Secchi, " Sulle variazioni periodoche del magnetismo terrestre ", *C.S.*, Vol. III, no. 27-28, (15 luglio 1854), pp. 209-21 and no. 33-34, (9 ottobre 1854), pp. 261-76; Father Secchi had another long article in *C.S.*, no. 22-23, (26 novembre 1855).

[91]For the *Risorgimento* and the Roman republic see Harry Hearder, *Italy in the Age of the Risorgimento 1790-1870,* (London: Longman, 1983), pp. 96-123, 240-251.

[92]For the Scarpellini's financial difficulties see Caterina's letter to her cousin Carluccio, Rome May 8, 1865 in B.C.F.: M 21/11; for gaps in the paper see *C.S.*, Vol. II, nos. 23, 24, no. 41, December 22, 1852, no. 42, February 1, 1853, no. 43, April 5, 1853, no. 44, August 17, 1853, Vol. V, no. 8, July 24, 1857, no.9, September 15, 1857; for the Scarpellinis' goal of a unified Italian science see Erasmo 's words on the subject in *C.S.* , Vol. II, no. 1, (17 marzo 1849), p. 1; C. Scarpellini, " Prof. Sanguinetti e la sua invenzione", *C.S.*, Vol. V, no. 44 (23 aprile 1859), p. 268; C. Scarpellini, " Sulli terremoti avvenuti in Roma negli anni 1858 e 1859", *C.S.*, Vol VI, no. 25 (13 agosto 1860), pp. 230-31.

[93]See " Una scossa di terremoto ondulatorio...Lettera del Prof. Zantedeschi alla Sig. Caterina Scarpellini, Padova 19 luglio 1860", *C.S.*, Vol. VI, no. 25 (15 agosto 1860), p. 232; " Lettera del Professore Zantedeschi alla...direzione dela Corrispondenza", *C.S.*, Vol. 5, no. 33, (28 gennaio 1859), p. 177; for Berti's work see her " Bullettino bibliografico", *C.S.*, Vol. 5, no. 25, (26 ottobre 1858), pp. 210-11.

[94]See " Settimana scientifica" of *C.S.*, Vol. II, no. 2, (2 marzo 1849), pp. 15-16, no. 5, (4 aprile 1849), p. 40, no. 9, (30 maggio 1849), pp. 71-72.

[95]C. Scarpellini, " Sul ritorno del cometa di Pons ", *C.S.*, Vol. III, no. 49, (marzo 1855), pp. 406-07; for the opposite view see C. Scarpellini, " L' etere come mezzo insensibilmente restaurato al movimento degli astri", *C.S.*, Vol. IV, no.6, (9 giugno 1855), pp. 43-44; for more details on comet Pons and its orbit see Pannekoek, p. 358.

[96]For the British Association for the Advancement of Sciences see *C.S.*, Vol. II, no. 6, (11 aprile 1849), p. 48, no. 7, (18 aprile 1849), p. 56, no. 14, (10 novembre 1849), p. 116; Vol. V, no. 33, (28 gennaio 1859), pp. 178-80; for the Biological Society see *C.S.*, Vol. II, no.10, (1 agosto 1849), pp. 78-79; for Cherbourg and Anvers respectively see *C.S.*, Vol. IV, no. 1, (4 maggio 1855), pp. 4-8, no.7 (30 giugno 1855), pp. 67-69; for Geneva see *C.S.*, Vol. V, no. 38, (12 marzo 1859), pp. 219-20, no. 42, (9 aprile 1859), pp. 251-52.

[97]For the French military presence in Rome see Hearder, pp. 118-19, 244-45; on the atmosphere of comets by Prof. Roche see *C.S.*, Vol. V, (13 ottobre 1859), pp. 110-12; " L' alluminio...", *C.S.*, Vol. IV, no. 10, (20 luglio 1855), pp. 81-84.

[98]Frank H. Hawkins, *Adolphe Quetelet as Statistician*, (New York: AMS Press, 1968), pp.9-35.

[99]" Osservazioni sulla elettricità dell' aria", *C.S.* Vol. II, no. 17, (23 febbraio 1850), pp. 136-38; " Sulla influenza della elettricità sulle altezze barometriche", *C.S.*, Vol. II, no. 26, (24 aprile 1851), pp. 212-213; " Su le onde atmosferiche", *C.S.*, Vol. II, no. 39-40, (20 novembre 1852), pp. 337-39; " Sulla meteorologia nautica e la Conferenza Marittima tenuta a Brusseles", *C.S.*, Vol. III, no.1, (5 gennaio 1854), pp. 2-4; " Osservazioni ozonometriche-meteorologiche fatte in Roma da Caterina Scarpellini...Anno IV", *C.S.*, no. 10 (16 settembre 1859), p. 84; " Sulla influenza delle temperature sullo sviluppo della vegetazione", *C.S.*, Vol. II, no. 51, (aprile 1855), pp. 430-32.

[100]" Scienza nello stato...", p. 59; for Calandrelli's lack of interest in meteorology see Secchi, " Necrologico cenno ...", p. 201.

[101]For the *Giornale Arcadico*, and the *Atti* see Redondi pp. 788-89, 796; Maylender, " Accademia dei Lincei ", pp. 488-90; C. Scarpellini, " Osservazioni ozonometriche istitute in Roma nell' agosto 1856 di Caterina Scarpellini all' altezza di metri 60,43 sul livello del mare ", *Giornale arcadico di scienze, lettere e arti*, no. 145, (novembre-dicembre 1856), pp. 177-184; for a history of ozone measurements in Italy see D. Anfossi, S. Sandroni, S. Viarengo, " Le misure di ozono troposferico nel secolo scorso e il contributo di Francesco Deza ", *Giornale di fisica*, XXXIII, no. 2, (aprile-giugno 1992), pp. 145-47; for the miasmatic causes of cholera, see Charles E. Rosenberg, *The Cholera Years. The United States in 1832, 1849, and 1866*, (Chicago: The University of Chicago Press, 1987), pp. 164-66.

[102]Scarpellini, " Osservazioni ozonometriche...", pp. 177-84; for the ozonometric tables in other journals see *Giornale delle strade ferrate* beginning with anno I, no. 10, (29 agosto 1857) to no. 52 (19 giugno 1858) and anno II, no. 1, (26 giugno 1858) to no. 52, (18 giugno 1859); for the *C.S.*, Vol. V: no. 32, (17 gennaio 1859), p. 168, no. 33, (28 gennaio 1859), p. 84, no. 36, (23 febbraio 1859), p. 204, no. 39, (19 marzo 1859), p. 228, no. 41, (2 aprile 1859), p. 244, no. 44, (23 aprile 1859), p. 268, no. 48, (14 maggio 1859), p. 300, Vol. VI: no. 2, (9 luglio 1859), p. 16, no. 3-4, (30 luglio 1859), p. 36, no. 5, (9 agosto

1859), p. 44, no. 6, (16 agosto 1859), p. 52, no.8, (26 agosto 1859), p. 68, no. 10, (16 settembre 1859), p. 84, no. 12, (6 ottobre 1859), p. 108, no. 17, (6 dicembre 1859), p. 160, no. 22, (20 marzo 1860), p. 204, no. 24, (26 maggio 1860), p. 228, no. 25, (13 agosto, 1860), p. 244, no. 26, (21 novembre 1860), p. 260.

[103]*C.S.*,Vol. VI: no. 35, (11 aprile 1862), pp. 368-69; no. 36, (15 maggio 1862), pp. 376-77, no. 38, (11 luglio 1862), pp. 392-93, no. 39, (11 agosto 1862), pp. 402-403, no. 45-46, (19 maggio 1863), pp. 460-61, no. 48, (5 agosto 1863), pp. 480-82.

[104]I was able to trace C.Scarpellini's *Bullettino delle osservazioni ozonometriche e meteorologiche del 1870 al 1872*, (Rome: Belle Arti, 1873) to the catalogue of the Biblioteca Alessandrina dell' Università di Roma in Rome, but the staff was unable to produce the actual bulletin; the bulletin on medical meteorology is at the B.C.A.B., and it is available for study, see C. Scarpellini, *Stazione meteorologica-Scarpellini in Roma (Campidoglio). Altitudine: 60^{m} 43 sul livello del mare-Anno XVI. Meteorologia medica dei mesi di Aprile, Giugno, Novembre, Decembre 1871, e Gennajo, Febbrajo, Marzo del 1872*, (Rome, 1873); for the August 1869 bulletin see Scarpellini, *Uranatmi, o stelle cadenti...agosto 1869....*

[105]P. Volpicelli, " Sulle osservazioni meteorologiche e magnetiche, nell' osservatorio dell' Infante D. Luigi a Lisbona. Cenno del prof. P. Volpicelli ", *A.A.P.N.L.*, T. XVIII, (1864-65), pp. 272-73; Scarpellini did not discuss politics in the *Corrispondenza*, but the way she constantly emphasized the need for unity in Italian science leaves no doubts in my mind that she was pro-unification, for an example see C. Scarpellini, " Sulle osservazioni fenologiche: regno animale e regno vegetale ", *Giornale arcadico...*, no. 195, (1865), pp. 167-69; for the members of the Royal Academy of Lincei see " Elenco dei soci attuali della reale Accademia dei Lincei Dal 3 luglio 1847, epoca del suo risorgimento fino a tuuto dicembre 1870 ', *Atti della Reale Accademia dei Lincei pubblicati conforme alle decisioni accademiche del 22 dicembre 1850*, T. XXIV, anno XIV, (1870-1871), pp. 125-28; for Scarpellini's medal see Lagrange, p. 525; Greco, pp. 446-47; for her membership in other academies see Scarpellini, *Catalogo degli uranatmi...*

[106]Scarpellini, " Il grande eclisse...", pp. 229-31.

[107]For Scarpellini's theories on lunar influence on tremors and tables see the communication that follows " Lettera del Professore Zantedeschi alla rispetabile direzione...", pp. 177-78; C. Scarpellini, " Sulli terremoti avvenuti in Roma negli anni 1858 e 1859. rapporto di Caterina Scarpellini", *C.S.*, Vol. VI, no. 25, (13 agosto 1860), pp. 233-39; C. Scarpellini, " Influenza della luna nei terremoti ", *C.S.*, Vol. VI, no. 33, (12 febbraio 1862), pp. 349-50; Huffer, Trinklein, Bunge, pp. 161-63; for belief in the effect of subterrenean water on seismic and vulcanic activities see François Ellenberger, " Les sciences de la terre avant Buffon: coup d' oiel historique " and K.I. Taylor, "The *Époques de la nature* and geology during Buffon later years ", in *Buffon 88: Actes du colloque international pour le bicentenaire de la mort de Buffon (paris, Montbard, Dijon, 14-22 juin 1988)*, (Paris: Vrin, 1992), pp. 327-42, 380-383 respectively.

[108]Pannekoek, pp. 419-22; Huffer, Trinklein, Bunge, pp. 225-26.

[109]C. Scarpellini, " Osservazioni sulle stelle cadenti periodiche del 10 agosto 1866. Lettera di Caterina Scarpellini all' eccmo. commendatore dott. Benedetto Trompeo a Torino ", *Giornale arcadico di scienza, lettere ed arti*, CXCII, (1864), pp. 230-33; the journal was actually published in 1866; it only carried the 1864 date.

[110]Scarpellini, *Catalogo degli uranatmini...*, pp. 4-15.

[111]The ratio of the number of shooting stars in the first and in the second half of the night allowed Schiaparelli to derive the ratio of the mean velocity of the meteors and the earth's velocity. This ratio was found to be exactly the ratio of parabolic and circular velocity at the same distance from the sun, which led him to conclude that meteors in general, also the Perseids moved in nearly parabolic orbits, see Pannekoek, p. 421.

[112]*Ibid.*, p. 421; C. Scarpellini, *Uranatmi o stelle cadenti visti in Roma ed in Civitavecchia nel periodo di agosto 1869. Private stazioni. (Lettera al commen. dott. B. Trompeo a Torino)*, (Rome: Belle Arti, 1869).

[113]Scarpellini, *Catalogo degli uranatmi*, pp. 14-15; C. Scarpelini, *Gli uranatmi ossia stelle cadenti del periodo di Novembre 1868 osservati in Roma e Civitavecchia. Stazione meteorologica a privata istituzione in Roma. Anno XI.* (Rome: Belle Arti, 1868); Pannekoek, p. 421.

[114]Pannekoek, p. 422; for writings on gender and science see Merchant, *The Death of Nature*; Merchant, " Isis' Consciousness Raised", pp. 398-409; Marina Benjamin ed., *Science and Sensibility: Gender and Scientific Inquiry, 1780-1945,* (Oxford: Basil Blackwell, 1991); Evelyn Fox-Keller, *A Feeling for the Organism: The Life and Work of Barbara McClintock,* (San Francisco: Witt Freeman & Co., 1983).

[115]Scarpellini, " Il grande eclisse solare...", p. 230; for her encouragement of industry see Scarpellini, " Settimana scientifica ", *C.S.*, Vol. II, no. 5, (4 aprile 1849), p. 40; *C.S.*, Vol. V, no. 16, (23 gennaio 1850), p. 126; " Delle proprietà fisico e fisico-chimiche dell' alluminio", *C.S.*, Vol. IV, no. 8-10, (20 luglio 1855); there are other examples, some have been already mentioned; the publications in which the Baconian language was more prominent are Scarpellini, *Gli uranatmi...novembre 1868*; Scarpellini, *Catalogo degli uranatmi*, but in fact the language can be found throughout most of her writings.

[168]According to Westman, Galileo sent his *Dialogue* quickly to friends and patrons, most of them outside university circles, in various Italian locations. The fact that it was assessible to people with little mathematical background, and in Italian, made it more likely to be read by women, see Robert S. Westman, " The Reception of Galileo's 'Dialogue" A Partial World Census of Extant Copies " in *Novità celesti...*, pp. 329-371.

Chapter VII

Women in Traditional Scientific Fields: Botany

A knowledge of plants by Italian learned women is of long standing; however, how this knowledge was represented changed considerably over time, and most dramatically in the eighteenth and nineteenth centuries.

Some of the earliest recorded associations between learned women and plants occurred among the women physicians of the Medical School of Salerno, a school which was geared towards the expertise and practice of medicine. The *Pseudo Apuleo Herbarium* manuscripts of Florence and Vienna, which originated at the School of Salerno in the thirteenth century, clearly depicts women as doctors, who treated men as well as women. These women doctors were illustrated in the *Pseudo Apuleo* applying remedies made of herbs to their patients.[1] To the most famous of the Salernitan women physicians, Trota, or Trotula (twelth century), has been attributed with certainty a *Practica*, similar in form to the *Practicae* of male physicians of the same school. The remedies in the *Practica* were either drops, plasters, ointments, powders, washes, drinks or syrups, based on herbals, and/or minerals. Most of the herbals used by Trotula can also be found in the *Herbal of Rufinus*, which was influenced by the School of Salerno.[2] The same school was also responsible for the compilation of several herbals, the most important of which, the *Circa instans*, was to influence the knowledge of plants displayed by women in later centuries.[3]

There was considerable growth of botanical knowledge in Italy during the late fifteenth and sixteenth centuries due to the inclusion of plant studies in medical faculties,

and the widening of the geographical environment (voyages to America, Africa, and Asia). Private gardens were created at the various Italian courts, and botanic gardens associated with universities appeared at Padua, Pisa, Bologna and Rome, to name the most important. Botanizing trips to identify plants, and to collect samples became common practice amongst physicians and apothecaries. Furthermore, whether they were associated with universities, or not, men wrote on their efforts to identify various plants. Some of these works could discuss ancient texts, such as Pier Andrea Mattioli's *Discourses on Dioscorides* (1548),and Ermolaro Barbaro's commentaries on Pliny's *Natural History*. They could also teach the proper method of botanizing, as Musa Brasavola's *Examination of all Samples* (1536), or describe botanizing trips, such as Francesco Calzolari's *Voyage to Monte Baldo* (1566). There also appeared at the time texts in agriculture, such as Agostino Gallo's *Days of Agriculture* (1566), and a work which represented the first serious attempt at plant taxonomy, Andrea Cesalpino's *On Plants* (1583). Efforts to identify plants were even made by the early medieval herbals, such as those of Rufinus.[4]

We know that some women studied Pliny's *Natural History*, visited natural history museums, were interested in the new plants brought from abroad, might have undertaken nature trips, and even produced medicinals from plants.[5] However, unlike the men, women of the period did not write tracts entirely dedicated to botany. They displayed their knowledge of plants in letters written either in Latin or Italian, in dialogues between friends, a work in defense of women, or a book which contained alchemical and cosmetic recipes, and remedies of various kinds. In short, one might say that the plant knowledge learned women of the Renaissance and Baroque periods displayed in print was either

drawn from the appropriate books of Pliny's *Natural History*, and / or from herbals. And yet, nowhere in these writings did the plants mentioned merit description, or accurate identification, as men practiced in their works.

Like their male counterparts, female humanists, like Olimpia Morati and Laura Cereta, drew from his work a classical vocabulary of scientific words not available in other Latin authors. Pliny's influence on Morati's work can be found in her " Dialogue between Lavinia della Rovere and Olimpia ", whereas Cereta's 1487 Latin letter to Deodata Leno provided us with perhaps the first description of a nature trip undertaken by a woman. Her climb to Mt. Isola, near Lake Iseo, near Brescia, in the company of her friends, was replete with descriptions of the nature around her, written with language borrowed from Pliny's work. Cereta was an astrologer, who, like her male counterparts, believed that celestial bodies influenced bodies in the sublunar region. Thus, in her 1485 letter to the natural philosopher Fortunato, Cereta stated that each plant had its planetary ruler, and that there were plants whose virtues were imposed by the signs of the zodiac.[6] Towards the end of the sixteenth century, Moderata Fonte made use of the the School of Salerno's herbal *Circa instans*, or one of its derivatives, to discuss the utility of many plants as remedies in her *Il merito delle donne*.[7]

As *Il merito delle donne* serves to illustrate, prior to the eighteenth century, most women's knowledge of plants rested in the medicinal properties plants supposedly contained. This knowledge was very much in keeping with what male educators of the Renaissance and Baroque periods expected of women. Whether they were aristocratic, or not, women were expected to care for the ill of the household, to ensure that the sick would have the right medicines, and that the appropriate physicians would be procured.

The humanist, Battista da Montefeltre (1384-1448) played such a role during the illness of her father-in-law, Malatesta dei Malatesta, Lord of Pesaro.[8] Francesca Bussa dei Ponziani's proceedings of sainthood inform us of the herbal and mineral remedies she used to assist the ill and destitute in Roman hospitals. The Lateran Canoness Semidea Poggi of Bologna felt quite confident about her herbal skills to prescribe a herbal remedy to Cardinal Scipione Borghese Carafelli in 1621. Isabella Cortese's book, *The Secrets of Ladies* contained remedies, diets, and cosmetics which often had a herbal basis.[9]

Convents usually had their own drugstores, where nuns made many of their own herbal remedies, and also sold them to provide extra incomes to their institutions, as was the case of Maria Celeste's convent of San Matteo di Arcetri in Florence. Maria Celeste's letters to her father, Galileo, are full of the herbal remedies she prepared, sometimes under order from hers, and Galileo's physician and gave to her father. Many of these remedies were also found in Moderata Fonte's book.[10]

Dissociation from the seats of learning such as universities, wherein most works on plant identification originated, might explain why women of the period failed to describe and identify plants, as men did. Botany at the time was closely associated with medicine. As the sciences evolved during the seventeenth and eighteenth centuries, botany would eventually develop into a field of expertise increasingly independent of medicine. Important works on plant physiology, as well as Linnaeus' popular artificial system of plant classification did much to bring botany to the forefront as a discipline during the course of the eighteenth century. As botany changed, so would change the relationship learned women would have with plants.

Changes began to occur in 1756, when Maria Angela Ardinghelli published her annotated Italian translation of the most important work on plant physiology of the first half of the eighteenth century, Stephen Hales' *Vegetable Staticks*. Ardinghelli not only translated the work, but also corrected the various calculations which were incorrect in the English text, completed calculations which Hales had left unfinished, and clarified passages which the author had not explained properly. She also carried out a few experiments on plants, similar to Hales' own, which were undertaken only to re-enforce Hales' findings. Thus she carried out experiments which demonstrated, more clearly than Hales'own, the lateral communication of sap vessels, which confirmed the author's findings that sap did not circulate, and which measured stem dilation when it rained, caused by the absorption of water through the stem's transpiring pores.[11]

Agriculture was another area of botany in which learned women from the elite became active by the mid 1700s. They had shown no interest on the subject during the Renaissance which survived in print. As mentioned, men wrote on agriculture during the period, and since the end of the sixteenth century, the Venetian patriciate had invested heavily in land, which they ran as capistalist undertaking.[12] However, the severe dearth which hit large areas of Northern Italy in 1764-1766, forced the governments of the area into action. Agricultural academies and societies were founded by governments in most Northern Italian states, where members carried out research on crop improvement, new crops, and plant diseases. Attempts to improve agriculture had become so popular by the second half of the eighteenth century, that journals of the period, like Elisabetta Caminer Turra's *Giornale enciclopedico,* published articles and reviewed books which discussed agriculture. Many of the articles and/or abstracts published in her journal, and

in other journals, were of a technical scientific nature, and reflected the activities of the various agricultural academies in Northern Italy, and abroad. Caminer Turra herself reviewed many works on the subject, and was not past giving her own commendation to what represented real progress in agriculture.[13] Under these circumstances, botany applied to agriculture could come useful to the women running their own estates, as there were in the Duchy of Milan, where Austrian law allowed married women to retain control of their properties.[14] It was this agricultural knowledge, based on experience and successful practice, which was most likely taken seriously by the promoters of improved agricultural practices in governments, periodicals, and in the many agricultural academies that dotted the Northern Italian landscape.

I. *Women 's Agricultural Knowledge*

Some women made such a success of their agricultural enterprises in the second half of the eighteenth century to receive prizes from agricultural academies for their efforts, or to have their expertise published in important journals for the benefit of others. The noble lady from Como, Donna Teresa Castiglioni Cicero received several prizes from the Patriotic Society of Milan to distribute amongst her farmers, for having taught, and encouraged them to grow potatoes as a food crop, as well as for her responsibility in spreading the cultivation of potatoes to her neighbours' estates.[15] The noble lady Marietta Pagani , from Belluno in the Venetian Republic, was so successful in raising silkworms that she was asked to publish her method in the *Nuovo giornale d' Italia spettante alle scienze naturale* in 1789.

In the article Pagani explained not only how the silk moth's eggs were fertilized, but how they needed to be stored throughout the winter month until May, when the best mulberry leaves had then to be harvested to feed them. Whereas some estate owners, following new trends, used the leaves from black mulberry to feed their silkworms, Pagani preferred to give her silkworms only leaves from the traditional male white mulberry. She never fed them berries, since these brought too much moisture to the bed, and harmed the worms. Pagani was also aware of the worm's sensitivity to temperature variations, and to being disturbed, particularly during moulting, and thus took precautions to avoid such disturbances. Her procedure allowed her to have good yields, even in so-called bad years, when the weather was cold and unstable. In fact, Pagani's article reads very much like a modern article in sericulture. Her successes in sericulture could be attributed to her direct involvement in the enterprise, careful observations on her part, and considerable knowledge of the lifecycle of the silk moth, which came in part from books, but also, to a great extent, through years of practice.[16]

The Countess Marianna di Coconato Rudianti, from Asti in the Duchy of Milan, had her own findings on what caused smut in wheat published in Carlo Amoretti's *Opuscoli scelti sulle scienze e sulle arti* in 1789. Smut was a disease which caused much concern, and considerable loss to those involved in the cultivation of cereals. Caminer Turra's journal published several reviews of works, and original articles, which attempted to present a solution to the problem. In 1786, Caminer Turra's collaborator, De Martino had found that treating wheat seeds with an alkaline solution gave good result against smut; a procedure wich was also found effective by the Marquis Dondi Orologio.[17]

Now Coconato was to provide her own solution to the problem, based on her own observations of her fields. The countess knew that smut caused damage in years when February and March were humid. After a humid spring, there grew, amongst the wheat, a tall plant from a bulb deep in the ground, which the botanists called at the time, *hyacinthus comosus*. In May the plant was higher than the wheat, and bloomed when the wheat had its flower spike. A fertilizing black dust fell from the hyacinth flower unto the wheat spike. Coconato became suspicious that this black dust was responsible for the corruption of the wheat spike; after all, the spikes were damaged on the side where the hyacinth flower was located, and thus, where its dust was likely to fall. This could not happen if the disease came from the roots. The countess took the decision to have her men remove all the hyacinths from the fields by April, so that there would be none left when the wheat flowers appeared. She had the satisfaction to have a good yield that year of smut-free wheat, whereas, her neighbours were affected by the disease. Coconato had found the hyacinth's black dust so powerful as to kill all the vegetation on which the plants were placed after removal.[18]

Coconato was aware that some naturalist attributed smut to microscopic worms, or some type of dew, but neither the worm, nor the dew theories provided adequate explanations to the corrosion that hit the wheat spike affected by smut. The recommendations provided by some naturalists that the seeds be treated with brine before planting, did not save her wheat from infection in wet years. Coconato was aware, also that more experiments were required to test her findings, such as applying the hycinth's black dust on healthy wheat plants to see if they became affected by the disease. Still, she believed her findings could have been useful to vegetable physics, and

agriculture, and therefore decided to publish them. Apparently, the paper' editor also felt the same, because he published the article. But to be on the safe side, he published also an attack on her findings by the naturalist Dondi Orologio.

A supporter of San Martino's method of preventing smut, the naturalist did not dispute that *hyacinthus comosus* could cause in wheat a disease that then would degenerate into smut. But he could not accept the plant to be the sole and true cause of smut in wheat. One should not assume that the eradication of the hyacinth from the fields would keep the crops safe from smut.[19] Without any knowledge of the true cause of smut in cereals, naturalists might object to Coconato's findings, but could not afford to be totally dismissive of them. After all, as Dondi Orologio observed, Coconato had based her findings on observations and trials in her own fields, and the successful results she had obtained there had to be taken seriously.

In 1825, 1858, and 1860, as shall be discussed later, the expert botanist Countess Elisabetta Fiorini Mazzanti, who administered her own Roman estates, published, respectively a classification of grapevines of the Roman countryside, and articles on fungi which affected silkworms, and olive groves.[20] All the references to women and agriculture discussed above have certain common characteristics: firstly, all the women mentioned, with the exception of the journalist Caminer Turra, were from the upper classes. Secondly, they showed that women not only owned and administered estates, but were involved in the day to day running of the lands in them. The ownership and administration of estates by women from the Duchy of Milan, as some of them were, can be easily explained by the fact that Austrian law allowed, as mentioned, married women to retain control of their properties. But similar trends appear to have been occurring

elsewhere in Italy, such as the Venetian Republic, where women , who had inherited mostly mobile goods during the Renaissance, were by the eighteenth century receiving landed property, and most importantly, retaining some control of it. It might explain why by 1774, Francesco Janisi del Tolmezzo, of the Venetian Republic, felt that a course of study for women had also to include agriculture and commerce as subjects. Such courses of study for women of the upper classes were unheard of during the Renaissance and Baroque periods.[21] One can conclude that women received prizes from agricultural societies, and had their articles on agriculture published in prestigious journals because, at a time when agricultural improvement had the attention of reformers and governments alike, the men who ran the academies, and journals could not afford to ignore the experience demonstrated by those women, nor, most importantly, their results.

Natural history provided a fashionable topic to an elite woman's salon throughout the eighteenth century. It needed not an institutional setting, or extensive equipment to be experienced first hand. During the second half of the eighteenth century, the field trip undertaken to collect plants, animals, or minerals became increasingly popular amongst male and female amateurs of natural history to the chagrin of professional naturalists like Alberto Fortis, who complained that amateurs collected specimens with little preparation, or knowledge. Some of the surviving records of women like Isabella Teotochi, the Marchioness Sassi, and Chiarina Segré, who participated in these field trips seem to indicate their preference for collecting the productions of the animal kingdom.[22] As seen, Castiglioni, Coconato, and Pagani, and probably many other elite women were interested in botany applied to agriculture, as elite women of the past had been interested in botany applied to medicine. Although not a botanist, Caminer Turra reviewed, and provided

abstracts for several works on plant taxonomy for her journal.[23] However, it is difficult to find records of women's activities in plant collecting for the sake of botanical studies. Therefore, if one were to look for the extensive culture of botany which overcame British women and their families during the same period, one could not find it in Italy.

British women published extensively on botany, and thus, contributed greatly to the popularization of the subject by making it accessible to woman and children. Similar publications by women interested in botany did not dot the Italian landscape. All women recognized as botanists by their male counterparts either engaged in their own plant taxonomy, and/ or assisted male botanists in their work. As L. Schiebinger, and Ann Shteir point out, Linneaus' sexual system of plant classification embodied then existing sexual differences and distinct gender boundaries. In taxonomy *class* stood, and still stands, above *order*. Linnaeus had used the male parts of the plants (stamens) to determine *class,* and the female parts (pistils) to determine *order* in his system of plant classification. Linneaus had no justifiable empirical reason, other than Aristotelean tradition, for giving male parts priority in determining the status of plants. Italian women of the Baroque period like Fonte, Marinelli and Tarabotti had objected strongly to Aristotelean reproductive theories which made women physically and mentally inferior to men. Italian women appeared not to have had any objection in print to the Linnean sexual system which again re-enforced female inferiority. Some British botanists had objected to Linneaus' pictorial language of plant sexuality as being " too smutty for British ears ". As far as it is known, Italian male botanists raised no such objections to the Linnean language, and Italian women were introduced to the Linnean system, as they had been introduced to Greek reproductive theories in the past. Whereas, botany

interested women of the middle and upper classes in Britain; in Italy this study was, to a great extent, in the hands of elite women, who received a systematic education on the subject. But they were very few as compared to their British counterparts.[24]

II. *Women and the Science of Botany*

The naturalist G.B. Brocchi, responsible for teaching the most important woman botanist Italy produced before the opening of the universities to women, Elisabetta Fiorini, referred to Candida Lena Perpenti, Clelia Durazzo Grimaldi, Carolina Marchesi, and of course his student, Fiorini, as botanists. It appeared to Brocchi that botany had made converts in Italy, as it had done in England and France, which was reasonable, for there was no science more agreeable to ladies. Brocchi was aware of having been over optimistic as to the activity of women in botany at the time. Carolina Marchesi of Ancona, a former singer, who had left the theatre to dedicate herself to botany, corresponded with Antonio Bertoloni, professor of botany at the University of Bologna, and supplied him with plants, but did very litle taxonomy on her own. The other three botanists, Candida Lena Perpenti, Marchioness Clelia Durazzo Grimaldi of Genoa, and Countess Elisabetta Fiorini Mazzanti of Rome, were far more adept botanists, having received a more systematic education in the field than Marchesi. As aristocrats with income and patronage to dispense, Durazzo Grimaldi and Fiorini Mazzanti were far more successful in attracting to themselves proper male teachers to educate them. Nothing is known of Lena Perpenti's botanical education. She might have been self-educated on the subject. However, her knowledge of the subject was extensive enough to allow her

to recognize plants which had not yet been classified. Furthermore her knowledge in natural history also extended to the field of minerology.[25]

A. *Candida Lena Perpenti (1764-1840): Botanist and Minerologist*

Little is known of Candida Lena Perpenti's life and education, except that she was from Como in the Duchy of Milan, and was apparently associated with the Napoleonic government of the Kingdom of Italy. One of Lena Perpenti's friends was the physician and biologist, Pietro Moscati, who was responsible for public instruction in the Kingdom of Italy. Apparently, Lena Perpenti took up with increased enthusiasm the study of botany only in 1816. She became expert enough on the subject to discover in one of her excursions around lake Como, in the Valtellina region, a plant hitherto unclassified, which belonged to the modern family of *Campanulaceae.* A botanist friend, who confirmed her finding, suggested she name the plant *Campanula perpentia*, in honour of the discoverer. But Lena Perpenti, whose loyalty to the newly restored Austrian crown was in question because of her former close association with the Napoleonic government, opted to call it instead, *Campanula raineiri.* She named the plant, wisely, after the new viceroy of the recently established Habsburg Kingdom of Lombardo-Venetia, Francis II's brother, the Archduke Renier. She presented to the viceroy not only the new flower, but several other plants of the Valtellina region. The results of her findings, which consisted of a drawing of the plant, its description, and the history of its discovery were then published in the *Biblioteca italiana* of 1817.[26]

Before becoming a botanist, Lena Perpenti had shown interest in minerology. Her principal work on the subject dealt with the processing of asbestos mineral from two

different locations in Northern Italy--the Valtellina region of the Alps, and the Genoa region--in order to turn it into fireproof cloth and paper. Lena Perpenti's publication described the method by which she was able to loosen the fibres from the mineral, to produce fibres from the Valtellina sample which were ten times longer than the diameter of the original rock. The Genoa sample yielded shorter fibres. The fibres obtained from both samples could then be spun into a thread as strong as that of silk. or linen. This thread then could be woven into fireproof cloth. Lena Perpenti was also able to make, and perfect some fireproof paper by using asbestos fibres, in lieu of rugs.[27]

Lena Perpenti's work on asbestos received a prize from the Napoleonic government in Italy. As the development of the asbestos industry was still to come, Lena Perpenti had to consult several of the ancient and medieval authors to get a little information on how to process the asbestos ore. Considering that the modern asbestos industry began when two hundred tons of raw material were produced in Italy in 1868, Lena Perpenti's article must have had some relevance to its development. Interestingly enough, Lena Perpenti used the skills of carding, spinning, and weaving, that man for centuries attributed as being so eminently suited to women, to produce a material that would be useful to industry.[28]

Lena Perpenti might have been self-taught in minerology and botany; nevertheless she was able to achieve a measure of success in both fields at a time when these fields were becoming increasingly specialized. The other botanists, Clelia Durazzo Grimaldi and Elisabetta Fiorini Mazzanti received the equivalent of an university education in botany, and therefore were, in principle, more prepared to face the changes which occurred in the field during the nineteenth century. One of these botanists, Durazzo

Grimaldi confined her botanical activities to her garden. The plants she grew in garden allowed her to keep in contact with institutions of higher learning to which she did not belong. The other botanist, Fiorini Mazzanti achieved considerable levels of specialization and professionalization in the field, and was made a member of the most important scientific academies of the peninsula.

B. *Clelia Durazzo Grimaldi: Botanist and Gardener*

Ann. B. Shteir in " Botany in the Breakfast Room " emphasizes the role the family played in introducing British women to botany. As seen throught this work, male members of Italian families played a dominant role in the education of aristocratic and bourgeois women, whether their fields of study involved botany or not. But it has to be said also, that in the eighteenth and nineteenth centuries, these women gained an increased control over, at least, their later education. The botanist, Clelia Durazzo's studies are a good example of this trend. Marchioness Clelia Durazzo, born in Genoa in 1760 to the richest family in town, was educated in convents at Genoa and Milan, and then at home under the supervision of her family, where she had access to one of the best libraries in town. She appears to have owed her introduction to botany directly to her uncle Ignazio Durazzo (1754-1818).[29]

Ignazio Durazzo had studied natural history under Prof. Onofri of the University of Genoa, where he developed initially an interest in minerology. But trips to France, Holland and England in 1786 and 1787, where he befriended men such as Jussieu, and James Edward Smith, the founder of the British Linnean Society, diverted his interest to botany. After his return to Genoa, Durazzo founded several botanical gardens in town,

and in his villas in the country. His garden at Zerbino contained some of the rarest plants found anywhere in Europe. He was also instrumental in beginning the fashion of creating private botanical gardens amongst the Genoese elite. Although his only published work seems to have been *The Garden of Zerbino* (Genoa, 1804), which was a catalogue of the plants cultivated therein, Durazzo was made a member of several scientific societies, such as the Academy of Georgofili of Florence and the Linnean Society of London.[30]

We have no proof that Durazzo taught his niece any botany; but, certainly , he served as an example to her, and encouraged her in the foundation of her own botanical garden at Pegli in 1794, after her marriage. It appears, however, that it was not until 1797, when political unrest at Genoa forced her and her husband to take refuge at the court of the Duke of Parma, that Clelia Durazzo Grimaldi began a serious course of study in botany under the supervision of Diego Pascal, professor of botany at the University of Parma, which was to last several years. Pascal made her an expert in exotic plants. It was also at Parma that Durazzo Grimaldi began her herbarium, which, when she endowed it to the Civic Library of Genoa at her death, contained 508 species of plants. Throughout this period, the botanist continued to supervise the cultivation of her garden at Pegli. But it is obvious from her letters to the botanist Nocca, that her garden suffered from her absence.

In 1803, the marchioness and her husband visited Austria, Bohemia, and Bavaria, where she met several of the foremost botanists of the region, such as N.T. Host, Von Jacquin, J.C. Miken and F. von Shrank, visited botanical gardens, took botanizing trips to enrich her herbarium, and spent considerable money on botanical books to add to her collection.[31] After her return to Genoa in 1804, Durazzo Grimaldi, childless, and married to a supportive, and rich husband, continued to expand both her botanical garden

and her library in her villa at Pegli, and came to rival her uncle in the enterprise. The botanist Antonio Bertoloni, who had stayed at Pegli informs us of the medicinal plants from New Holland, and plants from China, Japan, and South America which were all cultivated in her garden.

Canonici Fachini pointed out that Durazzo Grimaldi was too modest to publish her own discoveries. In fact, we are not aware that she discovered new species, or contributed to plant taxonomy, or morphology, as Lena Perpenti and Fiorini Mazzanti were to do. The marchioness was best known for her botanical garden, and for her library, which at the time of her death contained five hundred volumes in botany and related fields. It was by means of her garden, and her books that she could bestow her patronage on professional Italian botanists like Antonio Bertoloni, professor of botany at the University of Bologna, Domenico Nocca, professor at Pavia University, Domenico Viviani, professor at Genoa, and others. Durazzo Grimaldi would provide them with plants from her garden to enrich their universities botanical gardens, welcome them to her villa at Pegli to discuss botany, consult her library, and take botanizing trips to the surrounding countryside.[32]

To elite women, patronage was a two-way street, for they received benefits from the men they assisted. First and foremost, if Durazzo Grimaldi could not belong to an university, by creating an environment (a botanical garden and library) which would attract those belonging to universities to her, she could be part, if indirectly, of that intellectual group. Secondly, grateful botanist were prone to name new species, or genera in her honour. Thus, F. von Shrank named a genus, *Grimaldia,* in her honour; whereas Domenico Nocca named a species, *Ornithogalum grimaldiae*, after the marchioness.

Furthermore, Durazzo Grimaldi, not only donated plants, but also received them, when her garden needed replenishing. For instance, in the early 1800s, Nocca was instrumental in providing her with the rare plants she lacked. Those who helped her would, in turn, have first choice from the available plants in her garden. Durazzo Grimaldi's surviving letters to Nocca are a good example of the businesslike transactions she carried on with institutionally based botanists. The letters dealt almost entirely with plant species required and sent by either Grimaldi or Nocca, with botanical books, which needed to be acquired, or were acquired by her, and with the printed catalogue of the plants contained in her garden.[33]

It is clear from Durazzo Grimaldi's letters to Nocca, and from Bertoloni's eulogy, that she published a series of catalogues of the plants in her garden; but as she sent them to different botanists only the 1812 catalogue survives amongst the books she donated to the Civic Library of Genoa. This catalogue contained the genera organized in alphabetical order; for each genus, the different species were again organized in the same manner. The catalogue contained 1617 species and varieties of plants divided into 625 genera. There were 40 species and two varieties of *Pelargonia*, from the modern *Geraniaceae* family cultivated in her garden; only three species occur in the modern European flora. Undoubtedly, several of the species received a different classification than what is found in modern European floras. But, it is very likely that many of the species in her garden originated abroad. After all, her aim was to cultivate as many rare and foreign species as possible. As expected the catalogue reflected the classification problems of the period. For instance, Durazzo Grimaldi, following Linnaeus, had *Cactus* as a genus, and the modern genus *Opuntia* as a species within it; consequently,

several of the species belonging to the modern *Opuntia*, and *Ceres* genera were classified under the genus *Cactus*.[34]

The catalogue contained many of the medicinal plants found in traditional herbals, such as rosemary, sage, aloe, mugwort, and othes. It contained also medicinal plants from New Holland, and several species belonging to the genus *Digitalis*, including *Digitalis purpurea*, a folk cure for dropsy, which had been introduced into orthodox medicine in 1775 by William Withering. Now, from her books' catalogue, one can surmise that she must have had but little interest in the healing properties of plants, since only three of these books obviously discussed the matter. Her friend, and professor of botany, Antonio Bertoloni, who also left us a list of his books, had only two works on the subject. This is perhaps illustrative of how the medicinal properties of plants had become a very small part of the non-medically trained botanist's agenda. One suspects Durazzo Grimaldi cultivated these plants to assist those physicians and botanists who researched the curative power of plants.[35]

Since catalogues of both Durazzo Grimaldi's and Antonio Bertoloni's books survive, it is useful to compare the two lists to see how the library of a rich amateur woman botanist differed from that of an university professor in botany, who was also the director of the university's botanical garden. Although Durazzo Grimaldi's catalogue contained far more books than Bertoloni's, they shared many works in common , or of a similar nature. For instance, both collections contained many books on Floras of different regions, such as De Candole and Lamarck's *Flore française*, and J. E. Smith's *Flora britannica*. Although Bertoloni had some Floras not possessed by Durazzo Grimaldi, the marchioness had the greatest variety of these book, undoubtedly determined by her

interests, her much greater wealth, and by the fact that twenty one years separated Bertoloni's list (1816) from that of Durazzo Grimaldi's (1837). As expected, as botanists who either possessed, or directed botanical gardens, Durazzo Grimaldi and Bertoloni had works which referred to botanical gardens implemented elsewhere in Europe and Italy. Whereas the works possessed by Bertoloni were French and Italian in origin, Durazzo Grimaldi's works on the subject came from more diversified locations.[36]

Bertoloni had a few works on fungi, but his interest in mycology appeared to have been minimal as compared to Durazzo Grimaldi's. At least fifteen of her works dealt exclusively with fungi; eight of these works were by Persoons alone. Durazzo Grimaldi seemed to enjoy studying them in her botanizing trips around the contryside. It was probably in these trips that she studied also the lichens and mosses for which she had important works from K. Acharius, J. Hedwig, and others.[37]

Both botanists had works that pertained to other fields in natural history; but considering the size of her library, Durazzo Grimaldi's works on the subject were more limited than Bertoloni's. Two of these works, on the water and soil of the Liguria region, and on the insects of the same region, had practical application in the running of her own estates and garden. Durazzo Grimaldi's and Bertoloni's catalogues differed greatly when it came to books useful to the running of an estate. As a salaried university professor of botany, with no estate at his disposal, Bertoloni had no need of books in agriculture. Whereas, Durazzo Grimaldi, as one of the richest persons in a maritime region, which had traditionally recognized women's needs to run their affairs independently of often absent husbands, had use for such works. The marchioness had at least twenty eight works in agriculture in her catalogue by relevant authors like

Filippo Rè, Targioni Tozzetti, Abbot Rozier, L. Mitterpacher, and others. In this concern she resembled other aristocratic women of the period. To them botanical knowledge applied to agriculture was more relevant than the same knowledge applied to medicine.[38]

Durazzo Grimaldi had very important works in plant physiology such as J. Ingenhousz's *Expériences sur les végétaux* and J. Senebier's *Expériences sur l' action de la lumière solaire dans la végétation*,[39]as well as several later editions of Carl Linné's most important works, such as his *Genera plantarum* (Schreber edition), *Specie plantarum secundum systema sexuale* (Willdenow edition), *Systema vegetalium* (Persoon and Scanagatta editions), *Fundamenta botanica*, *Flora lapponica*, and *Systema plantarum europeae* (Gilibert edition).[40]

As expected from someone who supported the Linnean system of classification, Durazzo Grimaldi had plenty of works which used that system. However, she did not neglect authors, who attempted to develop a natural system of classification, because they found the Linnean system of classification artificial., such as J.B. de Lamarck's *Flore française*, A.. de Jussieu's *Genera plantarum*, R.L. Desfontaine's *Tableau de l' École de Botanique*, and *Flora Atlantica*, and A. Haller's *Historia stirpium indigenarum Helvetiae* to name the most obvious. If Durazzo Grimaldi did not simply collect these works, but read them also, she would have been aware of the difficulties with the artificial Linnean system.[41] The marchioness might have had problems with the system herself, but failed to record any problems in print. Had Durazzo Grimaldi done so, she might have become member of a few Italian academies.

As she stood, Durazzo Grimaldi's contributions to the field of Italian botany were not enough to make her a member of Italian academies, as the Georgofili of Florence. To

have a botanical garden of rare plants, to assist botany professors, and the gardens they ran with samples, to have an extensive library, which experts could use, and to print catalogues of the plants owned were enough contributions to botany to make the uncle, Ipollito Durazzo, a member of the Academy of Georgofili of Florence, and the Linnean Society of London, but the same contributions were insufficient for the niece. Women would have to wait until 1904 to become members of the Linnean Society. A few decades after Durazzo Grimaldi's death, Caterina Scarpellini and Elisabetta Fiorini Mazzanti would become members of the Academy of Georgofili. The former was made a member for her extensive ozonometric work, and the latter for her research on lichen morphology. Durazzo Grimaldi could boast no such claims, as neither could her uncle; but as a woman, she needed to try harder to achieve the official recognition easily given to a man of similar qualifications.[42]

The woman to achieve the greatest success in Italian botany was undoubtedly Countess Elisabetta Fiorini Mazzanti of Terracina and Rome. At the time of her death on April 23, 1879, she was not only a corresponding member of the Academy of Georgofili of Florence, but also of Brussels' Academy of Horticulture, the Leopoldine Academy of Dresden, the Agrarian Academy of Pesaro, the Pontificial Tiberine Academy, the Turin Academy of Sciences; and, most relevant to her scientific career, in 1856, she was elected one of the thirty ordinary members of the Pontificial Academy of the New Lincei, which in 1847, under Pope Pius IX, had received a new lease on life. Fiorini Mazzanti was able to become the member of so many academies because of the pioneering work she carried out in Italian botany. [43]

C. *Elisabetta Fiorini Mazzanti: Professional Botanist*

Elisabetta Fiorini was born in 1799 in Terracina, in the Papal States, into a local aristocratic family. The unstable political conditions of the times, and financial setbacks, forced the family to move to Rome, where a recently widowed father paid considerable attention to his only surviving child's education. Under her father's supervision, Fiorini studied French, English, German, Latin, literature, music, history and geography. Her father insisted that she study also administration to enable her to administer her own future estates. But he went further, and passed the administration of these estates into her hands years before his death. According to her biographer and friend, Castracane, Fiorini was so successful in the enterprise, as to bring the estates back to wealth. The study of botany was her own idea, and was motivated by her interest in the plants she would observe in her trips to the countryside to visit her estates. Fiorini had a family friend, Abbot Cimarelli, introduce her to the eminent naturalist, Giovanni Battista Brocchi (1772-1827), a native of the then extinct Venetian Republic, who in 1818 had settled temporarily in Rome to study malaria, and also the Roman soil.[44]

Although Brocchi had published, and would publish works in botany, as an ex-student of the minerologist Alberto Fortis, he was better known for his contributions to minerology, metallurgy and paleontology. With his principle opus, *The Subapenine Fossil Conchology* (1814), in which he subscribed to the slow extinction of species, and to fossils as indicators of determined features and age of the terrains (strata) which contained them, had gained him international praise from naturalists like Georges Cuvier.[45] But it was botany that interested Fiorini, and this was the only natural history subject that Brocchi volunteered to teach her with any sort of method. After all, as

Brocchi himself, would state to Fiorini: "of all of nature's kingdom, the plant kingdom is the one most amenable to ladies."[46]

Thus, Brocchi began to teach her a regular course in the Linnean system of plant classification, which allowed her to determine the classes, genera and species of phanerogams. Her rapid progress in the course allowed her to classify many plants on her own, and to find species that had been missed by botanists A. Sebastiani and E. Mauri in their *Florae romanae prodromus* (1818). How Brocchi encouraged Fiorini to classify her own plants can be surmised by the surviving correspondence between teacher and student, which occurred when the young woman was obliged to spend many months in Terracina, Castellone and Gaeta (all sea places) for health reasons. During that period, Fiorini sent Brocchi packets of plants she had gathered, dried, and attempted to classify, accompanied by a letter, which explained the difficulties she had encountered in classification. The plants with the necessary corrected nomenclature were then returned to Fiorini by Brocchi. The errors she made were few, but Brocchi never failed to point out where the error had been made, and to scold her for making an error, which should never have been made by someone of her ability.[47]

Brocchi's departure to Milan, then Carynthia, and finally to Egypt, where he died in 1827, did not leave Fiorini without a teacher. Brocchi ensured that Prof. Ernesto Mauri (1791-1836), one of the co-authors of the *Florae romanae*, continue as her teacher, and examine the plants she sent for errors in classification. The naturalist also sent her several botanical works from Milan, such as Persoon's *Synopsis plantarum*, so that she might continue to study classification and physiology in his absence. Before he left for Egypt, Brocchi made botanists in Northern Italy, such as G. Moretti of the University of

Pavia, Antonio Bertoloni of the University of Bologna, and Giuseppe Acerbi of Milan, acquainted with her botanical abilities; and thus he helped her establish the beginning of an epistolary network with others in the field, which was to grow extensively as her reputation as a botanist spread. Both Moretti and Bertoloni were in the process of publishing Italian floras, and thus were glad for any sample sent them by botanists across Italy. Of the two, Bertoloni turned out to be the better correspondent, for he informed her of any errors in classification she had made in the samples she sent him. The Milan botanist, Acerbi made her responsible for a description of the different varieties of grapevines in the Roman countryside. Her contribution, along with those of others, were published in his work on Italian grapevines classification and geographical distribution which appeared in 1825.[48]

Most importantly for Fiorini's career as a botanist, Brocchi encouraged her to publish a description of those plants she had classified in Terracina, and which had been missed by Sebastiani and Mauri in their *Florae romanae.* She was to receive a similar encouragement from her new teacher, E. Mauri, as well as from his co-author of the Roman flora, Sebastiani. In 1823, Fiorini's first publication, " Notice on a Few Plants to Add to the *Forerunner of the Roman Flora* ", appeared in the most important Roman scientific journal, prior to the publication of the Academy of Lincei's acts, the *Giornale arcadico di scienza, lettere ed arti.* The article contained a list of thirty species of angiosperms, to which Latin descriptions were provided, as well as the locations in which they were found, and times of bloom in Italian.

The Linean binomial nomenclature was used, but Fiorini did not provide the classes and orders of the plants. She was to do that on her second publication of seventy other

plants to be added to Sebastiani's and Mauri's Roman flora, which appeared in 1828 in the *Nuovo Giornale de' letterati* of Pisa. In the article, Fiorini had classified the seventy species under their respective classes and orders. Thus, there were, for instance, eight species under Triandria Digynia, and so on. She provided descriptions for each species which were more extensive than the ones she had provided for the first article. Persoon's *Synopsis plantarum*, which featured prominently as a source in her first article, was no longer used in the second publication, where the sources of information were more varied and extensive than those previously used. On the whole, the second article was the product of a young botanist more confident in her craft. The 1828 article, and her friendship with Carlo Luciano Bonaparte, Prince of Canino, were pivotal in ensuring that she would become corresponding member of her first two academies, the Horticultural Academy of Brussels, and Pisa's Agricultural Academy.[49]

In 1829, Fiorini married the aristocratic Roman magistrate Luca Mazzanti; marriage and children did not curtail her botanical activities, for in 1831, she published *Specimen bryologiae romanae*, a classification and description of mosses of the Roman region, the result of her own studies and research on the subject. Fiorini had shown an interest in cryptogams in 1821, but had been discouraged to study them at such an early stage of her career by Brocchi. A few years later, her second teacher, Mauri was to encourage her in the pursuit, after he had received moss samples from a German botanist, which he had no interest in investigating because of his indifference to cryptogams in general.

Works on moss classification were fairly frequent north of the Alps. In Italy, botanists had usually discussed mosses in conjunction with other plants in general floras. Fiorini's article *Specimen bryologia romana*, entirely dedicated to the classification of

mosses, was a first amongst Italian botanists, and did much to spread her fame as a botanist in Italy. It ensured her a membership to the Turin Academy of Sciences, and when G. de Notaris and B. Crivelli published their most important *Prodromus bryologiae mediolanensis* (1834), which classified some very rare mosses of the high Alps, they dedicated their work to Fiorini in honour of her pioneering publication on mosses.[50]

Fiorini's 1831 *Specimen bryologia* followed the Hedwigian method of classification based on the moss external characteristics, position and type of the capsule's peristome, or mouth. Thus her mosses were divided into four classes, according to the absence or presence, nudity, simplicity, or doubleness of the peristome's teeth, or cilia or in *astome, gymnostome, aploperistome,* and *diploperistome.* To each class, there belonged its different genera, and to each genus, its different species. Only the species merited description, according to their external characteristic, such as shape of stalk, leaves, capsule and operculum; the species location, and synonym, according to other authors, were also provided.[51]

Ten years were to pass before Fiorini was to publish her second work on mosses. More extensive than her first work, it again used the Hedwigian method of classification, based on external characteristics only. The mosses were divided into the four classes of the earlier work. This time the classes were subdivided into various tribes, established on the basis of affinity of external characteristics. Fiorini provided a general definition of each tribe. There followed the genera and then, the description of each species within a genus. However, her 1841 work on mosses demonstrates well her conservative attitude towards all the innovations that were occurring in the field. Some of these innovations sprung from Italian botanists, such as Giuseppe de Notaris, a recent comer to the field,

but who soon gained an international reputation in it for his contributions to the classification and morphology of mosses.[52]

In her *Specimen bryologia* (1841) Fiorini reacted against many botanists' frenzy to create new genera and species of mosses based on the slightest accidental variations. Thus in the work, Fiorini eliminated various species that could still be found in W.P.L. Schimper's *Bryologia europeae* (1836-1856). Furthermore, Fiorini could not accept the definition of families centered around the moss organs of reproduction, since these organs were more in the nature of supposition than of observation, due to their invisibility. Schimper in his *Bryologia* had provided descriptions of the organs of reproduction, and of the spores for each species. De Notaris did not believe that spores were specific, but that all species of a genus would have spores of equal conformation. De Notaris stressed also the taxonomic importance of the cellular structure in mosses, and thus, detached himself from the Hedwigian method of classification, based on external characteristics.

Fiorini was eventually to accept all these innovations in the moss section of her *Coliseum Flora* published in 1877. Most of the mosses described in 1877 had already made an appearance in her 1841 *Specimen bryologiae*. Some had as source De Notaris' *Epilogo della briologia italica* (1869). But whatever the source, in most cases, Fiorini provided by then descriptions of the species' organs of reproduction, as well as its cellular structure. In fact, influenced by De Notaris, with whom she corresponded, Fiorini was more likely to provide description of the species' cellular structure, than its reproductive organs.[53]

The deaths of her husband, father, and surviving daughter in 1841 and 1842 seemed to have put Fiorini's botanical publications, and research on hold for several years. Ultimately, her love of botany allowed her to continue as a botanist, with more regularity and greater success than she had previously achieved. In June 1852, Fiorini was yet made a corresponding member of another academy, this time of the Royal Academy of Georgofili of Florence. On September 5, 1852, she read to the members of the Georgofili Academy there assembled her brief memoir on the nature of the *nostoc* and *collema*, a work for which Fiorini had been named a member in June.[54]

In the nineteenth-century, there was considerable interest in the nature of lichens, and in the study of their anatomy and development, morphological traits, which were viewed as relevant by botanists like Tuslane, Fées and De Notaris to lichen taxonomy. Particular attention was paid to lichens of the *collema* genus of the *Collemataceae* family, whose resemblance in habitus with some *nostoc* species (blue-green algae) led several eighteenth-century botanists to confuse those plants taxonomically. In the 1830s, Elias Fries went so far as to exclude the *collemataceae* from the lichens, and classify them within the class of algae from the same family as the *nostocs*. In 1820, C.A. Agargh believed *nostoc muscorum v. lichenoides* metamorphosed into *collema linosum*. In 1825, Wallroth believed *nostoc* and *collema* to be closely related.[55]

In the memoir she presented to the Academy of Georgofili, Fiorini followed in Agargh's footsteps, whom she mentioned, and came to the conclusion that the *nostocs* formed no separate species. From her extended observations of such plants in the Coliseum, and other Roman ruins, she had concluded that *nostocs* were nothing more than imperfect *collemas,* and that the former held a subordinate position in relation to the

latter. Both forms were of the same substance; their matrix was equally gelatinous and mucilaginous, and their epidermoidial membrane was the same. Able to follow the same plants throughout their development, Fiorini noticed the individual plants, at first *nostocs*, either of spherical form, or of small shapeless mass, gradually developed, under more favourable conditions, collematic thallus, until there appeared apothecia. The reverse could also occur, under sterile conditions.[56]

The fact that independently botanists, like Itzisohn and Julius Sachs, from across the Alps, were to come to Fiorini's conclusion as to the subordinate position of *nostoc* in relation to *collema* in 1854 and 1855 respectively, was important in determining her election as an ordinary member of the Pontificial Academy of the New Lincei on March 2, 1856. By then, she had already been made corresponding member of several important academies. But being a corresponding member of an academy did not imply either regular attendance at meetings, or the regular presentation of memoirs by the academician. Whereas, an ordinary member of a hometown scientific academy was a full-time participant of that academy. And such was the case with Fiorini; as an ordinary member of the Academy of Lincei, she attended academic meetings on a regular basis, unless trips or illness prevented her attendance. Most importantly, Fiorini could present her works, and have them published regularly in the acts of the academy, a journal which appeared on an annual basis. Fiorini had always managed to publish without the aid of any academy; however, after 1856, her publications were frequent indeed, and dealt almost entirely with cryptogams, if one exempts her Coliseum Flora, which covered both cryptogams and phanerogams.[57]

It was in the acts of the academy, which she published her detailed morphological work on the *nostoc* and *collema* in 1857 and 1858 entitled " On the Identity of the Nostoc with Collema ". Fiorini's claim in 1857 was the same as in 1852: the *nostoc* was not an algae, but an anamorphosis of the *collema*; and to prove her point, she provided a chemical analysis of the two forms, as well as a detailed morphological analysis of their anatomy, which included a study of their reproduction. Her chemical analysis of the *collema*, and what appeared to be the *nostoc*, led her to conclude that both forms had the same chemical composition. The morphological study was amply illustrated by the botanist herself. The first nineteen illustrations showed the degradation and anamorphosis of the *collema pulposum* with apothecia to common *nostoc* passing through, what might appear, *nostoc sphericum*, and then back by stages to *collema pulposum* with apothecia and its thallus. To her, the anamorphosis of *collema pulposum* was always common *nostoc.*[58]

Most of the article was then dedicated to the internal morphology of the type (*collema*) and its anamorphosis (*nostoc*). According to Fiorini, the thallus of the *collema* contained filaments of two different configurations; one consisted of utricles disposed and connected like beads, which varied in length, and were distinguished occasionally by a major utricle (the algal host). The other filaments were continuous tubes, either simple, or branched (the fungus hypha). Some authors would say that the difference between the *nostoc*, and the *collema* lay in the absence of the continuous tubes in the first, and their presence in the second. But according to Fiorini, this rule could not always be applied, for she had detected the presence of the continuous tubes in the *nostoc*, as her illustrations demonstrated. It was also true that in the *nostoc* these tubes,

were scarce, simple, and never branched, dilated, or enclosed utricles. The thickness of the matrix favoured development of tubes, whereas, its thinness favoured the multiplication of beads.[59]

As far as the multiplication of the vegetative system was concerned, the beads, being nothing but simple cells connected in a series, did not multiply by division, but by intrautricular formation. The true autonomous generating organ of the vegetative system was the major utricle, either single, or joined to the other utricles. It not only generated the beads, which to Fiorini were true gonidia, but also the continuous tubes, either directly, or through the emission of microgonidiae. Fiorini seemed to have recorded the algal reproduction within the lichen thallus, as her illustration indicate. Unaware of the true nature of lichens, she was also unaware of the algal reproduction within them. Furthermore, her same ilustrations, as well as her own explanations, seemed also to indicate isidia, vegetative diaspores, and organs of dispersal of the lichen. In fact, in her conclusion Fiorini referred to the reproduction of the vegetative system by means of gemmules from the thallus.[60]

The botanist observed that *collema* reproduced also through the hymenium and the spores contained therein. The continuous tubes (hypha), with their enclosed nuclei were the principal sources of the hymenium. The tube walls dilated and became asci, and the nuclei therein angiospores, which were initially lumpy masses of protoplasm shed by the utricles of the dilating paraphyses of the hymenium. Those spores, which numbered no more than eight, were expelled at maturity, and if conditions were suitable, they would begin reproduction. Fiorini's table seven showed various drawings of the apical part of

asci at different levels of maturity, which were very similar to modern illustrations of the same.[61]

Fiorini also examined, what she referred to, as the obscure forms of antheridia or spermogonia (pycnidia), described by some authors, as small tubercules, or punctiform stains. She observed the punctiform black stains in *collema pulposum, nigrescen, cheileum.* and *cristatum.* All she could notice in the first three species were morbous alterations in the paronchyma, caused by, what she assumed, were external forces. But in the *collema cristatum*, Fiorini did see a membraneous conceptacle, with a rimose ostiolum within which there were a multitude of eliptical one celled, or two celled corpuscules, which when freed, agitated themselves with translation motion (conidia).[62]

Like Tuslane in 1852, and Itzisohn in 1850, Fiorini, in 1857, provided good description and illustrations of asci, paraphyses and pycnidia with conidia, which made her anatomical work very relevant for the times. But, unlike Itzisohn, she did not accept that the conceptacles she had observed were spermagonia or antheridia, and the corpuscules therein to be spermatozoides, for she had no proof that they were male organs. As she had done with mosses in 1841, Fiorini could not accept in 1857 the sexual reproduction, this time, of lichens. For her it was sufficient that the lichen reproduce in the vegetative system by means of gemmules, and in the hymenial system by means of (asexual) spores. In fact, what Fiorini and Itzisohn had detected was not the lichen's sexual reproduction, but that of the lichen's fungal component.[63]

A. de Bary in 1866 and Schewandener in 1868 came to understand that the lichen was an organism composed of algae and fungi living in a symbiotic relationship. Opposition to this view remained strong in Germany, where it had originated, as

elsewhere, through the 1860s and 1870s. Twenty years later, Fiorini in her Coliseum Flora also classified and described the seventeen species, and one variety of lichens found in the ancient monument. Always well-informed on the new theories which appeared in the field of cryptogams, because of her correspondence with botanists in Italy and abroad, the countess did not fail to mention the new theory, as expounded by De Bary and Schewandener. But as many botanists in Germany had confirmed her findings, she saw no reason to change her views. Thus, to her, all the *nostocs* found in the Coliseum were nothing but anamorphoses of the four *collema* species and one variety, already described.[64]

Fiorini's belief in anamorphism in lichens is again demonstrated in 1878 in her description, of what she believed to be, an unusual lichen, which had already been the subject of an article in 1871 in the Acts of the Lincei Academy. The lichen, a whitish crust, grew in the north wall of the Coliseum, inaccessible to the rays of the sun. Other botanists had classified it as alga, or fungus, or lichen. Fiorini named it *Lichen atypicum latebrarum*, and believed it to be abnormal, and constant in form, when it grew in places inaccessible to the sun. When sunlight reached it, the abnormal lichen would then develop into a perfect organism, or two, for she had it develop into *Lecidia compostus ß sableterum*, with its apothecia, and equally into a foliose lichen, *Cladonia pyxidata var. gracillima*.[65] Anamorphosis brought about by environmental conditions also provided an explanation as to why a new species of colonial algae, identified by Fiorini, after microscopic analysis, as the *Palmodicton lubricon* had disappeared after a rainfall, and in its place there appeared dark green, boat-shaped, unicellular, bivalve algae, with spores

and antheridia, similar to diatoms, to which she attributed not only a new species, but also a new genus, the *Andina*, and thus, *Andina evanescens.*[66]

Fiorini 's other works would not be, perhaps, as relevant, and as trend-setting to Italian botany, as those on Roman mosses, and on the *nostoc* and *collema* morphology. Nevertheless, most of these works dealt with the discovery of new species of cryptogams, particularly algae. Fiorini adventured not only through fields, cliffs, stagnant ponds and waterfalls, but also where sewers discharged into the sea to search for new species of algae. But most of them were found in the different mineral water sources--many of them of sulfurous nature--of the Roman countryside, such as in the albescent waters of Tivoli, and in the sulfurous waters of the Maddalena. These works followed an established pattern, in so much that they contained detailed descriptions of the new species, their habitat, the occasional chemical analysis, and, in most cases, illustrations of their morphology.[67]

The most relevant, and certainly the most extensive of Fiorini's works on algae, dealt with the new species she found in the various mineral water springs of Terracina, her hometown. The work consisted of three articles published in the Acts of the Academy of Lincei in 1861, 1863 and 1867 respectively. The first article contained chemical analyses of the mineral water of the various springs carried out by a chemist, Dr. Viale, and a notice by Fiorini, which stated, that it had been her pleasure to name several of the new species after Italian botanists who had honoured her with letters, and had provided useful advice. Thus, she had amongst the new species, *Calotrix de notaris, Synedra targioni, Scytoneme parlatori, Sphaerozyga massalongii*, and so on. One such new species was named after her by Montagne, to whom she had sent the algae. Again the

articles provided detailed descriptions, habitats, and illustrations of the morphology, but only of the new species. For descriptions of the species already known, including the ones previously discovered by her, Fiorini directed the reader to the appropriate sources. Altogether, the three articles contained eleven new species of algae discovered by Fiorini, and thus never described, or illustrated before, either by her, or other botanists.[68]

One might think that as an aristocrat, responsible for the administration of her estates, and as an expert in cryptogams, Fiorini might have been interested in botany applied to agriculture, particularly in cases of vegetable parasitisms, so relevant to agriculture. The countess showed interest in this field, but she published little on the subject, in relation to her other publications in botany. Still, these publications were more extensive, and more learned than women had previously done, which serves to indicate the level of specialization Fiorini had achieved, without attending university and receiving a degree. Besides her classification of grapevines of the Roman countryside, already discussed, Fiorini published two articles on the subject, all in the acts of the academy. The first article was essentially a review and summary of a work by Dr. Ciccone of Turin on the muscardine, a disease, which affected silkworms, caused by a fungus, the *Botrytis bassiana*, whose spores germinated in the worms' body fluids.[69] The second article dealt with parasitism in olive trees caused again by a fungus, which was identified by Fiorini.[70]

Fiorini's last work, *Florula del Colosseo* was carried out over a number of years, and published in the Acts of the Academy of Lincei from December 1874 to February 1878. There were other Coliseum floras, before Fiorini published hers, as she mentioned in the introduction of her own flora. Sebastiani had compiled an alphabetical list of two hundred and sixty species of phanerogams contained in the monument. An Englishman

had compiled a flora of the place; but many of the species in his flora could not be found therein, and were simply taken from Sebastiani and Mauri's *Roman Flora*. None had classified its cryptogams, and it was very much Fiorini's intent to do so.[71]

In spite of Fiorini's referral in letters to a cryptogamic section, her flora no longer contained the Linnean system of classification. Instead, the author, using the natural system, divided her plants into vascular and cellular. The approximately two hundred and seventy one species of vascular plants were then divided into three classes: monocotyledones, dicotyledones and acotyledones, and contained within fifty two families. With some variations, most of these families can still be found in modern floras. For instance, what Fiorini called the *Lineae* family, is now defined as *Linaceae*, but all the species found in the flora match the modern species. Whereas, the *Asparageae* family has disappeared, and the species in it, are now classified under the *Liliaceae* family.[72] The biggest changes occurred within the *Compositae* family, where many of the genera have changed name, and where the division of the family into homogamous homoflosculi and heterogamous heteroflosculi has also disappeared.[73]

It was Fiorini's intention to make the cryptogamic section as extensive as possible, but loss of material, and severe ill health prevented her to go out when such organisms were likely to thrive. At the end of the publication, she excused herself for, what she defined, as a very poor cryptogamic section. If one adds the four species of ferns classified, very properly, under vascular plants, her so-called cryptogamic section contained seventy nine species and fifty one genera of cryptogams. If one considers the variety and number of phanerogams within the Coliseum's walls that she had recorded, undoubtedly there were far more cryptogams than what Fiorini had managed to describe.

Just the same, amongst the cellular plants there were four species of *hepaticae*, twenty species of *musci*, seventeen species of lichens, sixteen species of algae, seven species of fungi, and eleven of imperfect fungi. To all the 346 species of plants, Fiorini gave the location in the Coliseum, so that they could be traced, and investigated by others. As a botanical work the Coliseum Flora remains a descriptive testimonial of how nature had clothed an ancient monument before, not only restauration, but twentieth-century polution took hold.[74]

The *Florula del Colosseo* was not as scientifically relevant as her earlier work, and had not intended to be so by the author. It was meant to be a tribute to nature's ability to ultimately conquer man. As Fiorini stated, the great monument of ancient Rome, with its floral dressing, stood as a testimony of the frailty of all human power. As far as she was concerned, archeological restoration of Roman grandeur, initiated by the government of a newly unified Italy, was destroying what nature had generously given. It was her intent to preserve in print the floral dressing that nature had given the monument, and which had provided a field of study for botanists past, and present.

These were intents more in tune with late twentieth-century ecological concerns, than with nineteenth-century positivistic science. Carolyn Merchant, Evelyn Fox-Keller, and several of the authors in Marina Benjamin's *Science and Sensibility* would point out that it was the way women produced science. As far as Italian women in science are concerned, one can only say that it was Fiorini's way of doing science, determined by her personality, and choice of scientific subject. The other major woman scientist of the period, also living in Rome, Caterina Scarpellini, as seen, believed in men and women's ability, need, and right to conquer nature.[75]

There was also a political aspect to Fiorini's reaction to the destruction of the Coliseum flora. It appears that she had little sympathy for the new government in Rome, and its policies. When Rome was taken over by the troops of the Kingdom of Italy in 1870, and Italy was finally united, the new government created the Royal Academy of Lincei, whose first session took place on December 4, 1870. All the members of the Pontificial Academy of Lincei were automatically made members of the Royal Academy, and amongst these members there was also Fiorini Mazzanti. The lay members of the Pontificial Academy joined the new academy; as expected, the clerics, men like Father Secchi, Canon Castracane and others, remained with the Pontificial Academy; thus, the Academy of Lincei was split in two. Fiorini refused to join the Royal Academy, and never attended any of its meetings. After two years her name was dropped from the Royal Academy membership, along with those of Castracane, Secchi, and eleven other scientists.

Prior to her death, the Pontificial Academy secretary wrote to the pope that the illustrious botanist deserved special mention in his book for the support she had given to the academy during the 1870 troubles. When her loyalties were tested, Fiorini opted for the papacy, with the view that it had been good to her family, and certainly to her. The Pontificial Academy had welcomed her amongst its members, to its meetings, and most importantly, it published all her works; she could do nothing, but support it in times of need. Furthermore, had Fiorini not been a member of the Pontificial Academy, it would have been very unlikely that she would have been made a member of the Royal Academy. Scarpellini, who was not a member of the Pontificial Academy, for all her support of an united Italy, was never offered a membership to the new academy. She

had to make do with a medal from the government for her scientific efforts.[76] This episode serves to prove that in Italy, at least, the Church could not be accused of being more misogynist than lay governments, when it came to women's participation in the sciences.

Proof that Fiorini might have been accepted as one of their own, by her male peers, rests in the fact that at the 1874 International Congress of Botanists in Florence, Fiorini was not only invited, but was made to sit besides the congress' president, Prof. Filippo Parlatore, one of her correspondents. Nevertheless, in spite of her qualifications, Fiorini was never offered a teaching position at any university, or as far as it is known, ever asked for such a position. Still, she was instrumental in teaching, and guiding Father Francesco Castracane, who was to become the foremost expert on diatoms in the world, when he entered the field.[77] Fiorini had achieved such a level of professionalization and specialization that botanists entering the field of non vascular plants could not, but listen to her advice. Perhaps the best compliment to her expertise a nineteenth-century male botanist could have given her was given by the Florentine botanist, Parlatore when he said that Fiorini had achieved the same rank as other illustrious Italian botanists.[78]

The development of botany as a science in its own right, independent of medicine, during the course of the eighteenth and nineteenth centuries, changed the relationship learned women would have with plants. Italian women of former centuries had shown considerable knowledge of plants, but to a great extent this knowledge was directed toward the medicinal properties of plants. Expert botanists like Lena Perpenti, Durazzo Grimaldi and Fiorini Mazzanti cared little for the medicinal properties of plants. To elite women like Castiglioni, Coconato, Pagani, Durazzo Grimaldi and Fiorini Mazzanti, in

charge of their own estates, it was more useful to apply botany to agriculture than to medicine. It can be said that by the late 1700s and early 1800s, women from the higher classes might have been aware of the medicinal properties of plants, but they no longer expounded such knowledge in print. Plants were studied not for their medicinal properties, but for their agricultural utility, or for the sake of the plants themselves. Plant diseases, taxonomy, physiology, and/or morphology were topics of interest for the learned women of the period.

That is not to say, however, that all Italian women lost their knowledge of the medicinal properties of plants by the 1800s. Knowledge of the medicinal properties of plants, or at least their extracts, could be found amongst the few women who received degrees in pharmacy, medicine and surgery from the University of Bologna in the early 1800s. Both Margarita Trippi and Sabina Baldoncelli had to be examined for their botanical knowledge, applied to pharmacy, to receive their degrees and licences to practice in pharmacy, as, as seen, they had to be examined on their chemical knowledge. The physician, Maria dalle Donne, expounded the medicinal properties of opium, extracted from the Persian poppy, and of quinine, extracted from the Peruvian bark, in her theses on *Universal Medicine* she published in 1800 to get her licence to practice.[79]

Women from the lower classes continued to be familiar with the medicinal properties of plants, particularly if they lived in rural areas, where physicians, and pharmacies were scarce. It was left to Candida Coronedi Berti (1820-1882) to record such a knowledge for the Bolognese region. The author could be described as an ethnologist by her association with the foremost Italian ethnologist at the time, Giuseppe Pitré, author of *Archive for the Study of Italian Popular Traditions* and *Bibliography of Popular*

Traditions, and by her own articles on the subject, such as " Popular Bolognese Words " (1877), " Marriage Customs of the Bolognese Countryside " (1874), " Some Bolognese Popular Customs " (1872), and most importantly, " Notes on Bolognese Botany ", and " Notes on Popular Bolognese Medicine " (1877).[80]

Coronedi's article " Notes on Bolognese Botany ", like Pitré's essay on the *Popular Botany of Sicily*, dealt with the superstitions and beliefs the lower classes associated with various plants.[81] In her " Notes on Bolognese Medicine ", however, Coronedi pointed out how Bolognese women from the lower classes were familiar with plants which they used to heal all kinds of ailments. Her research showed that this knowledge was more widespread in the rural areas, particularly in the mountanous regions, than in town. The peasants still made use of herbal medicines, as Coronedi had the opportunity to witness during her research trips to the contryside. Whereas, city folk had a tendency to follow new trends and abandon what they perceived as old fashioned.

The article was organized not unlike a herbal; except that the plants were not annotated in alphabetical order, as was customary with herbals. Each plant was given its medical use or uses, and methods of preparation, according to custom. For instance, mallow eaten in a salad was a laxative. The infusion of its leaves healed inflamed eyes, and its decoction, or a decoction mixed with milk freed one from cough. Its leaves boiled were used as a poultice against hemorrhoids, and its boiled roots facilitated birth. Several of the cures attributed to specific plants coincided with some of the cures for the same plants in medieval Italian herbals such as the *Herbal of Rufinus*, or the *Circa instans*. For instance, anise served to cure intestinal ache. This was one of the cures attributed to the plant by the *Circa instans*. Thus the botanical knowledge Moderata

Fonte had displayed proudly in *Il merito delle donne* in 1600, by the second half of the nineteenth-century was mostly in the hands of the female peasantry, and old city folk, and was the object of interest of ethnologists. The intent of Coronedi from Bologna and Pitré from Sicily in publishing works on popular botany may have been to show to a recently united Italy, that what appeared to have been different customs may have had a common source. Coronedi may have proved her point: the *Circa instans* had originated in the School of Salerno, in Southern Italy in the 1100s, yet its effects could be felt among the Northern Italian peasantry of the nineteenth-century.[82]

Coronedi's study of popular Bolognese botany is relevant to the development of botany as a science in Italy, because it serves to illustrate that the knowledge of the healing properties of plants rested by then either in the hands of professionals in the health fields, or in the hands of the female peasantry by the mid of the nineteenth century. Ann Shteir found similar patterns for Britain, where by the second half of the eighteenth century many women in the gentrifying middle ranks were no longer familiar with traditional healing practices. They came to rely more on male physicians than on female skills. However, knowledge of the medicinal properties of plants continued amongst women of the lower classes. In Italy this knowledge still remained in the hands of a few elite women, because they had been instructed, and had received university degrees in the health sciences at a time when British universities were not accessible to women.[83]

As seen, elite women had shown interest in botany from, at least, the Middle Ages onwards. Until the eighteenth century, women's botanical knowledge could be drawn from Pliny's *Natural History*; but on the whole it rested in the medicinal properties plants

supposedly contained. This knowledge was very much in keeping with what male educators of the Renaissance and Baroque periods expected of women. As botany began to develop into a science in its own right in the course of the eighteenth century, aided to a great extent by the appearance of important works in plant physiology, and the artificial system of plant classification devised by Linnaeus, elite women became no longer interested in the healing properties of plants. This knowledge was found either in the hands of a few professional women doctors, and pharmacists, or in the hands of the female peasantry.

By the second half of the eighteenth century, reflecting changes in inheritance patterns in Italy, elite women applied botanical knowledge to agriculture, when running their own estates. Several of these women achieved considerable success in their enterprise, and had their works published in important journals, or rewarded by agricultural academies. The men who ran these journals, or academies could not ignore the successful practices in agriculture carried by these ladies in their own estates, particularly when improvements in agriculture became major concerns of governments, and of many scientific academies at the time.

Elite women also studied botany for its own sake. They took part in nature trips in order to collect plants, animals , and/or minerals during the second half of the eighteenth century, but left very few records of their activities behind. A considerable number of British women botanists wrote extensively about their botanical experiences. In fact, they contributed greatly to the popularization of the subject in Britain. In Italy the number of women botanists who were recognized as such by male botanists remained pitifully small. But, if Italian women botanists were few, they were probably more

systematically educated in botany than their British counterparts. Accustomed to the tradition of learned women, university professors, experts in the field of botany, did not object introducing these women, who already knew Latin, to a university level course of study on the subject. Italian female botanists did not attempt to make botany accessible to other women and children. They either carried their own research, and attempted to publish it, like Lena Perpenti and Fiorini Mazzanti, or worked in conjunction with male botanists associated with universities and botanical gardens, like Carolina Marchesi and Durazzo Grimaldi.

Some British women botanists might, and did achieve a high level of expertise in the field. But this expertise would not be recognized by their male counterparts by the fact that they were kept out of Royal Society, and the Linnean Society until the twentieth century.[84] Now Italian scientific academies welcomed some women as members, if they carried out research in their field of expertise. Thus, Fiorini Mazzanti's pioneering work on mosses and on lichens, ensured her membership in several distinguished scientific academies. An ordinary membership to the Academy of Lincei not only allowed Fiorini Mazzanti to present and publish her research, but also bestowed on her a professional status, which permitted her to be recognized as a botanist by her male counterparts, at a time when the field was specialized. By belonging to scientific institutions Elisabetta Fiorini Mazzanti and Caterina Scarpellini were able to be active in their respective fields at a time when to practice any science as an amateur had become increasingly difficult.

If Italian scientific academies were more welcoming to women botanists than their British counterparts, they greatly favoured men. As seen, similar contributions to botany by Clelia Durazzo and her uncle were not equally rewarded.

[1]Siraisi, *Medieval and Early Renaissance Medicine*, pp. 13, 57-58; Orofino, pp. 43-58.

[2]Benton, pp. 32-33, 41-45; Green, p. 453; De Renzi ed., *Collectio Salernitana*, Vol. II, pp. 160, 163, 165-67, 175, 180-81, 188-90, 253, 259-60, 262-65, 317-18; Thorndike ed., *The Herbal of Rufinus*, pp. xii-xvi.

[3]Thorndike ed., *The Herbal of Rufinus*, p. xvi; Cook, pp. 91-105.

[4]Findlen, *Possessing Nature*, pp. 155-93, 241-77, 58-61; Ambrosoli, pp. 100-21; Cunningham, pp. 38-56; Findlen, " Courting Nature ", pp. 57-74; for the description of plants in herbals see the description of *casella sanguinaria* in Thorndike ed., *The Herbal of Rufinus*, folio 35 rb.

[5]Findlen, " Courting Nature ", pp. 66-67; B.U.B.: *Aldrovandi* Ms. 101-I: Catalogus virorum qui visitarunt musaeum nostrum et manu propria...

[6]Morati, ' Dialogo di Lavinia della Rovere e di Olimpia ' in " Opere. Volume secondo...", p. 36; see Cereta's letters LXIII, December 12, 1487, LXX, February 29, 1487/88, and LVII, October 15, 1485 in Cereta, *Epistolae*, pp. 168-77, 214-20, 133-37; Robin, pp. 117-28; Rabil, *Cereta*, pp. 63-65.

[7]Fonte, pp. 114-30; Thorndike ed. *The Herbal of Rufinus*, ff. 19rb-vb, 20rb-va, 24 ra-rb, 23 rb, 17rb, 29vb-30rb, 66va-vb, 74rb-va, 102rb-va, 90ra, 94vb-95ra, 46ra, 53rb, 62ra, 63ra, 22vb, 64ra, 98va, 50rb, 43rb, 65ra, 63va, 110rb, 72rb, 34vb, 46vb, 7rb, 77va-vb, 71rb.

[8]Piccolomini, *Della institutione morale*, p. 549; Antoniano, pp. 27r-28v; Da Montefeltre, pp. 201-03, 205, 207, 212.

[9]Lugano ed., pp. 170-73, 234, 242-43, 282-83; Masetti Zannini, " Una canonichessa erborista...", pp. 396-97; Cortese, pp. 3r, 3-16, 4r-8v, 84-94, 98-205.

[10]See Maria Celeste's letters no. XVIII, XIX, XXV, XXVIII, XXXIII, XXXVIII, XXXIX, LVII, LXVIII, LXIX, LXXI, CI, LIII in Viviani della Robbia, pp. 22, 28, 31, 37, 44, 47, 74-75, 85, 86, 88, 90, 138, 69; Fonte, pp. 121, 119, 118, 116, 115, 120.

[11]Hales, *Statica dei Vegetabili*, pp. 22, 102, 105-06, 112-16.

[12]For attempts to improve agriculture in Northern Italy in the Renaissance, see Ambrosoli, pp. 41-162; Braudel, pp. 284-87.

[13]Pasta, " L' Accademia dei Georgofili...", pp. 448-50; Venturi, *Settecento riformatore*, V, Tomo secondo, pp. 64-70; Ciancio, p. 179; Caminer Turra, " Memoria che ha ricevuto il premio...", *G.E.*, (aprile 1774), pp. 33-36.

[14]Women dealing in trade on their own accord had a degree of autonomy from husbands elsewhere in Northern Italian city states. Normally under Roman law, and then the Napoleonic Code, women needed the husband's authorization for the sale of property, but she could administer her mobile, or immobile property not belonging to the dowry; see Maria Teresa Silano, " La sottomissione legalizzata. Le donne e i codici fra settecento e ottocento " in *Esistere come donna*, pp. 73-78.

[15]" Accademie ", *N.G.E.*,(marzo 1786), pp. 110-12.

[16]Marietta Pagani, " Pratiche municipali che osserva nell' alievo de' cavalieri la Nob. Signora Marietta Pagani nobilissima dilettante di Belluno, da essa pubblicate con esatezza tanto le univoche quanto le discordanti dagli importanti ricordi dati in luce del chiariss. nob. sig. Conte e Cav. Enrico Mazzi ", *Nuovo giornale d' Italia spetante alle scienze naturali, e principalmente all' agricoltura, alle arti e al commercio*, T. I, no. 3, (Venezia 1789), pp. 22-24; see also P.W. Gaddum, *Silk How and Where It Is Produced*, (Chesire: H.T. Gaddum & Company, 1968), pp. 9-13.

[17]For San Martino's article see " Sulla coltivazione del formento...", *N.G.E.*, (settembre 1786), pp. 72-86; for Dondi Orologio's results see " Lettera del S. Marchese Antonio Dondi Orologio...al p. Gio: Battista de San Martino...", *Opuscoli scelti sulle scienze e sulle arti*, T. XII, (1789), pp. 285-88; S.C.M.D.C., " Memoria sul grano carbone che i Francesi chiamano *bled noir* e dai contadini milanesi si chiama *grado*", *Opuscoli scelti sulle scienze sulle arti*, T. XII, (1789), pp. 95-98. In the article she referred herself by her initials, Ferri identified her as the Countess Marianna di Coconato Rudianti.

[18]Di Coconato, pp. 95-98.

[19]Smuts are caused by Basidia-bearing fungi of the *Ustilaginaceae* and *Tilletiaceae* families. Seed treatment is only effective in seedling infection when the smut spore adhere to the outside of the grain; for flower infection seed treatment is ineffective, see J.W. Harshberger, *Mycology and Plant Pathology*, (Philadelphia: Blakiston, 1977), pp. 177-85; the plant Coconato referred to is probably the *muscari comosum*, see F.C. Tutin et al., *Flora Europea*, Vol. 5, (Cambridge: Cambridge University Press, 1976), p. 47; Di Coconato, pp. 95-98; Dondi Orologio, pp. 285-88.

[20]Castracane, pp. 313-14; " Communicazione sulla malattia del calcino. Estratto della Contessa E. Fiorini ", and " Nota della Contessa Elisabetta Fiorini Mazzanti riguardo agli avvertimenti che precedono sulla crittogama degli olivi-avvertimenti di Mons. Leonardo Ciuffa ", *A.A.P.N.L.*, T. XI, (1857-1858), pp. 432-36 and T. XIII, (1859-1860), pp. 202-03, respectively.

[21]Silano, pp. 73-78; during the Renaissance, Venetian women appear to have received more mobile property see Donald E. Queller and Thomas F. Madden, " Father of the Bride: Fathers, Daughters, and Dowries in late Medieval and Early Renaissance Venice ", *Renaissance Quarterly*, Vol. XLVI, no. 4, (Winter 1993), pp. 685-711; for Tolmezzo, see " Coloquio sopra gli studi delle donne di A. Francesco Janisi del Tolmezzo, Udine 1774 ", *G.E.*, (agosto 1775), pp. 124-27.

[22]For Teotochi, Sassi and Segré see letters no. 62: April 17, 1766, no. 84: June 6, 1767, no. 85: October 5, 1767, no. 92: March 28, 1768 in Vol. I, pp. 87, 145, 148, 154; see letter no. 1254: December 30, 1792 in Vol. IV, pp. 38-87; letter no. 1472: January 6, 1795 in Vol. V, pp. 228-30 of Spallanzani, *Epistolario*.

[23]For Caminer Turra's extracts see *E.L.*, (ottobre 1771), pp. 47-48; *E.L.*, (aprile 1772), p. 35, 86; *N.G.E.* (marzo 1784), pp. 93-95; *N.G.E.* (aprile 1788), pp. 85-105; *N.G.E.*, (agosto 1788), pp. 88-89; *N.G.E.*, (marzo 1789), pp. 38-44.

[24]For Britain see Ann. B. Shteir, " Botany in the Breakfast Room. Women and Early Nineteenth Century British Plant Study " in *Uneasy Careers and Intimate Lives...*, Abir-Am and Outram eds., pp. 31-43; see also Ann B. Shteir, *Cultivating Women, Cultivating Science. Flora's Daughters and Botany in England, 1760 to 1860*, (Baltimore: The Johns Hopkins University Press, 1996), pp. 16-18, 107-45,197-231; Londa Schiebinger, " Gender and Natural History " in *Cultures of Natural History*, pp. 163-77; L. Marinelli, *Della nobiltà et eccellenza delle donne*, pp. 33v, 41v, 45v-46r; Tarabotti, *Che le donne siano...*, pp 18, 43, 65, 68, 91-92; Fonte, pp. 113-130.

[25]See G.B. Brocchi's letters to Fiorini from Milan of August 18, 1821 and September 8, 1821 in Tiberio Roberti, *Alcune lettere inedite di G.B. Brocchi dirette alla Contessa Fiorini Marzanti* (it should read Mazzanti), (Feltre: Castaldi, 1902), pp. 10-11,13.

[26]Candida Lena Perpenti, " Descrizione di una nuova campanula ", *Biblioteca italiana*, T. V, (gennaio 1817), pp. 133-34; see also Ferri, pp. 282-83; for a modern description of the *Campanula raineiri* see Tutin et al., *Flora Europea*, Vol. 4, p. 79; Hearder, pp. 30-32; for Moscati see Redondi, pp. 698-708; Candida Lena Perpenti, " Sulla filatura dell' amianto ", *Giornale della società d' incoraggiamento delle scienze e delle arti*, no. 10, (ottobre 1808), pp. 330, 334; Hearder, pp. 27-30.

[27]Lena Perpenti, " Sulla filatura dell'amianto ", pp. 328-3. The prize was given by Viceroy E. Beauharnais and the government of the Kingdom of Italy; for the political situation in Northern Italy see Hearder, pp. 27-30.

[28]Lena Perpenti, " Sulla filatura dell' amianto ", pp. 329-32, 334; see Hearder, pp. 27-30; for a history of asbestos see Melvin A. Bernarde, *Asbestos the Hazardous Fiber*, (Boca Raton: CRC Press, 1990), pp. 3-12.

[29]Shteir, ' Botany in the Breakfast Room ", pp. 33-43; for Durazzo Grimaldi see Antonio Bertoloni, " Elogio della nobil donna Clelia Durazzo Grimaldi " in *Elogi...*, pp. 19-27.

[30]Antonio Bertoloni, " Elogio del cav. Ippolito Durazzo ", in Bertoloni, *Elogi...*, pp. 6-16.

[31]Bertoloni, " Elogio della nobil donna...", pp. 19-27; the same biography also appeared in Luigi Grillo, *Elogi di liguri illustri*, T. III, (Turin: Fontana, 1846), pp. 237-46; for Diego Pascal see Ireneo Alfò ed., " Diego Pascal " in *Memorie degli scrittori e letterati pamigiani racolte dal Padre Ireneo Alfò*, T. VII, (Parma: Ducale tipografia, 1833), pp. 647-48; Durazzo Grimaldi remained at Parma until 1803, but she resided in Genoa at least from April 1801 to October 1801 see her letter to Father Domenico Nocca, professor at Pavia no.1: Genoa April 1, 1801, no.2: Genoa, April 25, 1801, no.3: Parma, March 18, 1802, no. 4: Parma, January 29, 1801, no.5: Parma, March 1803, no.6: Genoa, September 1801, and no.7: Genoa, March 30, 1804 in B.U.G.: Msc. VII. 36: *Coppia di lettere (7) esistenti nella R. Biblioteca Universitaria di Pavia della March. Clelia Durazzo Grimaldi al Pa. Nocca Domenico.*

[32]Canonici Fachini, " Clelia Durazzo Grimaldi ", p. 241; Bertoloni, " Elogio della nobil donna...", pp. 23-27; for A. Bertoloni see Daniele Merozzi, " L'età napoleonica e la restaurazione ", *L'Università di Bologna, maestri, studenti e luoghi del XVI al XX secolo*,C.P. Brizzi, Lino Marini, Paolo Pambeni eds., (Bologna: Silvan, 1989), p. 33; for her return to Genoa see letter no. 7, and introduction in B.U.G: Msc. VII . 36.

[33]Bertoloni, " Elogio della nobil donna...", p. 22; for Nocca's discovery see Domenico Nocca, *Ticinensis Horti Academici plantae selectae quas descriptionibus illustravit, observationibus auxit Domenicus Nocco*, Fasciculus Primus, (Ticino: Galeati, 1800), pp. 7-8; see Durazzo Grimaldi's letters nos. 1 to 7 to Nocca in B.U.G.: Msc. VII . 36; interestingly enough the *ornothogalum grimaldiae* was not amongst the plants of her garden n 1812, and what Von Schrank named as the *Grimaldia assurgens*, continued to be referred in Grimaldi's 1812 catalogue by its former name *Cassia nichitans*, see Clelia Durazzo Grimaldi, *Catalogue des plantes cultivées dans le jardin de Madame Durazzo de Grimaldi à Pegli. Département et arondissement de Gènes*, (Genoa: Bonardo, 1812), pp. 5, 14.

[34]Durazzo Grimaldi, *Catalogue...*, pp. 15, 13; Tutin et al., *Flora Europea*, Vol. 2, pp. 193, 299-300.

[35]Durazzo Grimaldi, *Catalogue...*, pp. 1-22, particularly, p. 8; for digitalis see Ackercknecht, p. 131; for a list to Bertoloni's books, see his letter to Ranzoni of September 1, 1816 in B.U.B.: Ms. 2086: *Carteggio Ranzoni*, Lettere A-B, no. 37: Bertoloni Prof. Antonio celebre botanico, 13 lettere (1816-1839); one of her books on herbal remedies was Mattioli's *Discourses on Dioscorides* (1557), for Grimaldi's books see B.C.B.Ge.: M.R. VII . 5 . 8: *Catalogo de' libri bottanici legato della Msa.Clelia Durazzo Grimaldi alla Biblioteca Civica Berio, 1837*, which one assumes is the date of her death.

[36]Bertoloni's letter to Ranzoni of September 1, 1816 in B.U.B.: Ms. 2086: *Carteggio Ranzoni*, lettere A-B, no. 37.

[37]*Ibid.*; see also her letter no. 7 to Nocca of March 30, 1804 in B.U.G.: Msc. VII . 36.

[38]See Bertoloni's letter of September 1, 1816 in B.U.B. : Ms. 2086: *Carteggio Ranzoni*, Lettere A-B, no. 37; *Catalogo dei libri...* in B.C.B.Ge.: M.R. VII . 5. 8, pp. 1-22; Sillano, p. 74.

[39]*Catalogo dei libri...* in B.C.B.Ge.: M.R. VII. 5.8, pp. 1-22; for the contents of Ingehousz's and Senebier's works see Nash, " Plants and the Atmosphere ", pp. 369-419.

[40]*Catalogo dei libri...* in B.C.B.Ge.: M.R. VII. 5. 8, pp. 2-14.

[41]Giulio Barsanti, *La scala, la mappa, l' albero. Immagini e classificazioni della natura fra sei e ottocento*, (Florence: Sansoni, 1992), pp. 204-26; *Catalogo dei libri...* in B.C.B.Ge.: M.R. VII. 5. 8, pp. 5-6, 15, 7, 4.

[42]Bertoloni made no mention in his eulogy of any academic membership held by Grimaldi; it was standard information in all eulogies, see Bertoloni, " Elogio della nobil donna...", pp. 19-27; Bertoloni, " Elogio del Cav. Ipollito...", pp. 14-16; for Scarpellini's membership see introduction in Scarpellini, *Catalogo degli uranatmi...anni 1861, 1862...*; for female membership at the Linnean Society see Shteir, *Cultivating Women...*, p. 236; for Fiorini Mazzanti's membership see A.E.A.G.F.: *Archivio storico Inventario 1753-1911*, Vol. 4: *Indice alfabetico*, (Florence, 1917), p. 233.

[43]The main source on her life is her friend Castracane's eulogy at the time of her death. See Castracane, pp. 307-28; for her death, see the death notice sent by her adopted daughter Enrichetta Fiorini to the Academy of Georgofili " Partecipazione della morte di Elisabetta Fiorini Mazzanti ", Roma, 23 aprile 1879 in A.E.A.G.F.: *Archivio storico*, Busta 37, no. 5149; for the Academy of Lincei see Maylender, " Accademia dei Lincei ", pp. 430-503, particularly pp. 488-90. Fiorini was the only woman member of the academy at the time.

[44]The political situation was unstable in the Papal States for most of Fiorini's life. The family appeared very much associated with the papacy and its court, see Castracane, pp. 309-14; Hearder, pp. 96-124; see Brocchi's lettter to Fiorini of June 26, 1821 in Roberti, pp. 5-6; see also the letter, one suspects, of the secretary of the Pontificial Academy of the New Lincei to the cardinal protector of the academy, anno XXXII, January 9, 1879 in P.A.S.V.C.: " Fiorini Mazzanti Elisabetta "; for Brocchi see V. Giacomini, " Brocchi Giovanni Battista ", *D.B.I.*, Vol. 14, pp. 396-99.

[45]*Conchiologia fossile subalpina* is considered the most important Italian paleontological work of the nineteenth-century; see Giacomini, pp. 396-97; Ciancio, pp. 72n, 95n, 197n, 227, 252n, 287-89.

[46]Castracane, p. 312; see also Brocchi's letter to Fiorini dated Milan, August 18, 1821 in Roberti, pp. 10-11.

[47]See Castracane, p. 312; see Elisabetta Fiorini's letters to Brocchi no.601: Castellone, June 30, 1821; no. 599: Castellone, June 10, 1821; no. 602: Castellone, August 16, 1821; no. 603: Castellone: September 17, 1821; no. 604: Castelone, October 5, 1821 in B.C.B.G.: *Epistolario di Giambattista Brocchi*, III. 22. 599-609: Lettere di Elisabetta Fiorini; see also Brocchi's letters to Fiorini dated Rome, June 26, 1821; Rome, July 22, 1821; Milan, January 26, 1822 in Roberti, pp. 5-8, 15-16.

[48]See Fiorini's letters to Brocchi no. 599, no. 602, no. 603, no. 604 dated as above and no. 605: Terracina, November 14, 1821; no. 606: Terracina, February 12, 1822; no. 607: Rome, June 13, 1822; no. 608: Rome, January 25, 1823; no. 609: Rome, October 19, 1824 all in B.C.B.G.: *Epistolario di Giambattista Brocchi*, III. 22. 599-609; see also Brocchi's letters to Fiorini dated Rome, July 22, 1821; Rome, August 1, 1821; Milan, August 18, 1821; Milan August 18, 1821; Milan September 8, 1821; Bleyberg in Carinthia, November 21, 1821; Milan, January 26, 1822 in Roberti, pp. 6-16; for Acerbi see D. Visconti, " Acerbi Giuseppe ", *D.B.I.*, Vol. 1, pp. 134-36; for Mauri see E.Ca., " Mauri Ernesto ", *Enciclopedia italiana*, Vol. 22, p. 612; for Bertoloni see V. Giacomini, " Bertoloni Antonio ", *D.B.I.*, Vol. 9, pp. 610-11.

[49]See Brocchi's letter to Fiorini from Rome, July 22, 1821 in Roberti, pp. 6-8; Castracane, p. 313; Elisabetta Fiorini, " Notizia sopra poche piante da aggiunsersi al Prodromo della Flora Romana ", *Giornale arcadico di scienze, lettere ed arti*, T. XVIII, (1823), pp. 161-68; Elisabetta Fiorini, " Appendice al Prodromo della Flora Romana ", *Nuovo Giornale de' letterati*, T. XVII: *Scienze*, (1828), pp. 110-32; Fiorini was already member of the two academies by the time of her next publication in 1831; see the introduction to Elisabetta Fiorini Mazzanti, " Specimen bryologia romanae ", *Giornale arcadico di scienze, lettere ed arti*, T. LI, (1831), p. 3; for Carlo Luciano Bonaparte see Castracane, p. 313; Hearder, pp. 110, 114-15.

[50]Castracane, pp. 314-18; Fiorini Mazzanti, "Specimen bryologia..." (1831), pp. 3-26; F. Garbari, " De Notaris Giuseppe ", *D.B.I.*, Vol. 38, pp. 773-74; for her membership to the Turin Academy of Sciences see Elisabetta Fiorini Mazzanti, *Specimen bryologiae romanae auctore Elisabetta Fiorini Mazzanti Academiarum Horticult. Bruxellen. Reg. Scientiarum Taurinensis aliorumque socia*, (Rome: Crispini Puccinelli, 1841).

[51]Fiorini Mazzanti, " Specimen bryologia..." (1831), pp. 3-26.

[52]Fiorini Mazzanti, *Specimen bryologia...*, (1841); for a very useful review of the work, by a botanist at the time see Enrico Castreca Brunetti, " Specimen bryologiae romanae auctore Elisabetta Fiorini Mazzanti Academiarum Horticul. Bruxellen. Reg. Scientiarum Taurinens. aliorumque socia. Romae typ. Crispini Puccinelli 1841 in 8 fasc. 56 ", *Giornale arcadico di scienze, lettere ed arti*, T. XCII, (1842), pp. 47-50; Garbari, pp. 775-77.

[53]Brunetti, " Specimen bryologia, pp. 47-50; W.H. Schimper ed., *Bryologia Europeae seu genera muscorum europearum*, Vol. I, (Stuttgart: Schweizerbart, 1836-85), pp. 7-8, 18,

3; Garbari, pp. 776-77; see the mosses section of Elisabetta Fiorini Mazzanti, " Florula del Colosseo, communicazione della Sig. Contessa Elisabetta Fiorini Mazzanti ", *A.A.P.N.L.*, Tommo XXX, (1876-1877), pp. 99-105, 156; for her correspondence see Castracane, p. 319. The differences in the type of information found in the different species might have been caused by the fact that Fiorini, already ill with cancer, had lost the whole cryptogamic section of the Coliseum flora, and had to start again, and thus, could not, in all cases, be as accurate as she wished; see her letter to the secretary of the Pontificial Academy of the New Lincei of June 15, 1878 in P.A.S.C.V.: " Fiorini Mazzanti Elisabetta".

[54]For the deaths of husband and teenage daughter see Fiorini's letters to Salvatore Betti no. 4: no date, but probably a few days after October 13, 1841, no. 1: November 5, 1841, and no. 2: July 3, 1842 in B.N.C.V.E.R.: Cat. A. 64. 8: *Lettere autografe di Fiorini Elisabetta vedova Mazzanti dirette a Betti Salvatore*; Castracane, pp. 316-18; for her membership to the Academy of Georgofili see A.E.A.G.F.: *Archivio storico*, no. 2769: Elisabetta Fiorini ved. Mazzanti a Luigi Ridolfi, Firenze, 22 giugno 1852; for her reading of the memoir see " Adunanza ordinaria del di 5 settembre 1852 ", *Rendiconti delle adunanze della R. Accademia Economico-Agraria dei Georgofili di Firenze*, Vol. I-Triennio I, An. 1851-52-53, (Florence: Galileiana, 1853), pp. 365-66.

[55]Lichens are associations of fungi and algae in a relationship of mutualism, a type of symbiosis. The fungal component (mycobiant) in the case of *collema* is an ascomycete (sac fungus) which succeeded in establishing a symbiotic relationship with a blue green algae, the *nostoc* (the phycobiant), see E. Hale Jr., *The Biology of Lichens*, (London: E. Arnold, 1967), pp. 1, 150; Gunnar Degelius, *The Lichen Genus Collema in Europe: Morphology, Taxonomy, Ecology*, (Upsala: Lundequistska, 1954), pp. 16-24.

[56]A.E.A.G.F.: *Archivio storico*, Busta 81, ins. 1378: 5 settembre 1852, cc. 6, " Memoria letta dalla sig. Contessa Elisabetta Fiorini di Roma, socia corrispondente, nell' addunanza ordinaria del di 5 7bre 1852 ", pp. 1r, 3r-5r. I would like to thank Dott.[essa] Daniela de Luca Picione of the Academy of Georgofili for providing me with photocopies of the material, as access to the academy's archives was impossible due to unfortunate bomb damage on May 27, 1993.

[57]For her election see *A.A.P.N.L.*,T. IX, (1855-1856), pp. 4-47, 70 and Vol. X, (1856-1857), pp. V-XV; for her attendance see, for instance,T. XV, (1861-1862), pp. 69, 151, 208, 279, 305, 407, 455, 461. During 1870, perhaps due to political troubles in Rome, Fiorini missed all the sections see *A.A.P.N.L.*,T. XXIII, (1869-1870), pp. 82, 124, 157, 198, 217, 230, 258; Hearder, pp. 244-45; during the last three to four years of her life, Fiorini, probably already ill with cancer of the tongue, missed many meetings; although she communicated with the secretary by letter, and continued to publish her " Florula del Colosseo"; for her attendance then see *A.A.P.N.L.*, T. XXIX, (1875-1876), p. 467 and T. XXXI, (1877-1878), pp. 374, 461; for her letters to the secretary of the academy related to the publication of the " Florula..." see P.A.S.C.V.: " Fiorini Mazzanti Elisabetta ".

[58]Elisabetta Fiorini Mazzanti, " Sulla identità del nostoc con il collema. Osservazioni di Elisabetta Fiorini Mazzanti ", *A.A.P.N.L.*, Vol. XI, (1857-1858), pp. 1-10, 103-13.

[59]*Ibid.*, pp. 5-7.

[60]See table IV, figs. 28, 29, 3, table V, figs. 32, 33, 34 in *Ibid.*, pp. 5, 7, 8-9; for algal reproduction and vegetative diaspores see Hale J., pp. 6-10, 20-22, 39-40.

[61]Fiorini Mazzanti, " Sulla identità del nostoc...", pp. 103-05, 108; for modern drawings of asci, see Degelius, pp. 85-90.

[62]Fiorini Mazzanti, " Sulla identità del nostoc...", pp. 106-07; Degelius, pp. 93-96.

[63]Fiorini Mazzanti, " Sulla identità del nostoc...', pp. 106-07; Degelius, pp. 18-19.

[64]Degelius, pp. 24-25; Fiorini Mazzanti, " Florula del Colosseo...", *A.A.P.N.L.*, T. XXXI, (1877-1878), pp. 157-61; there is still debate on the exact relationship between the alga and fungus in the lichen, and on the lichen's reproduction, see Hale Jr., pp. 39-48.

[65]Fiorini Mazzanti, " Florula del Colosseo...", *A.A.P.N.L.*, T. XXXI, (1877-1878), p. 158; Elisabetta Fiorini Mazzanti, " Nota critica sull' anormalità di un organismo crittogamico della sig. Contessa E. Fiorini Mazzanti ", *A.A.P.N.L.*, T. XXIV, (1870-1871), pp. 190-92.

[66]Elisabetta Fiorini Mazzanti, " Sovra una nuova specie di *Palmodityon* e sovra un singolare organismo di alga unicellulare. Nota di Elisabetta Fiorini Mazzanti ", *A.A.P.N.L.*, T. XVIII, (1864-1865), pp. 377-79; for diatoms see H.C. Bold, *The Plant Kingdom*, (Englewood Cliffs: Prentice-Hall, 1965), p. 19.

[67]Elisabetta Fiorini Mazzanti, " De novis microphyceis...", *A.A.P.N.L.*, T. XIII, (1859-1860), pp. 259-60; E. Fiorini Mazzanti, " Cenno sulla vegetazione della delle Marmore in una rapida escurzione di luglio...", *A.A.P.N.L.*, T. XXII, (1868-1869), pp. 143-44; E.Fiorini Mazzanti, " Sopra due nuove specie crittogamiche...", *A.A.P.N.L.*, T. XXVII. (1873-1874), pp. 101-03; E. Fiorini Mazzanti, *Sovra due nuove alghe delle acque albule della Sig.ra Elisabetta Fiorini Mazzanti*, (Roma: G. Menaconti, 1857); E. Fiorini Mazzanti, " Osservazione sulla materia colorante delle *Calothrix jantiphorae* e diagnosi di una nuova microficee...", *A.A.P.N.L.*, T.XVII, (1863-1864), pp. 101-03; E. Fiorini Mazzanti, " " Botanica: Sopra una nuova diatomea ", *A.A.P.N.L.*, T. X, (1856-1857), pp. 1-11; E. Fiorini Mazzanti, " Retificazione di una nuova diatomea ", *A.A.P.N.L.*, T. XV, (1861-1862), pp. 83-84.

[68]E. Fiorini Mazzanti, " Microficee osservate nell' acque minerali di Terracina...", *A.A.P.N.L.*, T. XIV, (1860-1861), pp. 235-40; E. Fiorini Mazzanti, " Continuazione delle microficee delle acque minerali di Terracina...", *A.A.P.N.L.*, T. XVI, (1863-1864), pp. 631-33; E. Fiorini Mazzanti, " Continuazione e fine delle microficee delle acque minerali di Terracina...", *A.A.P.N.L.*, T. XX, (1866-1867), pp. 133-34.

[69]For control of her properties, and her assistance to Acerbi, see Castracane, pp. 313-14; E. Fiorini Mazzanti, " Comunicazioni sulla malattia del calcino...", *A.A.P.N.L.*, T. XI, (1857-1858), pp. 432-36.

[70]E. Fiorini Mazzanti, " Nota della Contessa Elisabetta Fiorini Mazzanti, riguardo agli avvertimenti che precedono [sulla crittogama degli olivi...] ", *A.A.P.N.L.*, T. XII, (1859-1860), pp. 202-03.

[71]Fiorini Mazzanti, " Florula del Colosseo...", *A.A.P.N.L.*, T. XXVIII, (1874-1875), pp. 9-13; see her letter to the academy's secretary of June 15, 1878 in P.A.S.C.V.: " Fiorini Mazzanti Elisabetta "; E. Fiorini Mazzanti, " Nota critica sull' anormalità di un organismo crittogamico...", *A.A.P.N.L.*, T. XXIV, (1870-1871), pp. 190-92.

[72]Fiorini Mazzanti, " Florula del Colosseo, Comunicazione II...", *A.A.P.N.L.*, T. XXVIII, (1874-1875), pp. 129-30, 133; Tutin et al., *Flora Europea*, Vol. 2, pp. 206-11, vol. 5, pp. 71-74. For other variations see Fiorini Mazzanti, " Florula del Colosseo. Comunicazione III " *A.A.P.N.L.*, T. XXVIII, (1874-1875), p. 257; Fiorini Mazzanti, " Florula del Colosseo. Comunicazione VII " and "... Comunicazione X" all in *A.A.P.N.L.*, T. XXIX, (1875-1876), pp. 55-56, 368 respectively; Tutin et al, *Flora Europea*, Vol. 1, pp. 252-59, Vol. 2, p. 246, Vol. 3, p. 79.

[73]Fiorini Mazzanti, " Florula del Colosseo. Comunicazione X ", *A.A.P.N.L.*, T. XXIX, (1875-1876), pp. 459-66; Tutin et al., *Flora Europea*, Vol. 4, pp. 103-410.

[74]See her letter to the academy's secretary of June 15, 1878 in P.A.S.C.V.: " Fiorini Mazzanti Elisabetta "; Fiorini Mazzanti, " Florula del Colosseo...", *A.A.P.N.L*, T. XXX, (1876-1877), pp. 98-105 and *A.A.P.N.L.*, T. XXXI, (1877-1878), pp. 155-67.

[75]See the introduction in E. Fiorini Mazzanti, " Florula del Colosseo. Comunicazione 1ª...", *A.A.P.N.L.*, T. XXVIII, (1874-1875), pp. 9-13; for Caterina Scarpellini see Scarpellini, *Gli uranatmi...novembre 1868;* Scarpellini, *Catalogo degli uranatmi*; for gender and science see Merchant, *The Death of Nature...*; Fox-Keller, *Reflections on Gender...*; Fox-Keller, *A Feeling for the Organism...*; Merchant, " Isis' Consciousness Raised ", pp. 398-409; M. Benjamin ed., *Science and Sensibility....*

[76]Maylender, " Accademia dei Lincei", Vol. III, pp. 490-91; for her membership to the Royal Academy of Lincei see " Elenco dei soci attuali della Reale Accademia dei Lincei ", *Atti della Reale Accademia dei Lincei*, T. XXIV, (1870-1871), pp. V-VI, 125-28; for her loss of membership see " Comitato segreto ", *Atti della Reale Accademia dei Lincei*, T. XXVI, (1872-1873), p. 568; see the Pontificial Academy secretary's letter to the papacy anno XXXII , 5 gennaio 1879 in P.A.S.C.V.: " Fiorini Mazzanti Elisabetta "; for Scarpellini's medal see Lagrange, p. 525.

[77]G.C. Giacobbe, " Castracane degli Antelmini Francesco Saverio Giuseppe Baldassare ", *D.B.I.*,Vol. 22, pp. 191-94; Castracane, pp. 321-23.

[78]Castracane, p. 326.

[79]I assume Trippi was examined in her botanical knowedge related to pharmacy in 1796, as her student Baldoncelli would be in 1807; for Trippi see A.S.B.: *Archivio di Studio no. 295*; for Baldoncelli see ' Sabina Baldoncelli', " Farmacia " in A.S.B.: *Archivio di Studio no. 549*; Fasc. no. 1 in A.S.B.: *Archivio di Studio no. 567*; see theses LV and LVI in Dalle Donne, *Theses ex Universa Medicina...*; for the degrees in the health sciences given at the University of Bologna to women at the time see ' Allegato: elenco di figure femminili collegate alla storia dell' Università di Bologna' in A. Barozzi, V. Toschi, " Presenza femminile nella cultura tecnico-scientifica tra la fine del Ottocento gli inizi del Novecento " in *Alma Mater Studiorum*, pp. 207-08.

[80]Roversi, pp. 156-58; for ethnology in Britain see Michael T. Bravo, " Ethnological Encounters " in *Culture of Natural History*, pp. 338-357.

[81]Carolina Coronedi Berti, " Appunti di botanica bolognese ", *La Rivista Europea*, anno VI, Volume IV, fasc. I, (1875), pp. 36-46; Roversi, pp. 156-58.

[82]Coronedi Berti, " Appunti di botanica...", pp. 36-44-45; Carolina Coronedi Berti, " Appunti di medicina popolare bolognese ", *Rivista di letteratura popolare*, Vol. I, fasc. I, (1877), pp. 1-12; for some coincidences with the *Circa instans*, and the *Herbal of Rufinus* see Thorndike ed., *The Herbal of Rufinus*, fol. 23rb, 66 rb, 68 vb, 88vb, 13 ra, pp. 26, 177, 186, 253, 419; Fonte, pp. 114, 130; Bravo, pp. 340-41; Shteir, *Cultivating Women...*, pp. 37-39.

[83]Shteir, *Cultivating Women...*, pp. 37-39.

[84]For English scientific societies' memberships for women, and an example of a learned British woman botanist see Agnes Ibbetson in Shteir, *Cultivating Women...*, pp. 120-35, 236; Greco, pp. 446-47.

Chapter VIII

From Learned Ladies to Teachers of Men: Doctors of Philosophy

Thirteenth century manuscripts of the Salernitan Medical School showed women physicians treating patients, assisted by men (students) in subordinate roles. Dorotea Bocchi supposedly taught her father's students medicine at the University of Bologna in the fourteenth-century, and received remuneration for her efforts. In the early sixteenth century Teodora Danti had taught astronomy and mathematics to the younger members of her family. In the eighteenth and nineteenth centuries respectively, the father of Diego Vitrioli, Maria Angela Ardinghelli's biographer, appears to have been one of her students, and Elisabetta Fiorini Mazzanti instructed, and greatly assisted Francesco Castracane when he entered the field of diatoms. Whereas, Danti's, Ardinghelli's and Fiorini Mazzanti 's teaching was dissociated from institutions, the women physicians of Salerno appear to have operated within a guild system, and while Bocchi's teaching cannot be corroborated by contemporary sources, there are no doubts as to the teaching positions, associated with publicly-funded institutions, offered Laura Bassi Verati, Cristina Roccati, Maria Gaetana Agnesi and Anna Morandi Manzolini in the eighteenth-century.[1]

Two of these women, Bassi and Roccati had degrees in philosophy from the University of Bologna, and thus were officially qualified to hold teaching positions. Agnesi and Morandi Manzolini had no degrees, but the publication by Agnesi of her one hundred and ninety one philosophical theses in 1738, and of her mathematical opus, *Instituzioni analitiche* in 1748, left little doubts as to Agnesi's extensive knowledge in

natural philosophy and mathematics. Morandi Manzolini's extensive practice and skill in dissecting, and in the preparation of models in wax of anatomical parts also left few doubts of her knowledge in practical anatomy, and of her competence to teach the subject.

Bassi and Roccati were to take up their official positions, but not before having to overcome a few obstacles on their paths. Bassi's position as lecturer in universal philosophy at the University of Bologna never translated into regular teaching at the institution. After many years of teaching experimental physics at home, in 1776 she was finally allowed to teach the subject at a public institution (The Institute of Sciences of Bologna) on a regular basis. Roccati's attempts to get a position at the University of Padua after her degree, never materialized. She had to make do with the position of lecturer in general physics at the Institute of Sciences of Rovigo, her hometown. In spite of being offered a lectureship in mathematics at the University of Bologna, at the request of Pope Benedict XIV in 1750, Agnesi never came to teach at the institution. Instead her teaching was achieved through her *Instituzioni analitiche*, a mathematics textbook, which enjoyed considerable popularity amongst students and professors of the subject in Italy, and in some colleges in France, even after its author had given up completely her interest in the sciences. Although salaried by the University of Bologna, Morandi Manzolini taught practical anatomy, and demonstrated her wax-modelling skills at home. Nevertheless, her anatomical preparations in wax were to teach students at the Institute of Sciences of Bologna during her lifetime, and years after Morandi Manzolini had died, much like what Agnesi's book would do. All these women, without exception, were awarded degrees, and/or positions at the University of Bologna, and its associate

institution, the Institute of Sciences, because of a belief on the part of those who governed the town and the university that women had been awarded degrees, and positions of lecturers in the past, and therefore had set precedents which other women could follow.[2]

I. *Laura Bassi Verati: Professor of Experimental Physics*

Laura Bassi was the first woman in Italy to receive a degree since Piscopia had received hers in 1678. That same year, 1732, she was made an ordinary member of the publicly-funded Academy of Sciences of Bologna and was offered a lectureship in universal philosophy at the University. In 1745, Bassi became a member of the newly founded Benedittina Academy, which had been created within the Academy of Sciences by Pope Benedict XIV and named after him. This membership allowed her access to the cabinets, and materials of the Institute of Sciences, and gave her the right to present every year a dissertation based on her own research to the meetings of the Academy of Sciences. These dissertations covered the topics of mechanics, optics, electricity, the physics and chemistry of gases, and capillarity. In 1766, Cardinal Alessandro Albani, Cardinal Protector of the Collegio Montalto, nominated Bassi as preceptor to the college's students in experimental physics. Finally, in 1776, Bassi was made professor of experimental physics at Institute of Sciences, a larger body of which the Academy of Sciences was part. These last two nominations came after many years of teaching experimental physics at home to students attending the university. In all it may be said that Bassi managed to have a career in the sciences which approached that of modern women scientists, for it combined teaching and research in physics.[3] Since, as the

previous chapters illustrate amply, it was easier for Italian women of the aristocracy and professional elites to get an education in the sciences, than to actually produce them, Bassi, determined to play a relevant role in the scientific life of her town, was to experience many of the difficulties women of the later centuries encountered when they attempted to be active in their scientific fields.[4] That Bassi was able to overcome some of these difficulties and carve a scientific career for herself, is testimony of her sheer determination, the role tradition played, powerful allies, and of the fact that she was ready to apply to these allies over the heads of local authorities, when need required.

The only surviving child of a lawyer, Laura Maria Caterina Bassi (1711-1778) began to study French, Latin, arithmetic, and one assumes, Italian at the age of five, under the supervision of her cousin, Father Lorenzo Stegani. The family doctor, Gaetano Tacconi, a professor at the University of Bologna, and a member of the town's Academy of Sciences was to supervise her philosophical studies, which began at the age of thirteen. Tacconi was also responsible for bringing the girl's abilities to the attention of the city's learned, many of them members of the Academy of Sciences. Meetings became frequent at her home prior to her degree; they offered Bassi an opportunity to dispute on philosophical matters with the best natural philosophers in town, as well as the possibility to become known to Cardinal Lambertini, the Archbishop of Bologna, who attended these meetings after his arrival in 1731.[5]

A Bolognese aristocrat, Prospero Lambertini was an intellectual with several publications to his name. From the moment he became Archbishop of Bologna, Lambertini turned out to be Laura Bassi's most important patron, one without whose help Bassi's career would never have taken off, in spite of all the lady's talents for physics and

mathematics.[6] Within a year of his arrival at Bologna, on March 26, 1732, Bassi was made a voting member of the Bologna Academy of Sciences; on April 17, 1732, she publicly defended her philosophical theses; on May 12, 1732, the degree in philosophy was conferred on her, and on June 27 of the same year she again defended a second set of theses at the Archiginnasio, the seat of the university. This latest feat permitted Bassi to petition the Bologna Senate for a lectureship at the university. Cardinal Lambertini attended all the ceremonies associated with Bassi's degree, and no doubts was instrumental in ensuring they were carried out, as he would be instrumental in forcing the senate to grant her a lectureship in universal philosophy on October 29, 1732. Although Bassi would play an active role in furthering her academic career in later years, one suspects that the petitions for a degree and lectureship were not her idea, but came at the instigation of her teacher, other natural philosophers who knew her, and, of course, of Lambertini himself.[7]

Lambertini was also to intercede on Bassi's behalf, when her teacher, Tacconi insisted that her second set of theses to be presented at the university be in ethics, rather than in natural philosophy, as was her wish. Pressure from Lambertini forced Tacconi to back down. The twelve theses Bassi eventually defended were all in natural philosophy, and dealt with the nature of water as a natural element, and as part of the universe.[8] The Cardinal may have been also responsible for getting Bassi access to the scientific books in the Vatican's *Index librorum prohibitorum*, after she had turned 24 years old, the age which males involved in the sciences were usually granted access to them. As seen, Borromeo's attempt to get this licence resulted in failure. Access to the restricted book in the Index were also denied to another woman scholar, not in the sciences, Bassi's friend,

Francesca Manzoni. [9] As shall be discussed later, in 1745, Lambertini, this time as Pope Benedict XIV, was to nominate Bassi, at her request, a member of the Benedettina Academy, which he founded in order to encourage and increase the quantity of research done at the Bologna Academy of Sciences.[10]

One has to question why such a high prelate in the Church, who was to become the head of the Papal States, was so willing to assist a woman like Bassi. A self-made man, whose career was guided by work and intelligence, Lambertini was a religious and political reformer. He was responsible for university reforms in Rome during his papacy. In Bologna, besides being responsible for the foundation of the Benedittina Academy, he donated instruments and materials to the Institute of Sciences, established a chair of surgery, and opened a school of obstetrics at the same institute to train midwives. Lambertini also lifted the restriction on new works defending the Copernican system in 1757. While still an archbishop, he was responsible together with Cardinal Alessandro Albani, for modernizing the teaching at the Collegio Montalto, a free seminary for students of the Marche Province. Other prelates who were to assist Bassi were also reformers, and/or self-made men, such as Cardinal Alessandro Albani, who nominated Bassi as lecturer in experimental physics at the Collegio Montalto in 1766, Cardinal Giulio Alberoni, who helped Bassi in her struggles with the senate for a regular teaching post, and Mons. Leprotti, who was active on her behalf in Rome to get her nominated to the Benedettina Academy.[11]

The fact that Bassi showed herself determined to work, and be useful for the salary she had received since her nomination to a lectureship, in spite of obstacles that were placed in her way, would certainly endear her to Lambertini, and others reformers like

him, who were critical of lecturers who did not. It serves to explain, to a certain extent their support for Bassi in later years, when she had given ample proof of her determination. But it does not explain Lambertini's initial support. Traditional factors likely played a role. Bassi had been aware of the Italian learned women who had preceded her in history, of their supposed accomplishments, and how they could serve as an example to her. Most importantly, Cardinal Lambertini also believed that women had played a role at the University of Bologna in the past, and he saw no reasons why they should not do so again. Ultimately, what motivated him was his personal belief that women who achieved the high level of learning of a Bassi, or Agnesi--whom he also helped to a lectureship in mathematics at the university--or the high skills in practical anatomy of a Morandi Manzolini, had to be rewarded accordingly.[12] Similar beliefs probably motivated also Mons. Leprotti, who had met Bassi while she was still Tacconi's student, and had been favourably impressed. This impression was further re-enforced by the glowing reports the monsignor would later receive from Bianchi on her abilities.[13]

Laura Bassi was to find out very quickly that a membership to the Academy of Sciences, a degree in philosophy, a university lectureship, and an initial salary of 500 lire per annum were no guarantee that she could either teach at the university on a regular basis, or that she would be allowed to practice the science that interested her. The senate that had granted Bassi the lectureship, also ruled that, because of her sex, she was not permitted to teach in public at the Archiginnasio unless commanded by her superiors. Furthermore, her membership in the Academy of Sciences did not guarantee her access to the Institute of Sciences' cabinets. Neither did it guarantee she would be able to

present her scientific dissertations at the meetings of the academy, or, for that matter, that they would ever be published.[14]

Thus Bassi's battle for a position in the scientific life of her town similar to the male natural philosophers who befriended her, was to take place on two fronts: one front dealt with her inability to teach publicly on a regular basis; the other dealt with her lack of freedom to do research in physics, a subject which interested her, and to which natural philosophers like Jacopo Beccari felt she was particularly suited. Interestingly enough, the battle turned out to be easier to win on the research front, on which Pope Benedict XIV had the greatest control. The teaching front turned out to be harder to conquer. Here, the Pauline veto, which was meant to keep women from preaching in church, unless by papal dispensation, was conveniently used by conservative lay men in the senate to keep Bassi from teaching at the university, unless they so desired.[15] Bassi' battles to insert herself in Bologna's academic life became known abroad. The aristocratic Mme. de Montanclos, director of the periodical *Journal des Dames*, referred to Bassi as a resolute bourgeois, whose examples other women had to emulate, so that someone like Bassi would no longer be the exception, but the rule.[16]

To be considered a natural philosopher in her own right, with her own body of research, Bassi had to establish first her intellectual independence from her teacher, Gaetano Tacconi. The step was unsual in itself; as seen with many examples, learned women, moved by affection, and gratitude to the men who bothered to teach them, had difficulties detaching themselves from the intellectual dominance of their teachers. But Bassi experienced considerable intellectual differences with Tacconi, which she could not, and did not want to overcome. These differences were already obvious in the set of

forty nine theses Bassi published to obtain her degree. Six of these theses were in logic, sixteen in metaphysics, and sixteen in physics, specifically, the nature of matter, motion and meteors. The rest of of the theses were concerned with the nature of the mind, or soul (*De anima*). The influence of the Galilean and Torricellian school is found in *De meteoris*, Theses X and XI of the physics section, whereby the motion of liquids was dependent on gravity. But most of the other theses show Aristotelean and Cartesian influences, not acceptable to Bassi even in 1732. Only Theses V of the section *De anima* illustrates Newton's influence, specifically his theory on light and colour found in his *Opticks*.[17]

Marta Cavazza in *Settecento inquieto* (1990) points out that the Cartesian influences one finds in Bassi's theses reflected the interests of her teacher, Gaetano Tacconi, and not of the author herself, who was a Newtonian as early as 1732. Francesco Algarotti in one of the poems published for her graduation in 1732, presented Bassi as very knowledgeable in Newtonian physics. Her Newtonianism was made clear in her first lecture at the university in December 1732, when she stated that the philosopher's duty was to deduce the laws that governed nature from phenomena that could be observed experimentally. The Cartesians deduced such laws from rationally evident principles, as thesis VI of the metaphysics section of her theses illustrates.[18]

Further evidence of Bassi's early Newtonianism is given by a set of twenty four theses found among her papers dating from 1732, and never published; in them, the physics section began with Newton's three laws of motion and continued in a similar vein. Perhaps these were the theses Bassi would have liked to defend in her petition for the lectureship in June 1732, instead of those in ethics that Tacconi wanted to impose.

The twelve theses on the nature of water she actually defended, after Lambertini interceded on her behalf, were influenced by the physician and mathematician Domenico Guglielmini of the Universities of Bologna and Padua, and probably represented a compromise reached between teacher and student.[19] The argument over the theses in ethics, and obvious philosophical differences, eventually caused Bassi and Tacconi to drift apart, in spite of some attempts on her part at reconciliation. But by then, Bassi was also free to attempt to follow the precepts she taught in her first university lecture: that a philosopher was to deduce the laws that governed nature from phenomena which could be observed experimentally, and it could be added that, throughout her career, Bassi worked within this Newtonian paradigm.

Since, as Heilbron points out the " reduction of experimental data to law, or the deduction of law from first principles is usually the domain of mathematical or theoretical physics "[20], Bassi set out to improve what she knew to be deficient in her philosophical education, her knowledge of mathematics. In 1735, perhaps soon after she had received the licence to consult scientific books which were in the *Index*, Bassi began a three-year study of mathematics with Gabriele Manfredi, one of the pioneers of infinitesimal calculus in Italy. Bassi was to give concrete proof of the knowledge acquired in calculus in a dissertation she published in the *Commentarii* of the academy, where differential calculus was used to determine the motion of the center of mass of two or more bodies moving along any curved paths in a plane.[21]

The other Italian woman to demonstrate such knowledge in print was Maria Gaetana Agnesi, who dedicated a whole volume of her *Instituzioni analitiche* to differential and integral calculus, and to differential equations. As already seen, Ardinghelli, Borromeo,

and particularly, Pignatelli, all skilful mathematicians, might have been familiar with infinitesimal calculus, since the men with whom they associated had demonstrated some skill on the subject, but they failed to demonstrate such knowledge in a concrete way. Bassi's new acquired knowledge of infinitesimal calculus gave her an advantage, not only over most Italian learned women of her generation, but also over a not negligeable number of Italian male natural philosophers of the first half of the eighteenth-century, who had little knowledge of the subject, and preferred to use the synthetic method, and/or the Cartesian analytical method in their calculations.[22]

As a young single woman, Bassi's meetings with other natural philosophers, and her attempts to carry out some sort of experimental activity with their collaboration, were the subject of considerable gossip in town. To put an end to the gossip, and to ensure that she could pursue her chosen path in relative quiet, Bassi chose to marry the young natural philosopher and physician, Giuseppe Veratti, a man she was sure would not impede her in her philosophical pursuits.[23] The marriage to Veratti in 1738, effectively put an end to the gossip, and made it easier for Bassi to attend meetings at the academy. An ex-student of Jacopo Beccari, a graduate of the University of Bologna in philosophy and medicine in 1734, and a lecturer in physics therein from 1738 onwards, Veratti seemed to have behaved according to her expectations, and appeared never to have attempted to curtail her activities.

In fact, the Bassi-Veratti marriage could be viewed as a scientific partnership, for they shared a common interest in what Thomas S. Kuhn defined as the Baconian sciences of electricity, magnetism and heat. Due to her mathematical background Bassi could also handle the classical sciences of mechanics--which included hydraulics--and optics.[24]

These latter sciences appeared to have been beyond Veratti's reach, for he lacked the mathematical training, and, most likely, ability of his wife. On the other hand, it might be expected that as a physician, Veratti would have a superior knowledge to his wife in the medical sciences. No doubts, he could diagnose and treat illness, something his wife, most likely, could not do. But Bassi, called upon by the the *Assunteria di studio*, the university's administrative body, to argue once a year on anatomical lessons given by others at the university, had, as it might be expected, knowledge in anatomy, and some interest in the biological sciences, as some of her scientific activity in association with her husband, and later with her cousin, Lazzaro Spallanzani would demonstrate.[25] This interest on her part, unlike her husband's, would never translate into dissertations on the topic. The dissertations she actually presented to the Academy of Sciences dealt with the physical sciences, and occasionally with mathematics.

The marriage did not have obvious, immediate benefits for her career, because conservative elements within the Academy of Sciences continued to hinder her efforts to either present dissertations, or to take full advantage of the academy's facilities. Bassi and her husband were to solve the problem to a certain extent, by the acquisition through the years of what turned out to be a very extensive physics cabinet, as the 1820 inventory made at the time of the cabinet's sale by Paolo Veratti, Bassi's son, to Count Carlo Filippo Aldrovandi would illustrate. The cabinet, which served for their research, as well as for Bassi's lessons in experimental physics, contained, as any physics cabinet deserving its name, several thermometers, including an electric one, hygrometers, barometers, eudiometers, pneumatic machines, microscopes, telescopes, electrical machines, including a portable one, Volta's electrophore, and batteries, Franklin's square,

many types of prisms, mirrors, and lenses, a Boerhaave stove, retorts, aerometers, hydrostatic scales, many types of capillary tubes, Nollet's machines to study central forces and the law of projectiles, a Mussenbroek tribometer to measure friction, percussion machines, several compasses, artificial and natural magnets, magnetic needles, to name but the most relevant, for a total of around 255 pieces; the collection was comparable in number, if not in quality, to the Abbé Nollet's teaching collection at the Collège de Navarre.[26]

Whereas the acquisition of instruments, which began soon after Bassi's marriage, would alleviate her need to make use of the academy's equipment, it did not improve her chances to present dissertations at academic meetings. These chances appear to have been non existent prior to 1746.[27] The opportunity to participate in the Academy of Sciences' activities appeared in 1745, and it was offered by her old friend, Cardinal Lambertini, now Pope Benedict XIV. In 1745, the pope, intent on increasing the quantity of research done at the Bologna Academy of Sciences, founded the Benedittina Academy within the academy itself with funds he controlled. The Benedittini academics consisted of twenty-four scholars selected from the best known members of the Academy of Sciences. They were to receive 100 lire a year for presenting original work at the academy annually, at a pre-determined date, and for attending three-quarters of all academic meetings. The new members were to be the heads of the scientific sections at the Institute, their assistants, the Institute's president, and its secretary, for a total of fourteen Benedettini. The other ten members, also from the Academy of Sciences, were to be selected by those fourteen, of whom Veratti was not one, and then the list was to be sent to the pope for approval.[28]

Bassi, having learned from some of her allies within the fourteen original members that her name was not among the ten chosen members, decided to appeal through her friends in Rome directly to the pope. Her desire was not to unseat any of the 24 selected Benedettini, but to have the pope create an extra position for herself within the Benedittina academy. The pope knowing Bassi, and petitioned by Flaminio Scarselli, a friend of Bassi's family and secretary to the senate's ambassador to Rome, by Mons. Leprotti, and by Mons. Malvezzi, a Bolognese nobleman and Master of Chamber to the pope, not only acquiesced, but in his *motuproprio* to the senate used Bassi's own words to Scarselli to justify her nomination to the extra Benedittina position. Conservative elements within the Benedettini, failing to block her nomination, attempted to deny her voting rights in the new academy--a right she had held at the Academy of Sciences since 1732. Again Bassi petitioned Rome. Scarselli then contacted Galeazzi, the head of physics at the time, with the suggestion that if the Benedittini had any doubts about Bassi's voting rights, they were to contact the pope for clarification on that point.[29]

Her appointment as Benedittina academic was of pivotal importance in her career as an experimental physicist. The appointment not only gave her access to the academy's facilities, but also offered her a forum for her dissertations. She might choose to collaborate with others, but as a Benedettina, she had to present her own dissertation, based on original research, once a year to the academy, and the members who had tried to stop her, could do nothing, but take notice. As far as opportunity to do research was concerned, Bassi had succeeded.[30]

Bassi's ability to present her dissertations to the Academy of Sciences did not necessarily mean that these dissertations would be published in the *Commentarii*, the

academy's journal. Under the editorship of the Institute's secretaries, Francesco Maria Zanotti, and then Sebastiano Canterzani, the *Commentarii* did not appear often enough to include all the dissertations. For instance, the journal failed to be published between 1766 and 1783. Thus had Bassi wanted to publish her five dissertations on electricity, which were presented after 1766, she would have been unable to do so. Furthermore, Zanotti and Canterzani also tended to favour physics publications with a mathematical bent to them.[31]

However, Bassi has to be assigned a share of the blame for her few publications. She could have published monographs of her research, independently of the *Commentarii*, as her husband had done on two occasions. She could also have published in one of the journals that appeared in Northern Italy in the second half of the eighteenth-century. Most probably, Elisabetta Caminer Turra would have been glad to publish one of Bassi's works in her journal, if one is to be guided by the eulogy the former dedicated to the latter at the time of her death.[32] Veratti in a letter to Abbot Giovanni Amaduzzi, written soon after Bassi's death, placed some of the blame on his wife's shoulders by pointing out that when it came to publications she could be difficult.[33] Without question, her constant occupation with the course in experimental physics she taught at home limited the time she might have allotted to writing. But, if one considers how determined she was in achieving her goals, ultimately, it has to be said that publishing her works was not as high in her list of priorities, as research and teaching might have been.

Just the same, Bassi's output of two *opuscula* and two summaries, which were published in the *Commentarii,* could be considered average for the members of the academy. Of the seventy-two authors who appeared in the journal during its existence,

fifty-five had less than four *opuscula* to their names.[34] However, these published works represent a very small part of Bassi's scientific activity. As her manuscript dissertations are lost, her activities can be surmised by the correspondence she maintained with other natural philosophers, through the works of the natural philosophers themselves, and confirmed by the instruments in her physics' cabinet.

Of the thirty-one dissertations Bassi presented to the academy, ten dealt with fluid mechanics. Water control was of particular concern to the region's governement. Through the study of fluid mechanics, the academy in general, and Bassi in particular, could prove themselves useful to the town. But leaving aside Baconian goals, there might have been a more mundane reason behind all the dissertations presented by Bassi on the subject: availability of equipment. The fact remains that by the second half of the eighteenth-century, interest in fluid mechanics appeared to have declined amongst the academy's members, in spite of the Institute having a room recently equipped by Benedict XIV's donations with instruments to study the motion of fluids, and to carry out experiments in hydraulic and hydrostatic; instruments, which were, probably, better than those she had at home.[35] The lack of interest most other members showed towards these new instruments facilitated Bassi's access to them. Only one of Bassi's ten dissertations in fluid mechanics was published in the 1757 *Commentarii.* It tested the law concerning the flow of liquids through openings. Bassi used Domenico Guglielmini's and Bernardino Zendrini's method, which calculated the quantity and average velocity of water exiting a hole and extended it to apply to two or more holes of known dimensions and positions under water. Once these solutions were found, and after considerable

simplification, Bassi was able to derive an equation that could be used to determine the position and size of another hole of similar shape under water.[36]

Like many other natural philosophers at home and abroad during the eighteenth century, Bassi was influenced by Newton in her methodology and, particularly, in her research, and therefore operated, as far as it is known, within the Newtonian paradigm. For instance, Newton was the direct inspiration behind Bassi's 1757 publication of a problem in mechanics, *De problemate quodam mechanico*. The inspiration came from Corollary IV, one of three corollaries central to Newtonian dynamics, and Lemma XXIII in Book I of the *Principia*. Newton had used Lemma XXIII to prove that the " common centre of gravity of two or more bodies does not alter its state of motion or rest by the actions of the bodies among themselves; and therefore the common centre of gravity of all bodies acting upon each other...is either at rest or moves uniformly in a right line ". Newton was there referring to two or more bodies moving in rectilinear trajectories, either in the same plane or different planes; Bassi extrapolated the problem to determine the trajectory of the centre of mass of two or more bodies moving along curved paths in a plane.[37]

Many of Bassi's experiments, either carried out on her own, or in collaboration with her husband and other natural philosophers were influenced by the Queries of the 1706 Latin version of Newton's *Opticks*, usually used in Italy. In the Queries, Newton attributed the phenomena of elasticity, capillarity, cohesion, reflection, refraction, diffraction and emission of light, heat, and selective chemical combinations to short-range interparticulate attractions and repulsions. For instance, a series of experiments undertaken by Bassi and/ or collaborators dealt with the effect of interparticulate forces

on the phenomenon of elasticity; or how the elasticity of the air might be altered by altering forces of attraction and repulsion, caused by physical factors. Bassi and collaborators believed, like Boyle that air was formed of naturally elastic corpuscles capable of occupying a space and having weight, like Newton that air consisted of "particles, which repel each other with a force inversely as the distance", and ultimately, like Hales that air could be in either an attractive (fixed) or a repulsive (elastic) state, depending on whether it was fixed or not in a substance, but not in both states simultaneously.[38]

Bassi's first experiments, which fit that category, appeared in the 1745 *Commentarii*, and dealt with deviations from Boyle's law. Doubts had appeared as to the general validity of the law. In 1732, while testing deviations in the Ammontonian thermometer, which was based on Boyle's law, Galeazzi found that its deviations were caused by variations in the air's elasticity. Bassi not only repeated the experiments in which the elasticity of the air was studied at different pressures and temperatures, but also made new investigations using air taken in days that varied from being very humid to being very dry. She found that the relationship between volume and pressure established by Boyle's law was approached on dry days, but not on humid days. On humid days, Bassi could not contract the air to half its volume by doubling the pressure; this led her to ask whether it was possible that "humours" in the air affected its elasticity, and therefore the results. Eventually, she concluded that the relationship between volume and pressure established by Boyle's law was not universally applicable.[39] This was well before scientists understood the behaviour of vapour under pressure. The experiments were considered important enough to cause the academy's secretary, Zanotti, to publish a

summary of Bassi's results before the experiments' completion. An eulogy at her death pronounced them her most important contribution to physics. Their assessment seems to have been confirmed by Prof. Paolo Volpicelli of the Academy of Lincei, over hundred years later. When Volpicelli published his own work on Boyle's law in the 1859 Acts of the Academy of Lincei, he again referred to Bassi's 1745 work, and the fact that she had found deviations in Boyle's law caused by humid air.[40]

Gain of elasticity by the air figured prominently in Gregorio Casali's dissertation presented to the academy in 1757, which dealt with the force released by gun powder. To Casali, as well as to Bassi, Veratti and Beccari, who had assisted him with the observations, that force was dependent on the considerable elasticity present in the "air" suddenly released from saltpetre by the explosion.[41] Following the same pattern, Bassi might again have provided changes in the elasticity of the air--this time its loss-- as an explanation for the dissertation, based on some of Hales' experiments on electricity, she presented to the academy in 1774. Hales believed that lightning caused sudden loss of the air's elasticity, which then forced an animal's lungs to collapse when hit by it, glass windows to burst outwards, and fermented liquids to become flat and vapid. Veratti in 1769 and 1770 presented dissertations on the effect of lightning on animals. Bassi's dissertation might contain similar variations--perhaps more inclined to physics--of Hales' experiments; after all her cabinet contained the instruments to produce imitation lightning, such as a large Franklin square and crystal to form lighting.[42]

Bassi also presented dissertations to the academy which dealt with the effect of Newtonian short-range interparticulate attractions and repulsions on the phenomenon of capillarity. In 1791, thirteen years after Bassi's death, the Institute's secretary,

Sebastiano Canterzani, motivated by physicists' attempts to formulate mathematically forces of attraction at smallest distances, such as those of capillarity, published a summary of dissertations on the subject that Bassi had presented to the academy in 1747 and 1748. Most likely, these dissertations were triggered by Alexis Clairaut's *Théorie de la figure de la terre* (1743), in which he analysed the capillary phenomena in terms of attractive forces acting between the molecules of a capillary tube and the molecules of a fluid.[43] Bassi's experiments concerned the action of air dissolved in various liquids that were contained in different shaped vessels including capillary tubes, once the air pressure was removed. Finding that air bubbles appeared more intensely in capillaries, she assumed that the phenomenon was a result of the greater attraction exercised by the glass surface on the air and liquids. She did not find this idea contradictory, since in electric phenomenon as well, pointed and angled objects showed a greater force of attraction.[44]

Besides its obvious Newtonian tendencies, the work is interesting for several reasons: first of all, it reveals Bassi's early experiments in electricity and her awareness that pointed objects attracted electricity, a conclusion to which she had arrived simultaneously with, and perhaps independently from, Benjamin Franklin, the Abbé Nollet, and Jean Jallabert. Secondly, the publication of the paper after Bassi's death indicates that the academy then possessed her dissertations in manuscript form, donated by Veratti soon after his wife's death, although most of them have since been lost. Thirdly, it demonstrates her knowledge of recent debates in physics, such as those that occurred in Paris. This knowledge of Parisian activities must have motivated Bassi to present another dissertation on capillarity on May 2, 1764 entitled "On the Phenomena of Liquids in Capillary Tubes of Various Materials ". Jean L. d' Alembert, a Cartesian at heart,

having had to swallow that gravity operated according to the law of inverse squares, warned philosophers in his " Preliminary Discourse " to Diderot' s *Encyclopédie* (1755) and in his *Elémens de philosophie* (1759) not to transpose the attractions from celestial bodies to those around us. It was not natural to think that if attraction was a fundamental principle, it would be uniform and the same in all parts of matter. To a Newtonian like Bassi, such statements deserved rebuke.[45]

Newton's *Opticks*, and the experiments therein had been great favourites with Bassi from her disputation days. Several Newtonian experiments on light and colours had been tried by her and collaborators before her marriage. She made also the teaching of Newton's theory of light, illustrated by suitable experiments, essential part of the curriculum of her private, and, later, public lectures in experimental physics. Following the Queries in Newton's *Opticks*, Bassi attributed the phenomena of refraction, reflection, diffraction and the emission of light and heat to short-range attractions and repulsions between the particles of bodies and the rays of light, as Dr. John Morgan, a Philadelphia physician, explained after having met her in 1764. Bassi was at the time

> giving lectures upon light & colours shewing the 4 primary original colours, which she said were red, yellow, blue and green, the purple, orange & violet being compounded of these..., made several curious experiments upon Phosphori [the Bologna Stone--barium sulphate] & to shew the reflection of Bodies--i.e.--ye attract'on of ye rays of light by ye Body it passes thro'--as in a slit or small hole or perforation thro' a Board with a ray of light let into a dark room from ye sun; thro' a perforation in a window shutt'r, by means of a speculum made to pass thro' the first mentioned hole. This rec'd at ab't a foot distance on a piece of paper, at a sort of focal point shows how ye ray is attracted by ye sides of the slit so as to shew a separation of the col'rs & a Dilation of them into a kind of fimbria.[46]

Bassi's cabinet contained many optical instruments for her own use, and for teaching purposes. She also received optical material from various parts of Europe. In 1753, the

Spaniard Giuseppe Hortega, an expert in scientific instruments, sent her from Barcelona two English prisms, recently acquired in England. Simultaneously, from Nollet, via Hortega, Bassi was also to receive a converging lens. In 1765, Father Giambattista Beccaria would send to Veratti and Bassi two prisms of rock crystal, of which he had studied the double refraction and how it related to the parallel lamina of the crystal's structure. From England she had also received an English prism composed of three crown glass prisms for the Dollondian correction.[47] In spite of all her interest in Newtonian optics, and availabilty of instruments in her cabinet, Bassi presented only two dissertations on the subject to the academy: one was on Iceland glass, used for refraction experiments. The second dissertation, entitled "On a Way to Correct in Telescopes the Inconvenience Derived from the Different Refractions of Rays, Which Unite at Different Points in the Axis Depending on Their Colour " and presented to the academy on April 28, 1763, clearly indicates by its date of presentation and its title that, in spite of continuing to function within the Newtonian paradigm, Bassi must have gone against, at least, one of Newton's optical findings. The dissertation demonstrates once again that Bassi was able to keep abreast of the latest scientific developments and debates, through her correspondence and the academy's meetings, and thus add her own contribution to these debates.

After attempting to correct chromatic aberrations in telescopes, Newton had come to the conclusion that such correction could not be undertaken for it required lenses of infinite focal points. As a result he abandoned dioptric objectives to build mirror-based telescopes. In 1747, Euler demonstrated the geometric possibility of achieving achromatic objectives. In 1755, a Swedish professor sent John Dollond of England a

geometrical demonstration that experiment 8 of proposition III, book 1, part 2 of Newton's *Opticks,* from which Newton had drawn his conclusions, was false. Redoing Newton's experiments, Dollond was able to correct chromatic aberration by making use of two different types of glass with different indexes of refraction, the English crystal (flint glass), which gave a strong dispersion, and an ordinary green glass (crown glass), with weak dispersion. The first telescope with achromatic lenses was presented to the Royal Society in 1758. However, Dollond's technique remained mysterious, which led Clairaut in 1761 and 1762 to attempt to provide a complete theory on the question of achromatic objectives. In this, Clairaut was assisted by a optician, who built him a prism with a curved surface in one of its faces, which allowed him to vary easily the angle of the prism, while modifying the point of incidence of light, and thus measure the refrangibility of a substance in relation to each colour. Clairaut also studied the error caused by the spherical shape of the lens surface, and compared it with the error caused by different refrangibility.[48]

It makes sense to suppose that the dissertation Bassi presented on the topic in 1763 must have dealt with some variation of Dollond's method to correct chromatic aberrations, especially, if one considers that she might have had already in her cabinet the materials to carry out such experiments. However, she did not have in her cabinet prisms similar to those used by Clairaut in his experiments; these she was to receive only in 1766 from the Venetian G.M. Ortes. Then, she was curious to try them to see if the different curvilinear surfaces were to cause different union in the rays, facts that would relate to the proofs made by Clairaut in his last correction of telescopes. The academy never published Bassi's 1763 dissertation; it published instead Ruggero Boscovich's

dissertation on the subject, presented at the end of 1763. This last dissertation not only referred to Dollond's correction, but also to Clairaut's theory, proofs and experiments, which Bassi's dissertation could not have contained in 1763, because she was only to receive the necessary prisms to repeat Clairaut's experiments in 1766.[49] Having to choose between two dissertations on related topics, the academy's secretary chose apparently the one which was the most complete.

Laura Bassi and her husband were amongst the first philosophers in Bologna to be interested in electricity. They were also to present the greatest number of dissertations on the subject prior to Luigi Galvani's and, his nephew, Giovanni Aldini's dissertations on animal electricity after Bassi's death. Urbinati points out that Veratti tended to concentrate on the effects of electricity on animals, with forays in atmospheric and artificial electricity. Whereas Bassi employed herself in the examination and exposition of the laws of electricity. Urbinati is correct, if one takes into account the dissertations the couple presented to the academy. Bassi and Veratti did not compete with each other scientifically; their marriage was a scientific partnership intent to benefit both partners. Thus their dissertations on related topics tended to be complimentary of each other. The couple collaborated in their studies of the physical properties of "airs", as they would later collaborate in the chemical properties of " airs ". But their collaboration is never more obvious than in the field of electricity, where a well-stocked cabinet in electrical instruments allowed them to carry out experiments at home different from those encouraged at the Institute.[50]

The couple's first activities in electricity dated from 1746, when they acquired their first electric machine. In 1747, Bassi was able to refer to the power of points to draw

electricity in her work on capillarity presented then to the academy. During that period Bassi collaborated also with her husband when Veratti was engaged, at the academy's request, in repeating Giovanni Francesco Pivati's experiments on the effectiveness of electrical therapy. The results of these experiments along with others were published in 1748. In the work, Veratti claimed, as did others, that the electrification of glass tubes containing medicinal substances allowed these substances to pass through the glass into the atmosphere. He also found that electricity by itself helped cure diseases such as arthritis. In the section dealing with the physical properties, Veratti criticized Nollet's double flux theory, which he claimed reduced electrical attraction and repulsion to a simple case of electricity " running from a body to another ". To Veratti, and, no doubts, to Bassi at the time, the " electrical virtue, like attraction, was universally scattered and diffused in all corporeal nature ", and the electric fluid, like light, had the property to be attracted by some bodies and rejected by others. Confused, as many others, as to the nature of electricity, Veratti referred to electricity sometimes as a "force", other times as "matter", or "virtue", and still other times as a "fluid". The Franklinian theory of electricity, as presented by Giambattista Beccaria, would help dissipate much of that confusion and give direction to their research.[51]

As Bassi's name appears nowhere in the book, we learn of her contribution to her husband's work from her correspondence with friends like Scarselli, from Nollet's journal of his trip to Italy, and from the abbot's correspondence with the Bologna Academy.[52] One might say that Veratti failed to give credit to his wife's contributions to his work. On the other hand, Bassi might not have desired any credit; after all, she had the opportunity to present to the academy her own work to which Veratti might have

contributed, and received no credit. As already seen with Gregorio Casali, others were far more careful to credit Bassi for any assistance she provided them.[53] Leopoldo Marcantonio Caldani, who as a young physician was able to use the couple's electric machine to carry out experiments which proved the validity of Albert Haller's theory on irritability , made sure both Veratti and Bassi were credited for their assistance. Like his friend, Felice Fontana, and Veratti himself, Caldani believed in Haller's theory of the irritability of muscles, and the sensitivity of nerves as causes of movement in the organism. The theory was rejected by another academician Tommaso Laghi, who believed that movement was the effect of spirits that flowed along the nerves. Laghi's, Caldani's, and Fontana's experiments, together with later experiments by Veratti on the same topic, laid the groundwork for further work in the same academy by Luigi Galvani, who eventually arrived at the concept of animal electricity. Bassi never presented dissertations on irritability; however, when Mme. du Bocage visited the academy in 1757, Bassi conducted several experiments on irritability for the benefit of Bocage, a neophyte in natural philosophy.[54]

In 1756, Bassi met Father Beccaria, from the University of Turin, while he was visiting Bologna. This meeting with Beccaria, and their subsequent correspondence seem to have heightened the interest Bassi already had in electricity. In 1761 she was to present her first dissertation in electricity and from then on, she presented other dissertations on the subject on a more regular basis.[55] Beccaria, who had written in 1753 *Dell' elettricismo artificiale e naturale*, to the " applause of the learned ", supported Franklin's theory of electricity, which expounded the idea of conservation of charge and rejected Nollet's notion of a double fluid. Franklin and his supporters viewed electricity

as one fluid, whose particles were able to act at microscopic distances, as most Newtonian experimental philosophers would believe, and also at sensible intervals, but then, only by means of a medium defined to be an electric atmosphere. Franklinists believed also that like charges repelled, and unlike charges attracted each other. However, they failed to explain repulsion between negatively charged bodies, which by their definition lacked the mechanism responsible for electric motion.[56]

During his stay at Bologna, Beccaria in collaboration with Bassi, Veratti and Casali engaged in a series of experiments on electricity at the academy. In his book *Elettricismo atmosferico* Beccaria, recorded an experiment suggested by Bassi that, according to him, supported the theory of the universal diffusion of the electric fluid.[57] Thanks to Beccaria, we have one of the few surviving records of an experiment in electricity devised by Bassi. It is also from her correspondence with Beccaria, Abbot Felice Fontana, and Lazzaro Spallanzani that we know that Bassi was a supporter of the Franklinian system, continued to support it in 1775, when many former Franklinists, such as Fontana and Carlo Barletti, had abandoned the field, and then came to question some aspects of it, as many others would do, after the invention of Volta's electrophore in 1775.

In 1759, the Englishman, Robert Symmer, through his experiments on the " contrary electricity" of black and white stockings, had resurrected the thesis of two distinct electric powers. Electricity did not consist of the afflux and efflux of those fluids, as suggested by Nollet, but by the accumulation of one or the other of them in electrified bodies. In a 1768 letter to Bassi, Fontana expressed his doubts about the Franklinian system of electricity, which he believed too general to explain certain effects. This letter was

indicative of the controversy that arose in the 1760s when the Franklinian system failed to explain why bodies deficient in electricity, and supposedly lacking an electric atmosphere, repelled one another (minus-minus repulsion). The controversy recommended the Symmerian system to many and forced defenders of the Franklinian system, such as Beccaria, to justify the Symmerian phenomena, and others of a similar nature, with principles as Franklinist as possible. To refute Symmer, Beccaria coined the term *vindex* electricity, first mentioned in a 1767 letter to Franklin and illustrated with many experiments in his *Experimenta atque observationes quibus electricitas vindex constituitur atque explicatur* (1769).[58]

Bassi, who corresponded regularly with Beccaria, also contributed to the debate. By March 1769, having received Beccaria's work on *vindex* electricity, and having already done some experiments on her own, Bassi communicated to him her reservations about the new double-fluid theory. Her participation in the controversy is also confirmed by an incomplete copy of her handwriting of a series of experiments done by Beccaria and repeated by her, along with her intention of doing new ones to disprove the double fluid theory. In 1771, Bassi presented to the academy a dissertation on *vindex* electricity, which was never published. Nevertheless, we can surmise its Franklinian content not only by its title, but also by Fontana's reaction in 1775 to a letter, or work Bassi had sent him on the subject. It is clear that in May 1775, Bassi was certain of the validity of Franklin's theory, since Fontana answered, " you have expressed in most ingenious and subtle terms of physics a defense of the Franklinian system".[59]

However, from one of her letters to her cousin, Spallanzani, dated December 1776, one can also surmise that by then, Bassi was no longer certain of the Franklinian system's

complete validity. These doubts were voiced after having received from her cousin a copy of Carlo Barletti's *Doubts and Thoughts on the Theory of Electric Phenomena*, in which the author asked why one should hold to Franklin's arbitrary guess, " Especially since he had a false idea of the spheres of activity, which he called and continues to call electric atmospheres, an idea corrected by Aepinus. " As far as Bassi was concerned, " it is proper that electric phenomena are questioned, or more correctly, the systems formed on their relationships, so we can better clarify out thoughts on such a relevant matter."[60]

Bassi's doubts, at least on the validity of electric atmospheres, may have risen, as did those of many others, by Volta's invention in 1775 of the electrophore, of which she had two in her cabinet. Volta's apparently inexhaustible purveyor of electricity, the electrophore, could not be explained away by referring back to Franklin's electric atmospheres; one had to appeal to forces acting at a distance. Its invention was viewed as a " menace to the Franklinist system " and ultimately affected electric theory profoundly. Spallanzani was responsible for introducing the young Volta to Bassi as a correspondent in 1771, and they corresponded from that date onwards. Most likely, Bassi received the electrophore directly from Volta himself, and probably, not much after its invention. It appears that the electrophore made her rethink the concept of electricity's action at sensible intervals by means of a medium, or electric atmosphere, as expounded by Franklin. Perhaps she came to accept that electricity, like Newtonian gravity, could be viewed as a force that acted at a distance, without the need of a medium, as Franz Aepinus had stated in his *Tentamen theoriae electricitatis et magnetismi* in 1759.[61]

From Bassi's correspondence with Beccaria we learn that in 1766, Bassi and her husband were testing the effect of electricity on various substances. Similar tests were carried out by Beccaria, Priestley and others. In 1769 Bassi had come to the conclusion that glass conducted electricity when heated. Priestley had come to similar conclusions in 1767. As early as 1759, Beccaria had informed Bassi that tourmalines became charged with electricity proportionally to the degree of heat that they actually absorbed or emitted. He intended to see if such a law was common to other bodies in nature. Following in Beccaria's footsteps, Bassi must have tested many such materials over the years, of which the glass mentioned above is an example, and finally, in 1777 she presented to the academy a dissertation which dealt with the property various bodies had to retain heat more than others, while also retaining electricity.[62]

The relationship that Bassi believed existed between fire or heat, magnetism and electricity is apparent in her 1766 letter to Beccaria. The astronomer De Lalande, having visited Bassi in 1765, mentioned in his *Voyage d' un françois en Italie* that she had made an association betwen fire, this time the flames from the burning lands of Pietramala (methane producing lands) and the electric fluid. To her, the odours produced by either the burning lands, or after an electric discharge were similar. The analogy between fire or heat and electricity was shared by many electricians, including Nollet, Beccaria and the natural philosophers of the St. Petersburg Academy. The close relationship Bassi saw between magnetism and electricity was shared by her husband in dissertations presented to the academy in 1757 and 1758 and by Franklin, Aepinus and others.[63] From what can be gathered from her correspondence, Bassi's experiments in electricity, if not greatly original, appear to have been up to the standards of most

workers in the field. Following the methodology she had embraced in 1732, Bassi helped advance the understanding of electricity, and most importantly, passed that understanding to her students. Her knowledge on the subject prompted an ex-student, like Fontana, to ask her advice on an electrical experiment as late as 1760.

Laura Bassi's extensive commitment to physics is reflected in her correspondence, which after 1745. the year she was made a member of the Benedettina Academy, became to a great extent scientific in nature. Bassi maintained some correspondence with foreign natural philosophers, men like Hortega and Nollet, who not only provided her with equipment, but as in Hortega's case with a student--his nephew-- and in Nollet's case with a detailed description, drawings, operation, and experiments to be carried out on electric apparati.[64] However, the bulk of Bassi's correspondence was with Italian natural philosophers, some of whom she had assisted, like Caldani, or met through the Academy of Sciences, like Beccaria. Others were ex-students, men like Fontana, Spallanzani and Rocco Bovi, and still others were young men starting out in the field of physics, such as Marsilio Landriani, Alessandro Volta and Giovanni Luigi Targioni. This correspondence helped keep Bassi informed on the latest scientific activity, instruments, and provided her with such equipment as might be needed for her cabinet.[65]

Fontana's letters to Bassi are one of the best sources of information on both Bassi and his own scientific activities. For instance, Bassi had sent him her own defence of the Franklinian system; in turn, he sent her his own doubts about the system. Fontana also asked for advice on experiments he was carrying out, and occasionally would also ask her to repeat them to confirm his results. As director of the Grand Duke of Tuscany's Museum of Physics and Natural History, Fontana could provide her with descriptions,

often at her request, of new instruments found in the museum, and acquisition prices. Thus in a letter he described the new electrostatic machine built by Edward Nairne of England, which was similar to others in design, but whose effects were greater. In the same letter he also discussed the pyrometer, and instruments to determine the declination of the magnetic needle. Having been asked, via an unidentified person, by M.J.A. Condorcet to provide declination readings for Bologna, and finding out that they had not been carried out since 1742, Bassi was determined not to shame the academy and carry them out anew, with more precise instruments. Her intent in November 1774 was to use an instrument invented by Quadri available at the Institute but difficulties with it might have forced Bassi to inquire from Fontana which were the best instruments to use.[66]

Fontana was also to provide Bassi with new instruments, such as English lenses for minute observations in 1760, a small electrostatic machine from England, based on Ingenhousz design in 1769, and in 1775, with eudiometers of his own design--based on nitrous air--which served to measure air salubrity, as suggested by Priestley in 1772. The eudiometers were indicative of the turn Bassi's research was taking a few years before Bassi's death. After having studied the physics of "airs" since her appointment as a Benedittina in 1745, her research now concentrated in studying their chemistry.

Bassi's correspondence with Fontana as well as with Volta would prove very useful for the study of the chemistry of " airs ". In 1776, she presented a dissertation on the Relation of Flame to Fixed Air (carbon dioxide). In 1777, Volta sent her several works, published in form of letters, on inflammable air from the marshes (methane), which he had discovered. It also included a work which discussed new instruments and experiments he had carried out on the chemistry of "airs". Amongst the new instruments,

Volta described a gun containing either metallic air (hydrogen), or swamp air (methane), which needed dephlogisticated air (oxygen) and the flame of an electric spark to trigger. He later also sent the instruments to carry out the experiments on inflammable air, or swamp air; however, she had been unable to carry them out, because illness prevented her from collecting the needed swamp air. In the same letter Volta also voiced his belief that the flames in the burning lands were caused by this swamp air, and begged her to investigate them further to clarify matters. This correspondence with Fontana and Volta, as well as her dissertation indicate that Bassi was becoming involved in a debate concerning Lavoisier and his oxygen theory and Priestley and the phlogiston theory. In Italy, Priestley was being defended by Fontana, and Lavoisier eventually by Spallanzani, two of her former students. Unfortunately, as Bassi's activities were brought to an end by her death in 1778, and her as dissertation on fixed air was lost, we do not know where she stood on the controversy.[67]

As mentioned, Bassi appeared ready to assist ex-students like Fontana , or newcomers to the field of physics like Volta, and she also helped her own cousin Spallanzani when he needed her to confirm some experiments, which were normally outside her field of activity, but not of interest. Spallanzini in his *Prodromo d' un opera sopra la riproduzione in animali* (1768) had maintained that snails were able to grow back a new head if the original had been cut off. The naturalist had assumed that when he removed the snail's head, he had also removed its brain or ganglia. Some disputed Spallanzani's results and objected correctly, that in those that survived, the ganglia had remained, and what the snail reproduced was only part of the head. The controversy on the reproduction of the snail's head lasted several years, and Spallanzani, whose reputation

was already considerable at the time, won out, in spite of his errors. During the first years of the debate, Spallanzani had asked several natural philosophers, including Bassi to repeat the experiments. In the spring and summer of 1769, and again in the spring of 1770, Bassi conducted the experiments according to Spallanzani's instructions, and with instruments provided by him, and Spallanzani checked the results in person. Nothing is known of Bassi results, despite Spallanzani's assurance they would be published. When he published the various naturalists' results on the reproduction of the snail's head in 1783, Bassi's findings were not among them.[68] Perhaps she had not completed the experiments to his satisfaction, but perhaps Bassi had arrived at a conclusion that the naturalist did not desire.

Bassi's scientific activities may be studied separately, but they should really be considered as related to her teaching activities. The two were connected. Her determination to keep up with the latest debates in experimental physics, and to be part of these debates at the local and national levels with instruments and experiments relevant to them, kept her private lessons in experimental physics relevant, up-to-date, and ultimately very successful with students at the university. It was the success of these private experimental physics lessons which elicited recognition on the part of those who had done their best to keep Bassi out of public teaching.

Restricted from public teaching at the university, unless commanded by her superiors, because of her sex, Bassi was nevertheless called upon to give several lessons at the institution over the years, but never on a regular basis. However, she never gave up in her attempt to give public lessons on a regular basis so that, as she told Scarselli, she could justify her salary. By 1739, the university administration had increased her salary

by 160 lire and stated that she could teach regular lessons at the institution, yet these lessons did not materialize. Attempts to regularize her situation at the university were also made by several cardinal legates--the pope's representatives at Bologna--and by her former mathematics teacher, Gabriele Manfredi, but without success. During the legation of Cardinal Alberoni (1741-1743) times for regular lessons had again been arranged--a fact also confirmed by the *Atti* of the Assunteria di Studio of November 1741. The lessons did not take place, however, because of the political and social disruptions caused by the uninvited arrival of the Spanish troops (1742-1744) into the territory which forced the closure of the university, followed by a series of illnesses that affected both Bassi and the cardinal at the end of his legation. In 1749, again under pressure from a new cardinal legate and because of a shortage of anatomy teachers, the Assunteria decided that Bassi could lecture on anatomy; this last attempt, like all preceding ones, led nowhere.[69]

At the same time Bassi was struggling to give regular lessons at the university, she began to give private lessons at home. At first, she taught mathematics, a course which apparently did not succeed. In 1749, Bassi switched to teaching experimental physics, in a course modelled, most likely, on Nollet's *cours de physique*, which in 1760 attracted 500 paying customers. Bassi's course became so popular that what began as a private enterprise aimed at young people starting off at the university soon grew into a course attended by grown men interested in physics. The teaching of physics at the Institute of Sciences, unlike that of the university, was supposedly based on experimental work as well as on theory. However, as this teaching was the responsibility of the head of physics or, in his absence, his assistant, the type of physics taught depended on their

interests. From 1734 to 1770 the physics' professors and their assistants were physicians. Although they presented dissertations in physics, their dissertations were generally physiological in nature, and their teaching of physics tended to be applied to physiology.[70] This focus provided an opportunity for Bassi, who had studied advanced mathematics, had done experiments in optics, hydrometry, electricity, and on Boyle's law, to offer a course in experimental physics which was not readily available at the institute.

Furthermore, as Bassi herself rightly represented to Scarselli in 1755, at a time when many universities abroad began to dedicate time and equipment to the teaching of experimental physics, the institute, under the regulations established at its foundation, could only provide one 2 hour lesson a week on the subject. On the other hand, Bassi gave her lessons on a daily basis, in the morning, during the eight months the university was in session. Bassi seemed to have had excellent dexterity and understanding of the instruments used in experimental physics. If Caldani is to be believed, Balbi, who preceded Bassi in the chair of experimental physics at the institute, did not. Caldani believed the physics instrumentation at the institute to have been destroyed by the inexpert hands of her predecessor.[71]

However, the acquisition of instruments for an effective cabinet of physics required money; for instance, Musschenbroek's air pump sold for 880 lire. Salaries for the University of Bologna's lecturers were low compared with those of several Italian universities, such as Pisa or Pavia. With a growing family and having received only one raise since 1732, Bassi found hers and her husband's salaries not adequate enough for the purchase of the instruments she had wanted, and of those she still required. In 1755,

Bassi decided to petition Benedict XIV, via Scarselli, for assistance in such a purchase. This time, Scarselli did not even petition the pope, whom he felt sure would answer that having just endowed in 1745 the institute with new instruments, he was not about to endow private lecturers. He advised her instead to petition the Bologna Senate. Help this time would come from the senators, who in 1759 recognized her private lessons in experimental physics by raising her salary with the condition that she would continue to teach as she had done in the last ten years. In doing so, the senators were granting Bassi what they had granted other lecturers who taught at home since 1665, when the senate officially recognized teaching at home. By 1776 Bassi's salary was 1200 lire, one of the highest at the university, but it was far less than the 5900 lire paid to Volta by Pavia University in 1795.[72]

To supplement her salary Bassi also applied for a preceptorship in experimental physics at the Collegio Montalto to Alessandro Albani, the cardinal protector of the college. The success of her private lessons in experimental physics ensured her nomination to the post in 1766. It provided her with an extra 378 lire per annum plus an increase in the number of students who would attend her course. However, this position did not lead to any public teaching on her part because the college lacked institutional facilities of its own, and its students had to attend classes either at the lecturer's home, or at the university.[73]

Teaching at home had some advantages. There Bassi was not constrained by the university curriculum, which remained essentially Aristotelean even though modern philosophies were introduced, as Bassi's theses illustrated. Bassi could use her lecture to spread Newtonian philosophy, the Franklinian system of electricity, the physical

properties of "airs" and later, their chemical properties. Keeping abreast of the latest debates in physics, Bassi could also instruct her students on changes that occurred, for instance, in Newton's optics, with the correction of chromatic aberration--something Newton had thought impossible--or in the Franklinian system, when its electric atmospheres were finally questioned, and eventually dropped. Some idea of how Bassi taught, and what she taught can be surmised from an eulogy by her students at the Collegio Montalto after her death, from the Philadelphia physician John Morgan, and from the instruments in her cabinet. According to her students, Bassi first taught the theory and then demonstrated it with experiments.[74] John Morgan pointed out how Bassi illustrated with experiments, incremented by a few local variations, the Newtonian optical theory on light and colours. He also mentioned her teaching in electricity and other philosophical matters. Throughout her career Bassi presented several dissertations on fluid mechanics, but only one in mechanics, that we are aware. However, her physics cabinet contained all kinds of intruments which served to illustrate the theories and problems in mechanics, and which, if one considers her mathematical background, she must have been apt at teaching. These instruments were machines to illustrate Newtonian central forces, to explain the pendulum theory, to study projectile motion, to illustrate percussion and the communication of motion, and to measure friction. There were several inclined planes--one adjustable to different angles--as well as Archimedian spirals, and precise scales for arithmetical operations. The same variety of instrumentation could be found in several other sections of the cabinet, which indicates that Bassi's teaching was far richer than her dissertations to the academy illustrate.[75]

As her reputation spread, students from different parts of Europe and Italy came to attend her course. As Fantuzzi informs us, Bassi could count amongst her students, young men of Polish, German and Greek origins. José Hortega thought well enough of her teaching to send his nephew to Bologna as a student. Students also came from the Venetian Republic, the Kingdom of Naples, and the Marche province. But for eighteenth-century science Felice Fontana and her cousin Spallanzani were her most famous students. Spallanzani credited Bassi for diverting him from the study of law into that of the sciences, to which he was to make major contributions while she was still alive.[76]

In 1776, the senators, who also controlled the administration of the Institute of Sciences, finally rewarded Bassi's many years of private lessons by making her professor of experimental physics at the institution. She had requested admission to the professoriate of the institute since 1773. Her initial intent may have been to be assistant to her husband, who had been responsible for the chair of physics there since 1772, after Balbi, the holder of the position, had become ill. In the usual course of things, Veratti would have been made professor after Balbi's death in 1776, since he had been Balbi's assistant; however, due to his poor mathematical background, Veratti had been unable to teach both the experimental and theoretical aspects of physics, which were his responsibility. In spite of Bassi's qualification in mathematics, the administration decided to split up the physics section for the first time, thereby giving Bassi the experimental physics section with Veratti as her assistant. The physical mathematics section, which dealt mostly with mechanics, a subject Bassi could handle very well, was assigned to S. Canterzani, the institute's secretaty, with Bonaccorsi as his assistant.[77]

For the first time after many years of struggles with the senatorial administration of both the university and the institute, Bassi was allowed to teach in public on a regular basis, but this good fortune came only two years before her death. The one advantage the institute may have offered Bassi would have been the possibility to illustrate her lessons with resources which were too expensive for her cabinet. In terms of what Bassi taught and the men she probably reached, it made little difference whether the teaching was done at home or at the institute.

Unlike Ardinghelli or, as shall be seen later, Agnesi, Bassi did not try to get recognition from foreign academies, such as the Paris Academy of Sciences. She seems to have understood that to succeed abroad, one had first to succeed at home, and as the preceding pages illustrate, succeeding at home proved difficult enough, in spite of the powerful allies Bassi had and of her willingness to use them. The powerful allies in Rome proved more effective in ensuring that she would get access to the institute's laboratories and that she would have a forum for her dissertations. They were far less effective in getting her to teach publicly. Bassi's determination to teach privately a course which was so essential to eighteenth-century scientific life and her success in teaching that course, ultimately, elicited recognition from those who had been more reluctant to let her teach publicly: the Bologna senators. It is important to stress, however, that this recognition was circumscribed since Bassi's regular public teaching did not take place at the university, but at the Institute of Sciences, a new institution, as far as Bologna was concerned, which therefore, unlike the university, did not have any tradition of excluding women from public teaching.

In 1890, Emma Tetttoni described Bassi, first and foremost, as a teacher in her article on Italian women scientists. Tettoni was essentially right, but ignorant of what to be an effective teacher in experimental physics entailed in the eighteenth-century, Tettoni appeared to undervalue Bassi's efforts.[78] To teach students effectively an experimental physicist had not only to be dexterous in handling the various scientific instruments, but needed also to have an understanding of the scientific theories that underlay many experiments and to keep abreast of the latest debates and developments in physics. To be well informed required an extensive correspondence with other experimental physicists, who, in turn to keep a person informed, needed to recognize that person as one of their own. Bassi appears to have succeeded, to a certain extent, on that front also; Beccaria, Fontana, Volta and others sent her their latest inventions, and kept her informed of their activities.

Bassi's surviving dissertations did not lack some originality. The one on discrepancies with Boyle's law was good enough to be mentioned more than one hundred years after its publication. Like most physicists of the past and present, Bassi did not make key contributions to physics. By essentially operating within the Newtonian paradigm, she contributed to the spread of Newtonian physics in Italy through research, teaching and publications. Her level of professionalism, however, made her a pioneer female physicist, and as such she was an exceptional case for her time. Her determination was to give her many victories in the end. Had other Italian women of her times showed as much determination as Bassi had done throughout her career, the University of Bologna might have truly opened to women one hundred years before it did. There was only another woman, contemporary of Bassi, who was to test the

scientific and university authorities of her times, Cristina Roccati. Like Bassi, she found them not very pliant, but, ultimately, like Bassi, Roccati was to find that succeeding to a certain degree in one's home turf was the best women could do at the time. Her victory was on a smaller scale than Bassi's, but important for Italian women nevertheless.

II. *The Teaching of Physics at Rovigo: Cristina Roccati*

Cristina Roccati (1732-1797) was born in Rovigo (Venetian Republic) into a household which had become associated through marriage with many of the town's aristocratic families. Her father, Giambattista Roccati, married also into the aristocracy and, like several of his ancestors, was involved in the town's government.[79] Thus Cristina had important family connections in Rovigo, foremost among them was her cousin Girolamo Silvestri. These relatives would prove useful patrons when she needed their assistance in order to insert herself into the town's academic life, the only venue which was left open to her.[80]

Bassi's parents may not have actively sought to promote their daughter's higher education. The opposite can be said of Cristina's father. There is plenty of evidence that the main impetus for Cristina's education came from Giambattista Roccati. If one is to judge from some of the works in defense of women in his library, one might say that Roccati might have been motivated to carry out this enterprise by his belief that women had the ability and right to achieve a higher education. However, it is also possible that, having in front of him the recent successful examples of Bassi and Agnesi (see chapter IX), he might have sought to increase his and his family's prestige through his daughter's successful studies; studies which would in turn, single her out as an

exceptional female. This policy of using one's own daughters' achievements to enhance the family's prestige could backfire and turn the daughters away from the path chosen by their fathers, as in Agnesi's case. But Cristina seemed to have shared her father's goals, and thus was motivated in her pursuits of a higher education by her own desire to succeed, and by her love of learning.[81]

Cristina Roccati's earliest relevant education was received in Rovigo from Father Pietro Bertaglia, who taught her Italian and Latin as well as Italian and classical literatures. The extensive collection of classics found in her father's library assisted Cristina in this pursuit. She achieved considerable success in this field during her lifetime. Several of her sonnets, songs, poems, eligies in Latin or Italian, usually in honour of persons and/or events were published from 1748 to 1780. These literary works, along with her studies and degree, were responsible for Roccati's membership to various academies, such as the Pistoia Academy, Florence's Apatista, Rome's Arcadia and Rovereto's Agiati academies as well as her hometown Academy of Concordi, and even Cornaro Piscopia's old academy, the Ricovrati of Padua. However, these published works do not allow us to gauge her knowledge of physics, which can only be surmised, to a certain extent, by a survey of the fifty-one surviving unpublished physics lessons she gave to students who attended the Institute of Science of the Concordi Academy from 1752 to 1777.[82]

The qualifications in natural philosophy which permitted Roccati to teach physics at Rovigo for twenty-five years were not acquired in her hometown, but at Bologna and Padua, traditionally two of the most important university towns in Italy. In 1747, Giambatista Roccati took the unusual step of sending Cristina, chaperoned by her aunt

and her teacher, Bertaglia to Bologna to study philosophy under the guidance of the Camaldonese monk Bonifacio Collina, public lecturer in logic at the University of Bologna since 1722 and under the patronage of the Bologna senator, Marquis Guido Pepoli. Collina was supposed to have taught Cristina Cartesian philosophy, and no doubts he did, because her physics lessons demonstrated an extensive knowledge of Cartesian natural philosophy. But as he was also to prepare her for a degree in philosophy, Collina introduced her to many elements of Aristotelean philosophy and methodology, which were still part of the university curriculum in the first half of the eighteenth-century as can be surmised from Bassi's 1732 theses.[83]

In January 1748, in one of her many letters to her cousin Silvestri, Roccati described the study program she was to undertake while at Bologna: it would encompass French, Latin, logic, metaphysics, ethics and physics. Besides the two languages, the first courses taken by Roccati were logic, and the sphere and meteor. By October 1748, she began to study metaphysics, which, according to her description to Silvestri in January 1749, was divided into three parts dealing firstly, with the Being, secondly, with causes, and thirdly with God, the angels and the human mind. By October and November 1749 Roccati began, to her great delight, the study of geometry and physics. She intended to dedicate a great deal of time to these two sciences, particularly to geometry, which she believed sharpened the mind. By December 1749, her study of physics consisted of the very Aristotelean concept of the generation and corruption of bodies, whereas geometry consisted of the study of Euclid's second book. Moral philosophy seems to have been the last course of studies she undertook before her degree on May 5, 1751.[84]

There are some indications that Roccati studied French and Latin with other young people. Amongst this group there were two other young women, the Countesses Carati. But as Cristina's principal instructor appears to have been Collina, who taught only logic in a public setting, it might be assumed that most of the courses he taught her were given privately. Since private lessons were common in Bologna, it is possible that Roccati shared these lessons with other students, as occurred in Bassi's experimental physics classes given at home. It is also possible that Roccati attended the logic lectures given by Collina at the university, as she appeared to be present at the many conclusions which were given in the various learned monasteries of the town, and at the physics' demonstrations given at the Institute of Sciences. However, one might assume that her lessons in Bologna were, on the whole, privately taken, as women would continue to do until 1874.[85]

As Collina had no expertise in mathematics, it befell to Giovanni Angelo Brunelli, a member of the Academy of Sciences and assistant of Eustachio Zanotti at the Bologna observatory, to teach the subject to Cristina. Unfortunately, Brunelli left Italy sometime in 1750 to become mathematician to the King of Portugal. Thus by September 1750, Roccati still had no mathematics teacher.[86] The fact that Roccati could not find anyone to teach her either Newtonian physics, or mathematics in a town where both subjects were well known amongst its intellectual elite, is proof that female university students were not exactly welcome, and might have prompted her to move to the University of Padua after her degree. Bassi was qualified to teach Cristina both subjects. But, perhaps, Bassi could not afford, so early in her teaching career to have a young woman amongst her university age male students. By the same token, perhaps the Roccatis felt that

Cristina's education might not have been taken seriously if imparted by a woman. It seems that Italians were not quite ready to have a woman natural philosopher teach another woman natural philosophy. Similarly, since the members of the Bologna Academy of Sciences failed to nominate Roccati for an academy membership, it also appears that many of these members were not quite ready to have two women members actively present in their rank. Thus, Roccati's move to Padua might have been motivated not only by her need to acquire a better education, but also by her failure to insert herself in the academic life of Bologna, as Bassi appeared to have done. Not being a native of Bologna, and with no scientific publications to her name--not even her theses--a degree was all that Roccati could realistically have achieved at the time. It was still considerably more than women achieved elsewhere in Italy. It appears that Cristina believed she would have better luck at the University of Padua, which was after all the official university of her own home state, the Venetian Republic.[87]

At Padua, Roccati's sole teacher in the sciences appears to have been Giovanni Alberto Colombo, who taught philosophy, physics, and astronomy, geography, meteorology at the university. Roccati seemed delighted with her new teacher, a man whose excellent manners and ability to teach encouraged her. There are no doubts that her scholastic year in Padua was profitable as far as the learning of Newtonian physics and mathematics were concerned. Roccati's familiarity with Newton's *Opticks* and *Principia*, which can be discerned in the lessons she gave later at the Academy of Concordi, offered proof of these studies' profitability. When she digressed from Newtonian mechanics, Roccati showed the influence of the Paduan schools of Jacob Hermann and Giovanni Poleni, who had been and were teachers at that university. The

enthusiasm Roccati was showing for what she was learning at Padua caused much chagrin to her former teacher Collina, who as a Cartesian, approved her studying the conic sections and algebra, but thought studying Newtonian physics of little value.[88]

Roccati might have been eventually able to insert herself into Padua's academic life, as she intended to continue to study physics and mathematics there for, at least, another scholastic year. This was at least the desire of her teacher and friends. However, her father's actions forced Roccati back to Rovigo, where she was to remain for the rest of her life. On August 15, 1752, Roccati's father had to flee Rovigo, after it was apparently discovered that he had taken some funds from the Camera al S. Monte, of which he was one of the administrators. The father was allowed to return to Rovigo just before he died in 1754, but not before, one suspects, the family had paid back the funds he had taken. The whole affair left Roccati in reduced circumstances, and unable to return to Padua. From then on Roccati's academic career was associated with the Academy of Concordi, of which she was a member, and where, fortunately, she had been nominated physics lecturer of its teaching Institute of Science since July 27, 1751.[89]

Initially, Roccati's residence at Rovigo did not prevent her from continuing her studies. Colombo encouraged and assisted her in this enterprise through his letters. From 1752 to 1754 Roccati studied the eighth book from Euclid's *Elements* as well as parts of Archimedes, Apollonius' conic sections, Musschenbroek's small pages (*Elementa physicae*?), the algebra in Maria Gaetana Agnesi's *Instituzioni analitiche*, and Colombo's work on statics with little or no difficulty. It is obvious from Colombo's letters that Roccati was familiar with finite analysis as it was expressed in Agnesi's *Instituzioni* but we cannot tell whether she ever attempted to study the infinitesimal calculus so well

explained in the same work. Her physics lessons cannot be used as guides to her knowledge in either finite, or infinite analysis for Roccati never made use of either in those lessons which survived. When mathematical explanations were required in the lessons, Roccati made exclusive use of synthetic geometry, which was the mathematics most familiar to a general audience.[90]

From Colombo's reactions to her mathematical and physical studies it appears that she managed both subjects with ease. Her solution to a problem derived from the sixth book of Euclid's *Elements*, of which she had a few doubts, was quickly confirmed by Colombo. He also approved of the dissertation she sent him in 1753 on her observations on the formation of lightning. She had been led to write the dissertation after noticing once a mass of "vapours" (methane?) rising from the ground, which agitated by the air, had exploded into a lightning bolt that then fell close to her feet.[91] Although the incident occurred after the Marly-la-Ville experiments in Paris and those of Veratti's and Francesco Marini's at Bologna in 1752, which confirmed in a dramatic way Franklin's statements on the electrical nature of lightning and on how to draw such an electricity, neither did Roccati or her teacher directly equate lightning with electricity.[92]

We do not have the dissertation Roccati sent to Colombo, but from the description of the incident, Colombo's answer, and from her lesson on effluvia given at the Academy of Concordi in 1758 we can surmise that both teacher and student were strongly influenced by Newtonian principles. The latter stated that a " body sufficiently agitated throws off subtle particles, which, if the agitation be regular, induce the effluvia of fire, light or electricity ". It is clear from Colombo's answer to Roccati's dissertation, that both believed that lightning would occur wherever the matter of lightning would be present,

whether it be in the clouds, on the surface of the earth, or underground. If lightning occurred underground, it would give rise to earth tremors. According to Roccati, the "vapours", strongly agitated by the air, gave off the effluvia of lightning. Although she did not refer to the lightning effluvia as electricity at the time, she might have believed as a Newtonian that the two were closely connected. During the eighteenth century, Newtonians believed that fire, heat, light, electricity and/or magnetism were interrelated. As already seen, Bassi believed in these interrelations in the 1760s, as did many others. Roccati in her 1758 lesson equated the effluvia, or light, given off by gun powder explosions, with that produced when two pieces of black marble, or glass, were rubbed together (static electricity). She also equated the effluvia of lightning with that given off by a magnet. The force of effluvia depended on the nature, shape and structure of the bodies from which they were given off. Newtonians used effluvia to explain descriptive forces of attraction and, occasionally, those of repulsion, and Roccati was no exception to the rule.[93]

In the same letter, Colombo had encouraged Roccati to attempt more works based on her own observations and experiments, and not simply repeat the sayings and findings of other natural philosophers. Had Roccati stayed in Padua, or Bologna, where she might have had access to equipment, and where she could have exchanged ideas with natural philosophers involved in experimentation, she might have been able to follow Colombo's advice. But, probably, finding herself in reduced circumstances in Rovigo, away from the most important centres of research, and after apparently having lost much of the correspondence she had amassed in the earlier years, Roccati was bound to reduce her expectations to what she could realistically achieve in her field of choice.[94]

The Academy of Concordi had apparently teaching facilities as did other Venetian academies of the period; and, undoubtedly, through the lessons taught by its members, the academy did much to improve the level of knowledge in the sciences and in a variety of subjects of those people of varied background who bothered to attend. These public lectures were given for a period of eight months, twice weekly. Each lecturer was assigned a specific number of lessons he/she had to give during the scholastic year. Until Roccati became an 'extraordinary' lecturer in 1777 at her own request, she invariably gave three lessons in physics each year, usually in December, March, and June, or May. Male lecturers gave approximately the same number of yearly lessons as she did. For instance, Francesco Angeli, who taught astronomy also gave three yearly lectures, as did Nicolò Angeli, who began teaching general physics in 1770. It is obvious that each lecturer gave few yearly lessons because they had to share a single teaching facility. Roccati faithfully gave her three yearly lessons over a period of twenty-five years and qualified practically every year for the prizes instituted by the academy in 1760 to those lecturers who gave and then deposited their lessons at the institution.[95]

In 1768, like other Venetian academies, the Concordi established an agrarian society as a branch of its Institute of Sciences, at the request of the Venetian government. Its purpose was to encourage research in the agricultural field in order to improve the agriculture of the Rovigo region in particular, and that of the Venetian Republic in general. However, unlike the Academy of Sciences of Bologna, the Academy of Concordi had no physics cabinets with suitable instruments with which experiments could be carried out. Thus, if Roccati wanted to follow Colombo's advice and engage in her own experimentations and observations, she would have to buy the equipment

herself. Her financial conditions might not have allowed such an expensive enterprise to be carried out; and thus, Roccati had to content herself with critically evaluating, and then presenting to her class what she believed to be the best physics of the period. Savaris mentions, perhaps accurately, that Roccati did not engage in experimentation; however, we have no proof that this was the case. Some of the experiments mentioned in her lessons were simple and straight forward enough, and thus could have been carried out by Roccati with practically no equipment: for instance, one could mention some of the experiments which were found in her 1757 and 1758 lessons on effluvia. Although it is true that Roccati did not formulate any scientific proposition that we know, it cannot be said with any degree of certainty that she never experimented or observed.[96]

Much has been made of the fact that in 1754 and 1755 Roccati was elected president of a public academy. At the time, her nomination caused a split amongst its members. Some members, who objected to have a woman as the head of the academy, left the Concordi to set up the Academy of the Allegri. But the Academy of Concordi's journal indicate that she had little to do with the running of the academy during her presidency as well as at other times. The academy's members met twice a year in the early 1750s, and six times a year after 1757; Roccati never attended any of these meetings. For the two years she was president, a male member acted as *in loco principis*. Thus it is as a lecturer in physics and, as someone who helped spread Newtonian physics that Roccati's greatest success rests.[97]

Savaris has appropriately pointed in her thesis that male historians, when discussing the spread of Newtonian physics in Italy have tended to ignore the role some women had in propagating it.[98] That Roccati, like Bassi, taught Newtonian physics can be easily

detected from the surviving lectures in optics she gave, and deposited at the academy. In them, Newton reigned supreme. Although the opinions of other philosophers were mentioned, these were dismissed if they did not coincide with Newtonian views on light, vision, colours or refraction. For instance, in a lesson given in 1759, Roccati presented various philosophical opinions from Greek to modern times on the nature of light. Amongst these she included Descartes' opinion that light consisted of pressure, and Malebranche's, which favoured an analogy between light and sound. To this latter philosopher, light consisted of vibrations; the greater the vibrations, the more luminous a body would appear. As far as Roccati was concerned, such explanations had to be dismissed, for if light consisted of pressure, or impulse it would propagate at all distances in an instant, which was contrary to the phenomenon of Jupiter's satellites. To Newton, and thus to Roccati, light was a real physical substance, finer, and subtler than air, running enormous distances in a very short time, in any direction, in straight lines.[99]

In other lectures Roccati used Newton's definition of white light and of colours, which she accepted implicitly. In 1762, for instance, she used descriptions and illustrations of Newton's experiments with two prisms, and one prism and lens to disprove various philosophers' hypotheses on colours. According to Roccati, Newton's experiments showed that white light rays were composed of heterogeneous particles, which differed in size, shape, and therefore colour. The prism sorted the particles like beams; the colour of one such homogeneous beam or ray could not change however much one reflected or refracted it. The rays that differed in colour also differed in refrangibility. Violet rays diffracted most and thus contained the smallest particles; they were also capable of exciting the briefest and shortest vibration in the retina. Red rays

diffracted the least, contained the largest particles, and would excite the longest vibrations in the retina. Rays of white light, diffracted by a prism could recombine by means of another prism, convex lens or concave mirror into white light again.[100] Roccati might be disparaging of Malebranche's concept of how different colours were produced by faster or slower vibrations; however, she was ready to accept Newton's explanation of how the brain perceived colours: the particles of light produced vibrations in bodies, which in turn produced vibrations in the subtle medium (aether); the vibrations then penetrated the eyes via this medium, and excited vibrations at the bottom of the eye (retina). These vibrations varied in length and thus caused varying sensations of colour in the brain.[101]

Roccati made reference in several of her lessons to Snel's law of refraction, or Descartes' law, as it was often known in the eighteenth-century. According to Roccati refraction was a shifting of light from its straight path while it passed from a medium to another; thus its law stated that the ratio of the sine of the angle of incidence to the sine of the angle of refraction was a constant. This ratio was always 4 to 3 for light that travelled from air into water, and 3 to 4 when it travelled from water into air. But because of the corpuscular nature of light, its velocity was directly proportional to the medium's refractive index. Following Descartes and Newton, Roccati believed that light travelled faster in a denser medim than a rarer one. As expected, she provided the Newtonian explanation that in the denser medium stronger attractive forces pulled light into the medium, refracting it closer to the vertical, and by the same token, increasing its speed. However, exception had to be made for sulfurous and unctuous bodies, whose greater attractive forces made light move faster in them than in a denser medium. With those

principles in mind, Roccati had to reject Fermat's and Father Magnan's statements that light travelled faster in rarer medium.[102]

On lessons dedicated to vision, Roccati described the anatomy of the eye. She showed how objects might appear larger or smaller, distinct or confused, or closer or further away from the eye. In other optical lessons, Cristina discussed catoptrics, or the vision of objects in mirrors, where she provided the needed geometrical demonstrations of how the eye perceived objects in mirrors, with a promise to her audience to keep the mathematics as simple as possible. Still in other lessons she explained convex and concave lenses, double refraction, and all the instruments of dioptric formed by one or more lenses which improved eyesight, such as microscopes, telescopes and glasses. Many of the lessons had geometrical demonstrations and proofs, and mentioned a considerable number of experiments. As some of the experiments did not require complicated instruments, but mirrors for instance, Roccati might have tried these experiments herself, at her own home. One cannot tell from the surviving lessons. She also provided illustrations for each of the students attending the class, and throughout optical terms were defined and clarified. On the whole, it can be said that Roccati's optics' lessons were clear, well explained, and thus, must have improved the knowledge in the subject of those who attended the lessons. This was, and still is, ultimately the function of a good teacher.[103]

Between 1764 and 1766 Roccati gave a series of lectures on hearing and sound, where she not only provided the anatomy of the ear, but also discussed how sound was propagated. If Roccati had been ready to accept Newton's view that vision might have been associated with vibrations in the aether, which then penetrated the eye and excited vibrations in the retina, she was not quite sure, that Newton was right when he claimed

that vibrations in the same aether were also responsible for propagating sound. As far as Roccati was concerned, a bell which was rung in a vacuum did not emit any sound. Thus sound seemed to need a medium like air or water to propagate. In fact denser cold air propagated sound better than warm air. To her, sound was but a vibration or ondulation of the external air caused by the motion of a sonorous body, which then gathered in the external ear, touched the eardrum, hit and agitated the four small bones. These bones vibrated the internal air, which then made an impression on the auditory nerves and thus the brain. Since there were various sounds, there must have been various impressions in the internal air. That air mattered in the propagation of sound was also obvious from the fact that the speed of sound varied, as Mussechenbroek claimed, with atmospheric conditions.[104]

Between December 11, 1766 and May 19, 1768 Roccati gave a series of lectures described in the catalogue of the academy as "On the Sensible Principles of Bodies ". They dealt essentially with chemistry as it was understood before the identification of many of the gases in the 1760s and 1770s, and Lavoisier's discoveries and chemical nomenclature. Again, Roccati based her lectures on the works of others; the authors she mentioned most often were Newton, Boyle, Boerhaave, E.L.Geoffroy and W. Hamberg. These authors shared in common a desire " to find a compromise between the experimental investigations they performed in the laboratory with a mechanistic view of nature ".[105]

In the first lesson Roccati defined elements as the simplest things which formed matter. The Aristoteleans had four elements: water, air, fire and earth and the chemists had five elements: sulfur, mercury, salt, water and earth. To Roccati the sensible

principles of bodies were a combination of the Aristotelean and the chemists' elements and consisted of air, fire, earth, water, sulfur, mercury and salt. Four subsequent lessons were dedicated to fire, air, water and sulfur, and another lesson to earth, salt, and mercury.[106] These lectures displayed much of the ambiguity that existed in chemistry in the first half of the eighteenth-century: elements could still be considered the principles of bodies, but came to mean, increasingly, material substances, like compounds, which obeyed chemical and physical laws. For instance, Roccati, following Hamberg, defined salt as a principle and the ingredient of all bodies: mineral, vegetable and animal, with the exception of a few metals and stones. But there could also be different sorts of salts, according to the different matters with which they were mixed. Laboratory work showed that niter, vitriol and marine salt were different from each other, and were compounds. Sulfur was an oily substance, which could be melted, was inflammable and could not be dissolved in water. Hamberg had said, and Geoffroy had proved, that sulfur was composed of an acid salt, some earth, oily inflammable matter and some metal. But mineral or fossil sulfur coud not be confused, according to Roccati, with sulfur, a particular matter or principle, which entered together with mercury in the composition of all metals. Mercury itself could be considered by some a metal, but not by Boerhaave, who believed it to be the basis of all metals, as alchemists had done before him. Nevertheless, mercury demonstrated to Roccati some of the metals' properties, such as specific gravity, or conductivity, or as she would have it, in the same cold, it felt colder, and in the same heat, it felt hotter.[107]

Influenced by H. Boerhaave's *Elementa chemiae* (1732) in her lesson on water, Roccati seemed to reject Van Helmont's and Boyle's concept (accepted by Newton) that

water could be transmuted into earth. To her, water was a solid crystal only when it lacked a certain degree of heat. She accepted that water was a general solvent, but as it was part of all bodies, it could be easily separated from these bodies by the use of heat, such as in distillation.[108] Like Boerhaave, Roccati believed fire to be a substance, whose subtle particles could penetrate bodies, and increase their weight by means of the absorption of those particles by the bodies. Thus mercury, heated slowly in a sealed glass over a period of time, would solidify and increase its weight considerably. Such weight increase occurred only by the addition of fire particles to the mercury. Roccati also discussed Boerhaave's concept of fire as manifested in heat--elementary fire--and fire manifested in combustion--common fire. The elementary fire had the effect of heating bodies and thus was responsible for the dilatation of solids and the rarefaction of liquids. Then Roccati mentioned the experiment she had observed, when a student, at the Academy of Sciences of Bologna, carried out with Nollet's machine, whereby a bar of iron, expanded by heat, would return to is normal size after cooling. Common fire, on the other hand, burned combustible bodies, needed air to sustain it and dissipated in vacuum.[109]

In her lesson on air, Roccati re-enforced what she already had made obvious in her lesson on fire, that air played purely a mechanical role in chemical phenomena like calcination, as Boerhaave claimed. In wood combustion for instance, the air's weight pressed the corpuscles of fire against those of the wood and impeded the rapid diffusion of the flame. In the best Newtonian tradition, Roccati believed that the forces of attraction and repulsion all bodies possessed could either fix air or make it expand; the attractive forces that fixed air might transform into repulsive forces either by heat or

another agent, causing "air" to expand , and thus become elastic. For instance, iron shavings combined with oil of vitriol (sulfuric acid) and water formed "air" so full of elasticity that the liquor could not return to its original place (volume).[110]

Hales' was never mentioned in these lectures; nevertheless, there is evidence that she was familiar with his analysis of air: the experiment on the iron shavings and oil of vitriol, and the concepts of forces of attraction and repulsion, and of fixed and elastic air reflected his work. Roccati absorbed Hales' work on "air" via Boerhaave's *Elements of Chemistry*, which were influenced by Hales' *Vegetable Staticks*. Ultimately, it is Boerhaave's influence which reigns supreme in Roccati's chemical lessons. His concept that chemical reactions were essentially solutions can found in her description of copper's reaction with *aqua fortis* (nitric acid) as a division of matter into very small parts. Boerhaave's theory on reaction and solution explained in terms of Newtonian attractive forces, or of the affinity that existed between the particles of the menstruum (solvent) and the particles of the dissolved substance, is again found in Roccati's lectures. Thus, if alkaline and acid bodies combined, they formed a body which could not be separated, unless mixed with another body which could be more attracted to the [alkaline] body that had united with the acid beforehand. She believed, like Boerhaave, that air might possibly have some chemical function. For instance, she thought possible that the air's abundant acid particles could corrode iron.[111]

Between July 1751 and June 1757, and then again between 1768 and 1770, Roccati gave a series of lectures related to mechanics. Of the sixteen surviving lessons on the subject, three were spent explaining simple machines, which Roccati defined as the lever, balance, pulley, inclined plane, axle, wedge and the Archimedian screw. In all these

lessons, Roccati demonstrated the relationship that existed between the force applied by the particular machine under discussion and the body which had to be worked upon by being lifted, shifted, or split. She relied on W.J. 'Gravesande for some of the lessons,[112] and Christiaan Huygens's *Horologium oscillatorium* (1673) for her lessons on penduli. She mentioned the fact that Huygens had discovered that a pendulum oscillated by cycloid arcs, and that these arcs were all travelled in perfectly equal times. Then Roccati proceeded to explain several of the properties of cycloid curves, some of which had been demonstrated by Johannes Bernoulli and Mairan in the *Memoires* of the Paris Academy in 1722. Newton had discussed, of course, the pendulum relation to the cycloid curve in his *Principia*, giving credit to Huygens for such a discovery; but Roccati did not mention him in the lessons.[113]

Newton's *Principia* played a dominant part in many of her mechanics lessons, but not without a few discordant notes. Roccati began her first lesson of 1752 by providing the students with Newton's three rules of reasoning in philosophy; then she defined what were the primary laws of nature, which depended on the will of God: gravity of bodies, force of attraction and inertia. In June of the same year Roccati explained the attributes of inertia, which she believed had been first observed by Newton. In another undated lesson she defined terms like quantity of matter, velocity and quantity of motion (this latter given as the quantity of matter times the velocity). She showed how the parallelogram of forces could be used in cases of equal (uniform) motion. Roccati then proceeded to give and explain Newton's three laws of motion.[114]

On her lessons on compound motion and on gravity, Roccati defined in Newtonian fashion the force of gravity as being proportional to the inverse square of the distance.

Roccati could not say what was gravity, except that it was an attribute of matter. Furthermore, according to Newton's second law, celestial bodies also had gravity. If the earth was a perfect sphere, all bodies moving downward would go perpendicular to the horizon; but Newton had calculated and Maupertuis and Clairaut later proved that the earth was a spheroid flattened at the poles. Thus, due to its spheroid shape, not all bodies would fall towards the same point. But as the differences were small, the force of gravity can be taken as a constant everywhere on earth.[115]

Roccati used the gravitation pulls, or actions, of the moon and the sun on the earth as expounded by Newton's Proposition XXIV of Book III in her lessons on oceans in 1769 to explain why tides were greater at syzygie, when the sun and the moon were in conjunction, and smaller at quadratures (the moon when at 90° elongation from the sun), when the water raised by the sun was depressed by the moon. In one of the lessons Roccati had also presented Descartes' and Galileo's reasons for the origins of tides to dismiss them both. Ultimately, it was Newton's hypothesis which was the most acceptable, but with a caveat, for modern philosophers like Euler believed that Newton had to draw not from a physical property, but from an occult quality--the force of attraction--to explain the flux and reflux of the seas.[116] In 1752, Roccati appeared to have accepted the force of attraction as one of the primary laws of nature, which depended on the will of God. By 1769, influenced by modern philosophers like Euler, she seemed no longer sure of its validity in explaining certain physical phenomena like tides.

Roccati had been educated by a Cartesian in Bologna; then she moved to Padua to study Newtonian physics at an university where Leibnizian and Cartesian influences had

been, and where still were present in men like J. Hermann, N. Bernoulli, the Riccati's, and particularly, Giovanni Poleni, whom she knew personally. The ideas that circulated at Padua and in the Venetian Republic affected how Roccati understood and taught mechanics, as it becomes apparent in her undated lecture on central forces. The unnamed source for that lecture was Johann Bernoulli, whose ideas had been communicated to her by Giovanni Poleni, or by her teacher, or even by Vincenzo Riccati, who shared her opinions whereby a body, following a curved trajectory around a central point, experienced two forces, a centripetal one which directed the body towards the centre, and a correspondingly equal, but opposite, centrifugal force which moved it away from the centre. Much of the work on central forces in the first half of the eighteenth-century arose from the need by natural philosophers like Leibniz, Bernoulli, Poleni, Malebranche and others, who accepted the Cartesian vortex theory, to conciliate it with Kepler's three laws of planetary motion, based on observation, and Newton's law of universal gravitation. Roccati's lesson was very much influenced by the work of these natural philosophers on central forces, and only indirectly by Newton's *Principia*.[117]

The influences of the Paduan school can also be detected in her lectures on force. These lectures seem to indicate that Roccati's definition of force changed over time. Unfortunately, as the lectures are undated, we cannot say in what direction the change occurred. In the lecture dealing with principles of mechanics, Roccati, like the Cartesians and Newtonians, used the quantity of motion--defined as mass times velocity--as a measure of force. In the lesson which discussed the parallelogram of forces, Roccati, like Leibniz, defined force as a space dependent function, which was made equal to the mass times the velocity squared. Most importantly, like the Leibnizians, Roccati did not

believe that the quantity of motion was conserved, as the Cartesians claimed.[118] Thus, one might conclude that, although Roccati towed the Newtonian line in optics, she was also under the influence of the Paduan school and of Leibniz in her approach to mechanics.

In 1770, Roccati was appointed to teach particular physics, which from the academy's catalogues can be surmised to have covered the sphere of the universe and principles of astronomy. The general physics she used to teach in previous years was taken over by the recently appointed Niccolò Angeli. His ten surviving lessons, all in Latin, dealt with topics similar to those covered by Roccati in the previous twenty years. Although his lessons were in Latin, they did not present any more difficulty than Roccati's lessons had; he also used synthetic geometry like Rocccati. Very few of Roccati's later lessons survive. In that period she also failed to qualify for prizes a few times, as she had not deposited her lessons at the academy. Perhaps illness prevented her to carry out her duties to the same level as before, but, perhaps, she was unhappy with the topics which were imposed on her. As it turned out, Roccati resigned from her position as regular lecturer in 1776, to become an extraordinary lecturer. This implied that her lessons were not given at fixed dates, but only occasionally. Her name remained in the catalogue as extraordinary lecturer until 1791. The catalogues of lessons given at the academy were printed until 1838, but no other woman's name appeared in them, Roccati had been the sole woman to have been a member of the teaching faculty.[119]

Only three known lessons survive from the 1770-1777, all dated from 1774. These have been discussed in detail by both Cessi and Savaris. Cessi, writing in 1901, dismissed in the best positivist tradition Roccati's efforts to explain the creation of the

universe as an act of God; he defined these efforts as the product of a mediocre mind, and as speculative theological metaphysics controlled by Jesuits.[120]

Savaris, writing in 1990, avoids positivist statements. She appropriately points out that Roccati's seeing the hand of God in the order, harmony and symmetry that existed in the universe, was a reaction against the Encyclopedistes and against the purely materialistic causes Buffon attributed to the formation of the solar system and which he developed in his *Histoire naturelle* published in 1749, or, as one can add more specifically, in the " Preuves de la théorie de la Terre" it contained. Savaris also stresses that Newton did not think any differently than Roccati. In fact, Newton called upon theological and final causes to explain the structure of the universe, its stability, its formation and its evolution. Consequently there were two Newtonian ideas present in Roccati's 1774 lectures: the first idea was the belief that there was a divine mind behind the disposition and the harmony of motion of bodies in the universe. The second was found in Proposition 8 of Book III of Newton's *Principia* whereby the planets were placed at different distances from the sun, according to their degrees of density.[121]

Savaris' arguments make more sense, but it is difficult to ascertain how Roccati's theology-infused lessons on the origins of the universe were taken by her 1774 audience. Although we do not know with certainty who attended her lectures, it can be assumed, from the mathematical knowledge which was expected of them, that they had a rather high level of education. Such a social group had become increasingly secularized in the second half of the eighteenth-century, and had become exposed to a variety of periodicals, such as Caminer Turra's *Giornale enciclopedico*, which were secular, reformist in nature, and influenced by the ideas of the *Encyclopedie.* Natural

philosophers, such as Alberto Fortis, objected in print to any biblical interpretation of natural phenomena. Thus, if Newtonian physics was always welcome, theology-infused lessons might not have been as welcome in 1774, as they could have been at the beginning of the eighteenth-century. Such a possible reaction on the part of her audience, or even by other members of the academy, might also explain why Roccati decided to retire from regular teaching by the end of 1776, when she was only forty-four years old.[122]

Roccati's former biographers have pointed out that she was no experimentalist, nor did she produce any original research, and thus, based her lectures solely on the research of others. This is essentially true, but in her defence one can state that Roccati's job was to teach physics, not to do research. The other teachers at the institute did the same. Some research might have been carried out by those responsible for the agricultural section of the academy, for it was part of their mandate from Venice to do so. Besides, as already discussed, we have no concrete proof that she never engaged in any experimentation. However, her choice of topic--physics--combined with her financial circumstances, and perhaps, her own inclinations, would certainly severely limit the types of experiments she could realistically attempt. Had family circumstances allowed her to remain in Padua, associated with the university, and as a member of the Academy of Ricovrati, the forerunner of the Padua Academy of Sciences, Roccati might have taken the research route, as Bassi was able to do at Bologna.

Thus, one might say that Roccati was never able to integrate in the Italian scientific life of the eighteenth-century quite as effectively as Bassi. Nevertheless, she broke some important ground. Firstly, Roccati was able to teach publicly on a regular basis, more

rapidly than Bassi had been able to do. That she gave only three lessons a year, was not because of her sex, but because she had to share a limited teaching facility within the academy. Men gave approximately the same number of lessons a year as Roccati did. Secondly, in order to receive an education, Roccati was willing to move to university towns where such an education could be obtained. Thus, she and her father were willing to test new ground. Had other young women and their families done the same, universities in Italy might have opened earlier for women. Finally, had Roccati received some teaching position at Padua, the university of her native republic, it is likely that she would not have returned to Rovigo permanently.

A survey of Bassi's cabinet, experiments and correspondence, and of Rocccati's lessons illustrates that both women should be considered pioneer women teachers' in physics, even by the modern definition of physics. Like their male counterparts, they had the official qualifications to teach: degrees in philosophy from an Italian university. They also continued to study after their degree in order to improve both their knowledge of physics and mathematics. Interested in experimental physics, and desirious to teach it, Bassi, in addition, learned to operate and explain the equipment needed to teach the subject effectively. Both women were eminently qualified to follow an academic career equal to that of their male counterparts. But because they were women they did not. Tradition ensured that they would never teach publicly at any university on a regular basis. Bassi and Roccati eventually taught publicly on a regular basis at new institutions (Institutes of Sciences) with no tradition of excluding women. Nevertheless, tradition played a part in the granting of their university degrees. The belief on the part of those who controlled the University of Bologna that women like Bittizia Gozzadini had been

awarded degrees from the institution in the past, facilitated the granting of degrees to Bassi and Roccati. Tradition also ensured that Bassi's home lessons in experimental physics would be recognized by the university's administrative body. The university's administrative body thought it reasonable that women teach the equivalent of an university course at home. Teaching at home by professors had been recognized by the Bologna Senate since 1665. Furthermore, women had supposedly taught law and medicine at home either independently, or as assistants to male members of their families during the Middle Ages and Early Renaissance, since the university did not really have the facilities for public teaching at the time. On the whole, it may be said that women could play a limited role in the University of Bologna's academic life by the eighteenth century. Roccati and particularly, Bassi had tested the limits of this role. Maria Gaetana Agnesi and Anna Morandi Manzolini were also given, at their own requests, the opportunity by Benedict XIV to test the limits of this role. These latter women had no university degrees, but their publications and productions clearly illustrated their learning on the subjects they were assigned to teach. However, they failed to show Bassi's determination in testing the limits of the role the university's administration assigned to women.

[1]For the women physicians of Salerno see Orofino, pp. 43-58; the source for Bocchi's teaching dates from 1714, see Orlandi, *Notizie degli scrittori bolognesi*; for Danti see Oldoini, pp. 313-14; for Ardinghelli see Vitrioli, p. 37; for Fiorini Mazzanti see Castracane, pp. 321-22.

[2]For Bassi's and Roccati's degrees see Berti Logan, pp. 787-88, 802; Savaris, pp. 22-25; for Agnesi see Carla Vettori Sandor, " L' opera scientifica ed umanitaria di Maria Gaetana Agnesi ", *Alma mater studiorum*, pp. 105-18; Anzoletti, *Maria Gaetana Agnesi*, pp. 156-58; for a discussion of the contents of her theses see Ulrike Klens,

Mathematikerinnen im 18. Jahrhundert: Maria Gaetana Agnesi, Gabrielle-Emilie du Châtelet, Sophie Germain, (Pfeffenweiler: Centarus- Verlagsgesellschaft, 1994), pp. 143-76; for Morandi Manzolini see Michele Medici, " Elogio di Giovanni e di Anna Morandi coniugi Manzolini ", *Memorie della Accademia delle Scienze dell' Istituto di Bologna*, T. VIII, (1857), pp. 3-26; Vittoria Ottani, Gabriella Giuliani-Piccari, " L'opera di Anna Morandi Manzolini nella ceroplastica anatomica bolognese ", *Alma mater studiorum*, pp. 81-103; Maurizio Armaroli, " Le cere anatomiche bolognesi del settecento ", in *Le cere anatomiche bolognesi del settecento*, M. Armaroli ed., (Bologna: Clueb 1981), pp. 41-64.

[3]Much of the ground covered in the following pages, has already been covered by Berti Logan, pp. 785-812; see also Cavazza, " Laura Bassi e il suo gabinetto di fisica...", pp. 715-53; Paula Findlen, " Science as a Career in Enlightenment Italy. The Strategies of Laura Bassi ", *Isis*, 84, (1993), pp. 441-69; Ceranski, pp. 207-31.

[4]For the scientific careers of women in the late nineteenth and early twentieth centuries, and the difficulties they encountered, and the strategies they used to achieve some sort of success see Abir-Am and Outram eds., *Uneasy Careers and Intimate Lives*; G. Kass-Simon and Patricia Farnes ed., *Women of Science: Righting the Record*, (Bloomington: Indiana University Press, 1990); Marianne Gosztonyi Ainley ed., *Despite the Odds: Essays on Canadian Women and Science*, (Montreal: Véhicule Press, 1990); Helene M.Pycior, Nancy G. Slack and Pnina G. Abir-Am eds., *Creative Couples in the Sciences*, (New Brunswick: Rutgers University Press, 1996).

[5]Bassi and her family belonged most certainly to the professional bourgeoisie, see Berti Logan, p. 786 and note; see Bassi's own description of her early education in the back of a letter from Flaminio Scarselli dated: Rome, July 20, 1743 in B.C.A.B.: Ms. B. 2024: *Lettere autografe scritte da illustri italiani e stranieri alla celebre dotoressa bolognese Laura Maria Caterina Bassi e al marito di lei Giuseppe Veratti;* see Giampietro Zanotti's letter to Father Riva of April 15, 1732 in B.C.A.B.: B. 382: *Lettere di Giampietro Zanotti al Padre Giampietro Riva*; Cardinal Lambertini became Archbishop of Bologna in 1731, see M. Rosa, " Benedetto XIV ", *D.B.I.*, Vol. 8, pp. 393-408.

[6]For more detailed information on Lambertini see Rosa, " Benedetto XIV ", pp. 398-408; Marco Cechelli ed., *Benedetto XIV (Prospero Lambertini). Convegno internazionale di studi storici*, (Cento: Centro studi Girolamo Baruffaldi, 1979); Mario Rosa, *Riformatori e ribelli nel 700 religioso italiano*, (Bari, 1969), pp. 50-85.

[7]For Bassi's membership at the Academy of Sciences see Rosen, p. 178; see also letter no. 32: April 15, 1732 of G. Zanotti to Father Riva in B.C.A.B.: B. 382; the ceremonies associated with the defense of the theses, degree and the granting of a lectureship are discussed in detail in for instance Comelli, pp. 3-47; Garelli, pp. 11-29; P. Cazzani, " Laura Bassi " in *Studi e inediti per il primo centenario dell' Istituto Magistrale Laura Bassi*, Elio Melli ed, (Bologna; STEB, 1960), pp. 9-15; for government documents on her degree and lectureship see A.S.B.: Fondo: *Senato*, Serie: Diari, anni 1714-1741, 11 e 12, ff. 131-132, May 14, 1732 and ff. 133-134, June 28, 1732; A.S.B.: Fondo: *Senato*,

Serie: Vacchetoni, Registro 60, f. 203, August 25, 1732; A.S.B.: Fondo: *Senato*, Serie: Partiti, Vol. 35, f. 45 dies 29 octobris 1732; for problems associated with the granting of the lectureship see letter no.34: Bologna, June 22, 1732 of G. Zanotti to Riva in B.C.A.B.: B. 382; see letter no. 219 of G. Zanotti to Eustachio Manfredi, of August 30, 1732 in B.C.A.B.: B. 163.

[8]See letter no. 34: Bologna, June 22, 1732 of G. Zanotti to Riva in B.C.A.B.: B. 382; letter no. 1730: n.d. of Jacopo Beccari to friend in B.C.A.B.: *Jacopo Bartolomeo Beccari: Lettere a diversi*, Collez. Aut. VI, 1710-1739; Laura Bassi, *Theses: De aqua corpore naturale elemento aliorum corporum; parte universi*, (Bologna: Lellio Volpe, 1732).

[9]See Leprotti's letters to Bianchi dated Rome, March 23, 1733 and Rome, March 4, 1733 all in B.G.R.: Fondo: *Gambetti*, Posizione: Leprotti; Manzoni's works were of a literary nature, see Manzoni to Bassi March 6, 1740, May 18, 1740 and July 13, 1741 in Cenerelli ed., *Lettere inedite..*, pp. 88-90, 93-94.

[10]For Bassi's petition for a membership, see her letters to Flaminio Scarselli of April 21, 1745, May 12, 1745, June 5, 1745, June 19, 1745 in Elio Melli ed, " Epistolario di Laura Bassi Verati ", in Melli ed. , *Studi e inediti...*, pp. 103-09; for Scarselli's answers see letters of April 23, 1745 in Cenerelli ed., *Lettere inedite...*, pp. 108-10 and no.5: Rome, May 25, 1745, no. 6: June 12, 1745, no. 7: June 26, 1745 in B.C.A.B.: Ms. *Scarselli* I, pp. 3-17.

[11]For Lambertini and reforms in the Church see Venturi, *Settecenti riformatore*, Vol. I, pp. 102-03; Rosa, " Benedetto XIV ", pp. 398-409; ; Rosa, *Riformatori e ribelli*, pp. 50-85; Giuseppe Alberigo, " Cattolicità e ecumenicità nel settecento ', in C. Buzoni e M. Pegrari eds., *Cultura, religione e politica nell' età di Angelo Maria Querini*, (Brescia, 1982), pp. 9-21; for the reforms at Bologna see Viviana Lanzarini, " Il museo ostetrico di Giovanni Galli " in *I laboratori storici e i musei dell' Università di Bologna: i luoghi del conoscere*, (Bologna, 1988), pp. 105-13; W. Tega, " Introduzione " in *Anatomie Accademiche*, Vo. I, pp. 28-32; " Benedetto XIV e la scienza fisica: nella Bologna del settecento nasce un papa Galileiano-Newtoniano ", *Bologna Incontri*, (17 giugno 1986), pp. 26-30; for Cardinal Alberoni's support of Bassi see her letter to Scarselli of May 12, 1745 in Melli ed., " Epistolario...", pp. 105-06; A.S.B.: Fondo: *Assunteria di studio*, Serie: Atti, anni 1735-45, Vo. 23: Act of November 15, 1741, f. 67; for Alberoni see Bruno Pirazzoli, " La formazione filosofica del Card. Giulio Alberoni ", *Archivio storico per la Provincia Parmense*, quarta serie, 39, (1987), pp. 321-55; for Albani's reforms of the Collegio Montalto see Giuseppe Cagni, " Il Pontefico Collegio Montalto di Bologna (1585-1797)", *Barnabiti studi*, (1988), pp. 81-100; a rough copy of Bassi's thank you letter to Albani is found on the back of Pio Fantoni's letter to Bassi dated Rome, July 9, 1766 in B.C.A.B.: B. 2024; for Leprotti's assistance see Scarselli's letters to Bassi no.5: Rome, May 25, 1745, no. 6: June 12, 1745, no. 7: June 26, 1745 in B.C.A.B.: Ms.*Scarselli* I, pp. 3-17

[12]B.C.A.B.: Bassi Laura, *Due cartoni contenendo autografi, scritti e documenti biografici, diplomi ed elogi della Bassi, sec. XVIII*, Cartone I, fasc. 2, 9, 12; for

Lambertini's actions on Bassi's behalf see B.C.A.B.: Giovanni Giacomo Amadei, *Libro delle cose che vanno accadendo in Bologna e principalmente quelle che spettano il governo sia civile sia ecclesiastico,* B. 517, c. 4r; see letter no. 219 of G. Zanotti to E. Manfredi of August 30, 1732 in B.C.A.B.: B. 163. See Benedict XIV's very important letter to the Bologna Senate to ask for a lectureship in mathematics for Agnesi in B.U.B.: Ms. 279, no. 32: *Lettera scritta al senato di Bologna dal papa Benedetto XIV, con la quale dimostra le premure che tiene acciò sia conferita una lettura onoraria alla Sig. Maria Gaetana Agnesi in matematica ed algebra...24 giugno 1750*; for Morandi Manzolini see A.S.B.: Fondo: *Senato*, Serie: Vacchetoni, no. 69, 1753-1755, f. 253v. A di 29 dicembre 1755; A.S.B.: Fondo: *Senato*, Serie: Partiti, Vol. 39, f. 2v-3r, 26 febbraio 1756.

[13]Cavazza, *Settecento inquieto*, pp. 72-73; Rosa, *Riformatori e ribelli*, p. 72; see Bianchi's letters to Leprotti of February 19, 1733, March 12, 1733 and June 17, 1733 in B.G.R.: Ms. 963, *Lettere autografe* alla data; Leprotti to Bianchi March 4, 1733 in B.G.R.: Fondo: *Gambetti*, Posizione: Leprotti.

[14]For the edict from the senate regarding her sex and the ability to teach see A.S.B.: Fondo: *Senato*, Serie: Partiti, Vol. 35, dies 29 octobris 1732; for her difficulties with the academy of sciences see her letters to Scarselli of April 21, 1745, May 12, 1745, June 5, 1745, June 19, 1745 in Melli ed., " Epistolario...", pp. 103-09.

[15]Traversi, pp. 21-23; see letters no. 1730, 1734, 1736, 1737 of Jacopo Beccari to friend, s.d. in B.C.A.B.: *Jacopo Bartolomeo Beccari: lettere a diversi*, Collez. Aut. VI, 1710-1739.

[16]For Mme. de Montanclos see Gelbart, " Le donne giornaliste e la stampa ", pp. 450-51.

[17]Laura Bassi, *D.O.M. Laura Maria Catherina Bassi civis bononiensis Academia Instituti Scientiarum socia se suaque Philosophica Studia humiliter D.D.D.*, (Bologna: Lelio della Volpe, 1732); for more detailed discussion of the theses see Berti Logan, p. 790; for Galilean influences on the motion of liquids see Maffioli, pp. 250-53.

[18]Cavazza, *Settecento inquieto*, pp. 249-56; Bassi, *Philosophica Studia.*

[19]Berti Logan, p. 793.

[20]Heilbron, *Electricity...*, p. 25.

[21]Bassi knew Gabriele Manfredi from as early as 1732, if not earlier, but she waited until 1735 to begin her lessons. I suspect because she wanted to see if a licence to consult the *Index* books would be granted to her, as was granted to male scholars. For more details see Berti Logan, pp. 794-95; see also Bassi's letter to Bianchi of April 26, 1738 in B.G.R.: Fondo: *Gambetti*, Posizione: Bassi; for the spread of infinitesimal calculus in Italy, and Manfredi's role in it see Pepe, " Il calcolo infinitesimale... ", pp. 56-60; for

Bassi's dissertation see Laurae Bassiae, " De Problemate quodam mechanico ", *Commentarii*, Vol. 4, (1757), pp. 74-79.

[22]For Agnesi's *Instituzioni analitiche* see Sandor, pp. 108-09; Ardinghelli's mathematics teacher, Caravelli was to publish on differential calculus only in 1786, see Amodeo, pp. 107-21; Pignatelli's teacher Nicola de Martino, published first on the subject in 1725 and 1727. Considering Pignatelli's level of mathematical expertise, she was the one most likely to know infinitesimal calculus, but never made use of it that we know. Grandi was the first in Italy to publish on the subject, and Borromeo was familiar with his work, whether she knew calculus it is impossible to tell. See Palladino, pp. 384-89; Pepe, " Il calcolo infinitesimale...", pp. 43-101; Giacardi, pp. 195-238.

[23]Beate Ceranski published the exchange of letters between Bassi and Bianchi in *Nuncius* (1994), see Ceranski, pp. 207-31; for the English translation of part of the relevant letter on her decision to marry, and the gossip associated with Bassi see Berti Logan, p. 795; for the original sources see Bassi's letters to Bianchi of April 26, 1738 and May 14, 1738 in B.G.R.: Fondo: *Gambetti*, Posizione: Bassi, and Bianchi's letters to Bassi no. 2261: May 1738, and no. 2262: June 3, 1738 in B.C.A.B.: *Lettere no. 75 di Giovanni Bianchi*, Collez. Aut. VIII, 2254-2328; Fantuzzi, *Notizie...*, Vol. 2, pp. 384-91; Giampietro Zanotti's letters to Riva are also a good source of the gossip, see his letters prior to 1738, and soon after in B.C.A.B.: B. 382.

[24]For Veratti's degree and position at the university see A.S.B.: Fondo: *Assunteria di Studio*, Serie: Requisiti dei lettori, Busta 57: Veratti Giuseppe filosofo-medico 1737-1793, fasc. 24: 1738; Giuseppe Veratti in *Commentarii*, Vol. 2, (1745), parte 1, p. 154; Fantuzzi, *Notizie...*, Vol. 9, p. 193. Giuseppe Veratti spelled his surname with two t's, unlike Bassi, who, for reasons unknown, spelled it with one t after marriage, see Berti Logan, p. 789; for Bassi's attendance at the academy see Bassi to unknown November 26, 1774 in B.C.A.B.: *Lettera di Laura Bassi*, Collez. Aut. poz. 238443; Bassi's letter to Scarselli of November 27, 1745 in Melli ed., "Epistolario...", p. 115; Bassi's letters no. 1671-1619 to her husband in B.C.A.B.: *Lettere e minute di Laura Bassi*, Collez. Aut. VI, 1614-1628; letter of October 1746 of Bassi to husband in B.N.F.: Fondo: *Gonelli*, cart. 40, no. 257; for Veratti's letters to Bassi see Cenerelli ed., *Lettere inedite...*, pp. 151-57; Kuhn, " Mathematical versus Experimental Traditions...", pp. 31-65.

[25]For Veratti's difficulties with the theoretical aspects of physics see Berti Logan, p. 799; see also letters of April 25, 1776 and May 6, 1776 in A.S.B.: Fondo: *Assunteria di Istituto*, Serie: Diversorum, Busta 15, no. 42; for Bassi's arguments in anatomy see B.C.A.B.: Bassi Laura, *Due cartoni..*, cartone 1, fasc.I, i: serie delle funzioni pubbliche annuali; see also her ' Nota di requisiti 1748, no. 39 ' in Melli ed. " Epistolario...", p. 128.

[26]Some of the instruments such as Volta's batteries must have been acquired after her death. Marta Cavazza has made the crucial discovery of the inventory of the instruments in the Bassi-Veratti physics cabinet. This inventory puts into focus the family's extensive activities in physics. The collection of the Collège Navarre contained 235 pieces, where almost all sorts of instruments were represented. Unfortunately Maurice Daumas does

not provide a list of those instruments, which could serve as comparison. Cavazza provides such a list. The Bassi-Veratti cabinet was sold by their son Paolo Veratti to Count Carlo Filippo Aldrovandi see Cavazza, " Laura Bassi e il suo Gabinetto di fisica...", pp. 232-39, 241-53; Maurice Dumas, *Les instruments scientifiques au XVII^e^ et XVIII^e^ siècles*, (Paris: Presses Universitaires de France, 1953); Heilbron, *Electricity...*, pp. 147-52; for the original inventory see A.S.B.: *Archivio Aldovrandi Marescotti*, Busta no. 430: Inventario delle macchine componenti il Gabinetto già appartenente alla signora Dottoressa Laura Bassi Veratti, passate al Conte Carlo Filippo Aldrovandi, Anno 1820, pp. 1-24.

[27]The first equipment acquisitions by Bassi and Veratti seems to have taken place soon after their marriage. Veratti made mention of such equipment in his petition for a raise in 1743. The petition was actually written by Bassi, and not Veratti, for it is in her handwriting. Such acquisitions might also explain why Bassi and her family moved house, from the parish of San Lorenzo di Porta Stiera before her marriage, to the parish of San Barbaziano. Bassi and her parents needed a larger house not only to accomodate Veratti, and future children, but also the equipment and students. For the raise see A.S.B.: Fondo: *Assunteria di Studio*, Serie: Requisiti dei lettori, Busta 57: Veratti Giuseppe, lettera no. 4: 1743; Parrocchia di San Lorenzo di Porta Stiera: *Status animarum* : anno 1735, Strada San Felice; Parrocchia di San Barbaziano: *Status animarum:* anno 1741, Casa Sacchi; Bassi's first dissertation appeared in the spring of 1746, after she was named Accademica Benedettina, see A.A.S.B.: *Catalogo dei lavori dell' Antica Academia raccolti sotto i singoli autori*, a cura di Domenico Piani, pp. 15-17.

[28]Urbinati, pp. 123-26; Rosen, pp. 72-75, 100; E. Nardi ed. , *Atti dell' Accademia delle Scienze del' Istituto di Bologna*, (Bologna: Compositori, 1988), pp. 8-10.

[29]I believe Jacopo Beccari might have warned Bassi, her name was not in the list. He was the head of chemistry at the time, and therefore knew who had been nominated as Benedittino. Beccari was Veratti's ex teacher; he was also one of Bassi's examiner during her first public debate. In his letters to a friend, free of misogynist statements, he demonstrated how impressed he was by Bassi's abilities, and hoped she would continue to pursue physics and mathematics. Furthermore, Beccari was always ready to collaborate with Bassi and Veratti in several experiments; Bassi considered him a friend and teacher. He also begged Agnesi, after her nomination as lecturer in mathematics, to come to Bologna and teach; see Berti Logan, pp. 800-01; Cavazza nominates also Domenico Galeazzi as one of her allies within the Benedettina Academy. Galeazzi was certainly a friend of the couple, and acted as Bassi's physician when Veratti was away; see Cavazza, " Laura Bassi e il suo Gabinetto di Fisica ', p. 721; for his role as her physician see Bassi's letter to Veratti no. 1618 of November 30, 1746 in B.C.A.B.: *Lettere e minute di Laura Bassi*, Collez. Aut., VI, 1614-1628; for Bassi's petition to Rome see her letters to Scarselli of April 21, 1745, May 12, 1745, June 5, 1745, June 19, 1745, November 25, 1745 and December 11, 1745 in Melli ed., " Epistolario...", pp. 103-09, 115-17; his letters to Bassi of April 23, 1745 in Cenerelli ed., *Lettere inedite..*, pp. 108-10 and letters no 5: Rome, May 24, 1745, no. 6: June 12, 1745, no. 7: June 26, 1745, no. 9: December 4, 1745 in B.C.A.B.: Ms. *Scarselli* I, 3-17.

[30]A.S.B.: Fondo: *Assunteria di Istituto*, Serie: Diversorum, Busta 9, fasc. 18, Accademia Benedettina: Dissertazioni degli Accademici Benedettini, 1757-1776; for Bassi's dissertations see Berti Logan, pp. 791n-92n.

[31]Berti Logan, p. 808; *Commentarii*, Vol. 5, pts. 1 and 2 and Vol. 6, (1783); Urbinati, pp. 503-04.

[32]Veratti's publications outside the *Commentarii* were Giuseppe Veratti, *Osservazioni fisico-mediche intorno alla elettricità*, (Bologna ; Lellio della Volpe, 1748); Giuseppe Veratti, *Osservazioni fatte in Bologna l' anno MDCCLII dei fenomeni elettrici nuovamente scoperti in America e confermati a Parigi*, (Bologna: Lellio della Volpe, 1752); some of the journals which would have accepted Bassi's work, because they were to publish works of other women were *Nuova raccolta di opuscoli scientifici e filologici*, published in Venice from 1728 to 1783; *Scelta di opuscoli interessanti tradotti da varie lingue*, Milano 1775 to 1779; *Giornale d' Italia spettante alla scienza naturale e propriamente all' agricoltura e al commercio*, Venice 1764 to 1796 and of course the Caminer journal, *Giornale enciclopedico*; for Caminer Turra's eulogy to Bassi see *G.E.*, (marzo 1778), pp. 39-41 and contrast it with the eulogy to Francesco Maria Zanotti, which only merited a few lines, *G.E.*, (gennaio 1778), p. 48; Ciancio, pp. 303-24.

[33]Quotation of the letter is found in Berti Logan, p. 808; the original is in R.A.F.S.R.: *Lettere a Giovanni Cristoforo Amaduzzi*, Vol. 1, no. 16, Verrati to Amaduzzi, March 28, 1778, p. 47.

[34]See *Anatomie Accademiche*, Vol. I: *I Commentari*, pp. 503-04.

[35]Bassi's dissertations in fluid mechanics were; April 29, 1751: On Two Problems of Hydrometry; April 19, 1753: On the Exit of Water from the Holes of One Container; April 25, 1754: On the Evacuation of Water through Various Openings; April 25, 1755: On Hydrodynamics; April 26, 1756: On a Problem in Hydrodynamics; April 26, 1759: On Different Fluids Exiting from one Opening; April 24, 1760: Hydrodynamics Dissertation; June 14, 1765: On Experiments and Observations in Hydrometry and Hydrostatics; May 1, 1766: Some Hydrometric Experiments Dealing with Genette's Observations; May 7, 1767: On the Speed of a Water Jet in a Container, see Berti Logan, pp. 791n-792n; Tega, " Introduzione" in *Anatomie Accademiche*, Vol. I, p. 27; Tega, "M*ens agitat molem...*" in *Scienza e letteratura...*, p. 85; for the *Commentarii* published works in fluid mechanics see *Anatomie Accademiche*, Vol I, pp. 492-94; for published and unpublished dissertations on the subject see Rosen, pp. 194-265.

[36]Cavazza, " Laura Bassi e il suo Gabinetto di Fisica...", pp. 745-46; the summary of her dissertation taken from Berti Logan, p. 805; Lauriae Bassiae, " De Problemate quodam hydrometrico ", *Commentarii*, Vol. 4, (1757), pp. 61-73.

[37]S. Chandrasekhar, *Newton's " Principia " for the Common Reader*, (Oxford: Clarendon Press, 1995), pp. 26-28; see Bassiae, ' De problemate quodam mechanico ",

pp. 74-79; for a contemporary judgement of the dissertation see Pio Fantoni to Giovanni Amaduzzi, April 22, 1778 in B.A.V.: *Lettere a Giovanni Amaduzzi*, Vat. Lat. 9036, ff. 114-115.

[38]Heilbron, p. 65; Urbinati, p. 133.

[39]Boyle's law states that the product of the volume of a gas and the pressure it exerts on a container at constant temperature is constant, see Berti Logan, p. 806; for Galeazzi's experiment see opusculum no. 36 in Tega, *Anatomie Accademiche*, Vo. 1: *I Commentari*, p. 158; for Bassi's see " De aeris compressione ", *Commentarii*, Vol. 2, parte 1, (1745), pp. 347-53.

[40]Vapour does not follow Boyle's law as it approaches the critical point where it becomes saturated and begins to liquefy see Berti Logan, p. 806; s.v., " Bassi Verati Laura ", *D.B.I.*, Vol. 7, p. 146; " De aeris compressione", pp. 347-8; see *Elogio* in B.C.A.B.: B. 2727: " Pubblica Accademia avutasi nel Collegio Montalto degli alunni del medesimo in lode della loro precetrice Laura Bassi "; Paolo Volpicelli, " Sulla legge di Mariotte sopra un congegno nuovo per dimostrarla, e su varie applicazioni di essa" *A.A.F.N.L.*, T. XII, (1858-1859), p. 81.

[41]See dissertation no. 41 in *Anatomie Accademiche*, Vol. 1: *I Commentari*, pp. 162-63; Gregorio Casali, " De ictus pulveris ", *Commentarii*, Vol. 5, parte 2, (1766), pp. 362-63, 371.

[42]See Bassi's dissertation of April 28, 1774 in Berti Logan, p. 792n; for Veratti's see summary no. 238 in *Anatomie Accademiche*, Vol. 1: *I Commentari*, pp. 421-23; Hales, *Vegetable Staticks*, p. 147; Cavazza, " Laura Bassi...", p. 751.

[43]The mathematical formulation that attempted to find molecular parallels to Newton's gravitation was published by Laplace in his *Exposition du système du monde* (1796); for Laplace and Clairaut see L. Bucciarelli and Nancy Dworsky, *Sophie Germain: An Essay in the History of the Theory of Elasticity*, (Dordrecht: Reidl, 1980), pp. 68-69, 134n-135n; Heilbron, p. 54. The academy was very familiar with Clairaut's works. The author was mentioned in several of the members' publications; *Anatomie Accademiche*, Vol. 1: *I Commentari*, pp. 186, 312, 325, 362, 422; for Canterzani's statements see" De immixto fluidis aere ", *Commentarii*, Vol. 7, (1791), p. 47; the dissertations presented by Bassi were April 27, 1747: On the Air Bubbles Observed in Fluids Relieved from Air Pressure and April 25, 1748: On the Air Bubbles Excited in Fluids in A.A.S.B.: *Catalogo dei lavori...*, pp. 15-17.

[44]Berti Logan, pp. 806-07; " De immixto fluidis aere ", pp. 4-47.

[45]" De immixto fluidis aere ", pp. 44-47; for Franklin, Nollet, Jallabert and D' Alembert see Heilbron, pp. 60-61, 327-28, 352-53; see also B. Cohen, *Franklin and Newton*, (Philadelphia: American Philosophical Society, 1956), p. 436.

[46]The Bologna Stone, after calcination and being exposed to light, would shine in the dark; several experiments were done with the stone to explain Newton's theory of light. Her friend and supporter Jacopo Beccari had worked on the stone and other material, to explain *phosphori*; see Berti Logan, pp. 790, 795, 798; the quotation is from John Morgan, *The Journal of Dr. John Morgan of Philadelphia from the City of Rome to the City of London, 1764; Together with a Fragment of a Journal Written at Rome, 1764*, (Philadelphia, 1907), pp. 98-99; for what Bassi taught at the Institute see *Diario bolognese ecclesiastico e civile l' anno 1777*(Bologna, 1777), pp. 142, 154.

[47]As Cavazza points out, although Beccaria's letters were directed to Veratti, the crystals and the explanation were meant for Bassi, see Cavazza, " Laura Bassi...", pp. 725-27; Berti Logan, p. 804; for the original letters of Hortega and Nollet, see Cenerelli ed., *Lettere inedite...*, pp. 75-78, 92-98; see Beccaria's letters to Veratti no. 1747: October 18, 1765, no. 1743: May 18, 1761 in B.C.A.B.: *Lettere di G.B. Beccaria a Laura Bassi e al marito*, Collez. Aut. VI, 1741-1754. The English prisms were supposed to have been sent by Newton; but certainly not Isaac Newton who had died in 1727, well before Dollond had succeeded in correcting chromatic aberration see Daumas, pp. 203-05.

[48]Daumas, pp. 203-05; Pannekoek, pp. 294-95; Jean Itard, " Clairaut, Alexis-Claude ", *D.S.B.*, Vol. III, p. 284; see Boscovich's dissertation no. 148 in *Anatomie Accademiche*, Vol. 1: *I Commentari*, pp. 324-25.

[49]A.A.S.B.: *Catalogo dei lavori...*, pp. 15-17; see her letter to Ortes from August 26, 1766 in M.C.V.: *Raccolta Cicogna*, 3195-3196, " Epistolario G.M. Ortes lettere a lui dirette ", B. 5: Lettere di Laura Bassi all' abate G.M. Ortes.

[50]Urbinati, pp. 503-04; for the equipment in electricity see Cavazza, " Laura Bassi...", pp. 726, 751-53.

[51]This is taken in part from my article in the *American Historical Review*; for the controversy his work caused in England and France see Berti Logan, p. 803.

[52]For their dispute with Nollet, who did not accept cures made by electrical therapy, or that electricity might induce porosity in glass, see letter no. 34 of Nollet to F.M. Zanotti of July 3, 1749; attached to letter no. 39 to Zanotti: Extrait d' une relation lue à l' academie des Sciences de Paris par M. l' Abbé Nollet; letter no. 45 of Nollet to Zanotti from Montpellier, March 21, 1750 in B.C.A.B.: B. 160: *Lettere di diversi a Francesco Maria Zanotti*; see Bassi's letters to Scarselli of January 8, 1749, February 8, 1749, November 12, 1749 in Melli ed., " Epistolario...", pp. 129-32, 140-41; and his to her no. 15: Rome, November 5, 1749 and no. 16: November 19, 1749 in B.C.A.B.: Ms. *Scarselli*, I, 3-17; for Nollet's version of the events see B.M.S.: Ms. 150: Abbé Nollet, *Journal...*, pp. 110-16.

[53]Casali was also to mention Veratti's and Bassi's assistance in gathering data from a series of experiments dealing with the shattering of glass. In 1747, Laghi in his dissertation concerning the reddish ashes produced by the burning of two types of

deciduous woods, mentioned that similar experiments had been carried out by Bassi; see G. Casali, " De quorumdam vitrorum fracturis ", *Commentarii*, Vol. 5, parte 2, (1766), p. 184; T. Laghi, " De rubentibus lignorum cineribus ", *Commentarii*, Vol. 2, parte 3, (1747), pp. 392-402.

[54]Haller's theory stated that in the body there were irritable, non-sensitive parts, which contracted when touched (the muscles), and that there were also sensitive parts, or non-irritable, which once touched transmitted the impression to the mind (nerves) see Berti Logan, p. 804; Tega, " Introduzione ", *Anatomie Accademiche*, Vol. 2: *L ' enciclopedia...*, pp. 22-25, 32-35; L.M.A. Caldani, *Sull' insensibilità e irritabilità di alcune parti degli animali . Lettera scritta al chiarissimo e celebratissimo signore Haller in sull' insensitività e irritabilità halleriana. Opuscoli di vari autori raccolti da Giacinto Bartolomeo Fabri*, (Bologna: Eredi Colli e S, Tommaso d' Aquino, 1757), pp. 323-25; Anne Marie du Bocage, *Recueil des oeuvres de Madame du Bocage*, Vol. 3, (Lyon, 1764), p. 180.

[55]May 2, 1761: Some Experiments on Electricity; May 8, 1768: On Electricity; May 17, 1770: On Electricity; June 7, 1771: On *Vindex* Electricity; April 28, 1774: On Electricity, Especially on Some Experiments by Hales; June 5, 1777: On the Property of Various Bodies that Retain Heat More than Others, While Also Retaining Electricity, see A. A. S.B.: *Catalogo dei lavori...*, pp. 15-17.

[56]According to Heilbron, Franklin did not " discover" conservation of charge, but was the "first to exploit the concept fruitfully", see Heilbron, pp. 330, 337, 365; Tega, " Introduzione ", *Anatomie Accademiche*, Vol. 2: *L ' enciclopedia...*, pp. 38-39; Joseph Priestley, *The History and Present State of Electricity*, Vol. I, (1769; rpt. edn., New York, 1966), p. 308.

[57]Giambattista Beccaria, *Elettricismo atmosferico: lettere di Giambattista Beccaria*, (Bologna: Colle Ameno all' Insegne dell' Iride, 1758), pp. 28-30.

[58]Berti Logan, p. 809; Priestley, *The History and Present State of Electricity*, Vol. I, pp. 303-33; Pace, *Benjamin Franklin and Italy*, pp. 22-25; A. Pace, " Beccaria Giambattista ", *D.B.I.*, Vol. VII, pp. 469-71; Heilbron provides an excellent explanation of the Symmerian and Peking phenomena and Beccaria's attempts to explain them in Franklinian terms see Heilbron, pp. 405-12, 431-34, 446; see Fontana's letter no. 8024: Florence, June 19, 1768 in B.C.A.B.: *Lettere di Felice Fontana*, Collez. Aut. XXIX, 7992-8054.

[59]Beccaria to Bassi, December 26, 1768, f. 74, April 19, 1769, f. 70 in B.A.V.: Autografi: *Patteta*, cart. 48, *Lettere di P. Beccaria a Laura Bassi e Giuseppe Veratti*; Bassi's letters to Beccaria no. 2: March 22, 1769, no. 3: April 26, 1769 in B.A.V.: Autografi: *Patteta*, cart. 45; see the back of a letter by Spallanzani to Bassi , July 14, 1768 in B.C.A.B: *Spallanzani, Lazzaro*, Collez. Aut. LXVI, 17923-963; in 1769, Volta explained the Symmerian effect as a case of electrical induction, although Beccaria did not accept it,

see Fontana's letter to Bassi no. 8028: Florence, May 9, 1775 in B.C.A.B.: Collez. Aut. XXIX, 7992-8054; Pace, *Franklin and Italy*, p. 24.

[60]Barletti's quotation taken from Heilbron, pp. 425-26; see her letter to Spallanzani of December 10, 1776 in Melli ed., " Epistolario...", p. 176.

[61]For the electrophore in her cabinet see Cavazza, " Laura Bassi...", p. 751; for the electrophore's effect on physicists see Heilbron, pp. 412-26; for Volta's introductory letter to Bassi of July 15, 1771 and others see Cenerelli ed., *Lettere inedite...*, pp. 157-59.

[62]See Bassi's letters to Beccaria no. 1, s.d. (1766),and no. 2: March 22, 1769 in B.A.V.: Autografi: *Patteta*, cart. 45. These letters are also published in G.L. Masetti Zannini, " Laura Bassi (1711-1778) Testimonianze e carteggi inediti ", *Strenna storica bolognese*, anno XXIX, (1979), pp. 221-41. He left out the letter of April 26, 1769; see also Beccaria's letter to Bassi of September 26, 1759 in B.A.V.: Autografi: *Patteta*, cart. 48, ff. 67-69; see her dissertation of June 5, 1777: On the Property of Various Bodies That Retain Heat More Than Others While Also Retaining Electricity in A.A.S.B.: *Catalogo dei lavori...*, pp. 15-17.

[63]Bassi's letter no. 1: s.d. (1766) in B.A.V.; Autografi: *Patteta*, cart. 45; for De Lalande's information on Bassi see Cavazza, " Laura Bassi...", p. 730; Fontana's letter to Bassi no. 8008: May 24, 1760 in B.C.A.B.: Collez. Aut. XXIX, 7992-8054; Veratti's dissertations of November 16, 1758: On Electrical Matter and May 5, 1759: On Magnetism; they were published as G. Veratti, " Experimenta magnetica ", *Commentarii*, Vol. 6, (1783), pp. 31-44; A.A.S.B.: *Catalogo dei lavori...*, pp. 137-38; Heilbron, pp. 391-97, 283-84.

[64]See Hortega's letters of April 23, 1759, September 12, 1757 and December 4, 1758, and Nollet's letters of March 30, 1753 and s.d. all in Cenerelli ed., *Lettere inedite...*, pp. 79-82, 97, 102; see also Abbé Nollet, *Lettres sur l' electricité: dans lesquelles on trouvera les principaux phenomenes qui ont été découvert depuis 1760*, (Paris: Durand, 1770), pp. 274-95.

[65]For Caldani's, Targioni, Spallanzani and Volta's correspondence with Bassi see Cenerelli ed., *Lettere inedite....* pp. 56-62, 125-40, 157-59; for Caldani's letters to Bassi see letters nos, 3668, 3672, 3674, 3676, 3685-3687, in B.C.A.B.: *Lettere di Leopoldo Marcantonio Caldani*, Collez. Aut. XII, 3665-3764; for Bassi's letters to Caldani see Melli ed., " Epistolario...", pp. 164, 168-69, 178; for her correspondence with Beccaria see B.A.V.: Autografi: *Patteta*, cat. 45; and for Beccaria's letters to her see B.A.V.: Autografi: *Patteta*, cart. 48 and B.C.A.B.: *Lettere di Giambattista Beccaria a Laura Bassi ed al marito*, Collez. Aut. VI, 1741-54; for Bovi and Landriani's letters see respectively B.C.A.B.: *Lettera di Rocco Bovi*, Collez. Aut. X, 3016 and *Lettera di Marsilio Landriani*, Collez. Aut. XXXVII, 10.054.

[66]Fontana's letter on instruments to measure declination is no. 8030: April 30, 1775, see also his letters nos. 8008, 8004, 8025, 8026, 8027, 8028, 8029, 8030 in B.C.A.B.: Collez.

Aut. XXIX, 7992-8054; for Bassi's letter of November 26, 1774 to unknown on magnetism see B.C.A.B.: Collez. Aut. CV, 23 843.

[67]See Fontana's letters no. 8024: June 10, 1768 and no. 8030: April 30, 1775 in B.C.A.B.: Collez. Aut. XXIX, 7992-8054; Cenerelli ed., *Lettere inedite...*, pp. 76-77; for Volta's letter to Bassi of June 15, 1777 see Cenerelli ed., *Lettere inedite...*, pp. 158-59; for Bassi's letter to Volta of September 20, 1777 in *Epistolario di Alessandro Volta*, Francesco Massardi ed., (Bologna: Zanichelli, 1949-1955), Vol. 1, p. 187; Marco Baretta, " Gli scienziati italiani e la revoluzione chimica ", *Nuncius*, Vol. 4, fasc. 2, (1989), pp. 119-45; for Fontana's role in the invention of eudiometers see Knoefel, pp. 163-170; Schaffer, pp. 285-318; Abbri, pp. 109-67; Cavazza, " Laura Bassi...", pp. 747-48, 751.

[68]Taken from Berti Logan, pp. 804-05.

[69]For Bassi's struggles to teach at the university see Berti Logan, pp. 787, 796-97; see also Bassi to Scarselli, May 22, 1745 in Melli ed., " Epistolario...", pp. 105-06; for the official side of the story see A.S.B.: Fondo: *Assunteria di Studio*, Serie: Atti, anni 1735-43, Vol. 23: Acts of December 5, 1739 and December 11, 1739, f. 44, November 15, 1741, f. 67; Serie: Atti, Vol. 24: Acts of January 22, 1749, f. 2v, February 16, 1750, f. 17, April 5, 1750, f. 21v, April 14, 1750, f. 23 v.

[70]See Bassi to Scarselli, June 14, 1755 in Melli ed., " Epistolario...", pp. 148-49, 180; A.S.B.: Fondo: *Assunteria di Istituto*, Serie: Diversorum, Busta 9, fasc. 1: " Le costituzioni dell' Istituto delle scienze " , December 12, 1711, cap V, nos. 3 and 6, cap. VI, no. 1. From 1734 to 1770 Domenico Galeazzi was professor of physics at the institute and Paolo Balbi was his assistant. In 1770 Balbi took over Galeazzi's position, and Veratti became his assistant. For Balbi's, Galeazzi's, and Veratti's dissertations see Rosen, pp. 170-71, 207-25; Tega ed., *Anatomie Accademiche*, Vol. 1: *I Commentari*, p. 372; Susana Gomes, " The Bologna Stone and the Nature of Light: The Science Academy of Bologna ", *Nuncius*, Vol. 6, fasc. 2, (1991), pp. 16-17; Heilbron, p. 160.

[71]Bassi's letter to Scarselli of July 16, 1755 in Melli ed, " Epistolario...", pp. 150-51; Caldani's letter to Bassi of October 25, 1776 in Cavazza, " Laura Bassi...", pp. 717-19; for the spread of experimental physics chairs in Europe see Heilbron, pp. 140-47.

[72]See Bassi's letters to Scarselli of June 14, 1755 and July 16, 1755 in Melli ed., " Epistolario...", pp. 148-151; Scarselli's answer of June 21, 1755 in Cenerelli ed., *Lettere inedite...*, pp. 12-24; for the senators recognition of her school see A.S.B. : Fondo: *Senato*, Serie: Vacchetoni, Registro 71, (Anni 1759-60-61) April 5, 1759, p. 26, December 14, 1759, p. 35; Registro 79, (Anno 1776), May 6, 1776, p. 45; Cavazza, " Laura Bassi...", pp. 719-720; Cavazza, *Settecento inquieto...*, p. 100; for salaries paid to professors in experimental physics in Italy, and elsewhere, and price of equipment see Heilbron, pp. 140-58.

[73]The author Cagni is not specific on whether the amount paid was on a yearly basis see Cagni, pp. 24, 34; Bassi to Scarselli, July 16, 1755 in Mellied., " Epistolario...", pp. 15051; see back of Pio Fantoni's letter to Bassi, Rome, July 19, 1766 in B.C.A.B.: B. 2024, *Lettere autografe....*

[74]B.C.A.B.: B. 2727: Pubblica Accademia di lettere avutasi nel Collegio Montalto ".

[75]For John Morgan see Berti Logan, pp. 797-98; for the university curricula see Gabriele Baroncini, " La filosofia naturale nello studio bolognese (1650-1750): preliminari di una ricerca ", *Scienza e letteratura...*, pp. 271-92; Brandon Dooley, " Social Control and the Italian University from Renaissance to Illuminismo ", *Journal of Modern History*, Vol. 61, (June 1989), pp. 205-39; Cavazza, " Laura Bassi..."., pp. 743-45.

[76]For students attending her course see Cenerelli, ed., *Lettere inedite...*, pp. 62, 74-75, 80, 141, 147, 218; Spallanzani's letter : Reggio, May 29, 1755 in Spallanzani, *Epistolario*, Vol. I, p. 5; Bassi to Caldani, February 7, 1768 in Melli ed., " Epistolario...", pp. 168-69; Caldani to Veratti letter no. 3668, February 7, 1766 in B.C.A.B.: Collez. Aut. XXI, pp. 3665-3764; letter no. 3016 to Bassi, Naples, January 2, 1773 in B.C.A.B.: Collez. Aut. X, 3016; B.C.A.B.: B. 2727: " Pubblica Accademia..."; *Avvisi di Bologna*, no. 8, (25 febbraio 1778); for Spallanzani's relationship with Bassi the introduction to Spallanzani's "De lapidibus ad aqua resilietibus dissertatio" in *Dissertazioni due dell' abate Spallanzani*, (Modena: Soliani, 1765) in B.C.A.B.: Bassi Laura, *Due cartoni*, Cartone II: Opuscoli e stampe riguardanti Laura Bassi, no. 9; for Spallanzani's accomplishments in all areas of natural history see the whole volume of *Lazzaro Spallanzani e la biologia del settecento*; for Fontana see Knoefel, *Felice Fontana, Life and Works.*

[77]Another factor in the splitting of the physics section was a dispute between the Verattis and Bonnacorsi, who complained that the couple was impeding his access to the laboratories. However, it is arguable how qualified Bonnacorsi was to act as assistant to Canterzani in the mathematical physics section; most of his dissertations, even more than Veratti's were concerned with the biological sciences, which indicates that the splitting of the section was done to bring peace in the department., see Berti Logan, p. 799.

[78]Tettoni, pp. 278-79.

[79]For Roccati's background see Cessi, pp. 5, 5n, 24, 24n, 25; Grotto, pp. 100-01. There are some disputes as to her dates of birth and death, but Cessi's are correct; see introduction in A.C.R.: Ms. *Concordiana* 381 (109): Roccati Cristina no. 4 lettere, con 8 poesie, 1 epigrafe, 1 lettera di Gir. Silvestri e 1 copia di lettera; for the date of death see Parrocchia dei S.S. Francesco e G.V.M in Rovigo: no. 8, Morti dal 1746 al 1803, Die 16 Martii 1797.

[80]For a summary of Girolamo Silvestri's life see Gio: Battista de San Martino's summary in *N.G.E.*, (ottobre 1788), pp. 98-102; for Silvestri's family relation with Cristina see Ubaldo Zanetti's entrance to his diary from May 5, 1751 in B.U.B.: Ms. 3832: *Diario di*

ciò che và succedendo giornalmente in Bologna del di 7 agosto 1750 al tutto di 1754 scritto di nuovo da Ubaldo Zanetti, p. 25v.

[81]Bassi's parents never stopped her academic pursuits in any way, but the impetus for her higher education came from Tacconi, the family physician, who used the girl's abilities to enhance his own prestige; see Berti Logan, pp. 786-87, 790, 793-94; Agnesi published her *Philosophical Propositions* in 1738; see Savaris, pp. 3-4, 8. Cristina's father's library contained works such as Pietro le Moyne, *Galleria delle donne forti* (1701), *Discorsi accademici di varj autori intorno agli studi delle donne* (Venice, 1729) and *Nobiltà et eccelenza delle donne. Opera tradotta dal francese con orazione di Alessandro Piccolomini in lode delle medesime* (Venice 1749); for a 1749 inventory of Giambattista Roccati's library see A.C.R.: Ms. *Silvestriana* 381: " Index librorum latinorum Joa. Baptistae Roccati Rhodigin. Anno...1749 ", pp. 65, 73, 79; Grotto, pp. 6-11.

[82]For Bertaglia see Grotto, pp. 7-10; Cessi, pp. 6-7, 13-18, 25; fo a list of Roccati's literary publications see Savaris, pp. 42-44; for the inventory of her father's library see A.C.R.: Ms. *Silvestriana* 381; for her membership to the Apatista Academy see Valentino Busa Villanova's letters to Roccati no. 24: May 12, 1750 and no. 25: no date, to the Ricovrati Academy of Padua see Gio: Alberto Colombo's letter to Roccati no. 106: Kal. Sept. MDCCLIII all in A.C. R.: Ms. *Silvestriana* 203: " Lettere autografe a Cristina Roccati "; for her membership to the Arcadia, Pistoia and Concordi academies see Rocccati's letters to Girolamo Silvestri no. 29: Bononiae 8 Idus Decemb. 1750 and no. 21: idibus Januaris 1750 respectively in A.C.R.: Ms.*Silvestriana* 195; for her physics lessons see A.C.R.: *Roccati Cristina. Lezioni academiche no. 51, n. 24/11/1732 m. 16/3/ 1797.*

[83]For her patron in Bologna see Collina's letter to Cristina no. 64: August 27, 1749 in Ms. *Silvestriana* 203; for Collina see M. Vigilante, " Collina Bonifacio ", *D.B.I.*, Vol. XXVII, pp. 58-60; for the Aristotelean curriculum at the university see Baroncini, pp. 271-92; for Bassi's theses see Berti Logan, p. 790.

[84]Roccati's letters to Silvestri no. 1: Tertii Id. Jan. 1748, no. 3: Prid. Non. Jul. 1748, no. 6: Pri. Idus Oct. 1748, no. 8: Postrid. Idus Jan. 1749, no. 12: XI. Kal. Jun. 1749, no. 15: Prid. Idus oct. 1749, no. 16: 4 Idus Nov. 1749, no. 19: 4 Non. Dec. 1749; no. 29; 8 Idus Dec. 1750, no. 35: no date, no. 36: Padua, September 29, 1751 all in A.C.R.: Ms. *Silvestriana* 195; Grotto has published some of these letters see Grotto, pp. 33-44. Unlike Bassi who defended forty-nine theses, Roccati had to defend only four known theses, one in logic and one in physics and two in metaphysics. These were far less specific than those of Bassi's. The logic thesis stated that she confuted and disapproved of the opinion of Cartesians of doubting everything. For this doubting about all things was useless and dangerous. The physics thesis mentioned that physics was the science of bodies so that it could explain the substantial form in inanimate bodies, and convey nothing but the harmony of parts, out of which most evident properties arose. The two metaphysics theses dealt with demonstration by reason, not only by faith, of the existence of God, and of the immortality of the soul. The theses were defended on August 4, 1750 at Rovigo. They were published in the *Novelle letterarie*, no. 35, (August 29, 1750), p.

288; see also as a copy of it together of Medori Rossi's letter to Roccati no. 169: September 12, 1750 in A.C.R.: Ms. *Silvestriana* 203. On April 15, 1751 Roccati was again questioned in a semi-public capacity by eight professors and lecturers; it is not clear if on similar arguments than those at Rovigo, since, to my knowledge, the arguments were not published. See A.S.B.: *Archivio di Studio* no. 228: " Secondo libro segreto di filosofia pp. 80r, 81 v. For who the professors were and the certificates they gave Roccati which follow Jacopo Grandicio's sonnet see A.C.R.: Ms. *Silvestriana* 203; Cessi, pp. 18-21.

[85]See letters no. 6; prid. Idus oct. 1748 and no. 12; XI Kal. Jun. 1749 in A.C.R.: Ms. *Silvestriana* 195; for Collina's lectures see Vigilante, " Collina...", pp. 58-60; for Bassi's lessons see Berti Logan, pp. 797-98.

[86]Collina had arranged for Petronio Matteucci to teach her geometry, but it appears that Brunelli took over the position. Brunelli then left Bologna for Lisbon before December 2, 1750, since by then he was already in Lisbon. There is no mention of mathematical studies again by Roccati until she arrived in Padua; see Collina's letters to Roccati no. 64: August 27, 1749 and no. 65: September 15, 1750 in A.C.R.: Ms.*Silvestriana* 203; see Giovanni Angelo Brunelli's letter to F.M. Zanotti no. 119: Lisbon May 1, 1751 in B.C.A.B.: B. 160; Grotto, p. 12; for Brunelli's position at the observatory see Baiada, " Geografia...", p. 238.

[87]Grotto, p. 12; Roccati's letter to Silvestri no. 29; 8 Id. Decemb. 1750 in A.C.R.: Ms.*Silvestriana* 195; see Valentino Busa-Villanova's letter to Roccati no. 36: Pisa 1751 in A.C.R.: Ms. *Silvestriana* 203.

[88]For a biography of Colombo see A. De Ferrari, " Colombo Giovanni Alberto ", *D.B.I.*, Vol. 27, pp. 207-08; Roccati's letters to Silvestri no. 36: November 29, 1751, no. 37: December 20, 1751 in A.C.R.: Ms. *Silvestriana* 195 and of May 2, 1752 in Grotto, pp. 45-46; see also her elegy to Colombo of October 1, 1752, and his letter to Roccati no. 91: VI Id. Aug. 1752; Collina's reaction to her Paduan studies in his letter to Roccati no. 75: May 14, 1753 all in A.C.R.: Ms. *Silvestriana* 203; for Poleni's and J. Hermann's schools of mechanics see Bergia and Fantazzini, pp. 46-60; Palladino, pp. 376-406.

[89]Her father attempted to sell much of his extensive library as early as 1749, which indicates his finances were already in trouble; see A.C.R.: Ms. *Silvestriana* 381. For her father's political and financial troubles, and when Cristina was forced to leave Padua see Cessi, pp. 23-24;. however, he was wrong about her departure date from Padua, which really took place between May and July 1752, at the end of the 1751-1752 scholastic year. See Busa-Villanova's letter to Cristina no. 42: July 24, 1752, Colombo's letter no. 87: Non. Majus 1752 all in A.C.R.: Ms. *Silvestriana* 203, and her letter dated Padua May 2, 1752; for this last letter and her reduced circumstances see Grotto, pp. 26, 45-46. For her election as lecturer in physics see A.C.R.: Ms. *Concordiana* 250: " Giornali dell' Accademia de' Concordi, 18 gennaio 1697-12 ottobre 1793 ", p. 213; for the teaching role of the Institute of Science within the academy see Savaris, pp. 22-25; for Cristina's intent to return to Padua see Colombo's letters to Cristina no. 90: kal. Aug 1752, no. 97:

October 16, 1752, no. 99: XIII Kal. April. 1753, no. 109: August 29, 1754, and Alberto Mussato's letters to her no. 131: September 15, 1752 and no. 132: January 1, 1753 all in A.C.R.: Ms. *Silvestriana* 203.

[90]See Colombo's letters to Roccati no. 86: no date, no. 90: Kal. Aug. 1752, no. 91: VI Id. Aug. 1752, no. 95: September 26, 1752, no. 103: VII Aug. 1753, see also Collina's letter no. 75: May 14, 1753 all in A.C.R.: Ms. *Silvestriana* 203. For the use of mathematics in some of her lessons given March 5, 1764, Third lesson, May 16, 1763, lesson 1757 on the inclined plane, lessons parziale 35, 36 and 50 on dates all in A.C.R.: *Roccati Cristina, Lezioni accademiche no. 51*; for the widepread knowledge in geometry, as compared to algebra and calculus see Palladino, pp. 376-402.

[91]See Colombo's letters no. 90: Kal. Aug., 1752, no. 91:VI Id. Aug. 1752, no. 95: September 26,1752, no. 107: Kal. Oct. 1753 all in A.C.R.: Ms.*Silvestriana* 203; Grotto p. 27.

[92]Heilbron, pp. 339-41, 346-52, 364-65; Colombo's letter to Roccati no. 107: Kal. Oct. 1753 in A.C.R.: Ms. *Silvestriana* 203.

[93]Quotation from Heilbron, pp. 295, 236, 239-242, 283-84, 391-97; Grotto, p. 27; Colombo's letter no. 107: Kal. Oct. 1753 in A.C.R.: Ms. *Silvestriana* 203; see her lecture no. 1 from 1758 in A.C.R: *Roccati Cristina, Lezioni accademiche no. 51*; see Bassi's letter to Beccaria s.d. (1766) in B.A.V.: Autografi: *Patteta*, cart. 45; Cavazza, " Laura Bassi...", p. 730.

[94]Her surviving correspondence seems to date from 1748 to 1754. From this we might surmise that Roccati might have lost contact with most of the people she corresponded with while she was a student, and a few years later see A.C.R.: Ms. *Silvestriana* 203.

[95]For a description of the academy's activities see Savaris, pp. 20-25; for when Roccati and others gave lessons and what these lessons were see the yearly catalogues printed by the academy on lessons given from 1756-1757 to 1776-1777 found in A.C.R.: *Manifesti con elenco, soci e lezioni accademiche;* for Roccati's qualification for the prizes and her demand to be made an extraordinary lecturer in 1777 see A.C.R.: Ms. *Concordiane* 250: " Giornali dell' Accademia...", pp. 338-39, 344, 359-61, 407, 432-33, 474-75, 502-03, 512, 529-30, 551-52, 566-67, 579-80, 597, 607-08, 616-17, 630-31. Roccati failed to qualify in 1772 and 1773, and the list of names was not provided for 1770 and 1771, although, according to the catalogue she was supposed to give the lectures, which were to cover the sphere of the universe and principles of astronomy; for the teaching role of the Venetian academies see Soppelsa, ' Jacopo Riccati...", pp. 39-40.

[96]See her 1758 and 1757 lessons on effluvia in A.C.R.: *Roccati...Lezioni...*; for the transformation of literary academies into agricultural ones see Ciancio, p. 179; Savaris, pp. 24, 28.

[97]Tettoni, pp. 276-77; Cessi, p. 25; A.C.R.: Ms. *Concordiana* 250; " Giornali dell' Accademia...", pp. 256-263, 265, 287-307.

[98]Savaris refers particularly to P. Casini's *Newton e la coscienza europea* (1983) and Ferrone's *Scienza, natura, religione*, see Savaris pp. 7n-8n.

[99]See Parziale 33, 1759: " Principles of Light " in A.C.R.: *Roccati...Lezioni...*; for Newton's opinions see Park, pp. 204-05.

[100]Lezione 2, 1-3-1762, Parziale 26 and Lezione, Parziale 37, no date in A.C.R.: *Roccati...Lezioni...*; the experiments Roccati referred to in the 1762 lesson are found in Proposition 2, Theorem 2, and Proposition 4, Problem 1, Experiment 11 of Book I, Part 1 of Newton's *Opticks*; Park, pp. 205-215, 291.

[101]Lezione 2, 3-3-1763, Parziale 29, and Parziale 37, no date in A.C.R.: *Roccati...Lezioni...;* Park, pp. 205-06.

[102]Lezione 1, 4-12-1760, "On Light ", Lezione 2, 5-3-1764, Lezione, Parziale 34: 1759, " On Light ", Lezione Parziale 42 : no date, Parziale 46: no date in A.C.R.: *Roccati... Lezioni...*; Park, pp. 171-73, 209; Axiom V, Book I, Part 1 and Proposition 10, Book II, Part 3 of Newton's *Opticks*.

[103]Lezione 1, 10-12-1762, " Vision "; Lezione 3, 13-5-1762, " Vision "; Lezione 3, 16-5-1763; Lezione 2, 5-3-1764; Parziale 42: no date, for plane and spherical refraction all in A.C.R.: *Roccati...Lezioni....* From the varying number of illustrations that survived, which varies from none to several, one can surmise that Roccati might have provided illustrations for each potential individual in attendance. As one would expect, the attendance numbers must have varied.

[104]Lezione 1, 4-12-1765, Lezione 3, 13-5-1765, Lezione 1, 6-12-1764, Lezione 2, 4-3-1765 in A.C.R.: *Roccati...Lezioni.* I am not sure whether, as she said, Newton really associated the vibration of ether with the propagation of sound. In Querries 13 and 14 of Book III, Part 1 of his *Opticks*, Newton associated air vibrations with the propagation of sound. The different sizes of these air vibrations excited the sensation of several sounds.

[105]A.C.R.: " Catalogo 13 novembre 1766-giugno 1767 " and " Catalogo 12 novembre 1767-giugno 1768 " in *Manifesti con elenco soci e lezioni accademiche*; quotation in Beretta, *The Enlightenment of Matter*, p. 122.

[106]The first lesson is dated by whoever dated Roccati's lessons as being given on December 12, 1765, but the dating is wrong and does not match the catalogue. Roccati gave a lesson on hearing on December 4, 1765. On December 11, 1766 the lesson was on the sensible principes of things, see A.C.R.: " Catalogo 13 novembre 1766-giugno 1767 " in *Manifesti...*; see Lezione 1, 14-12-1765, Parziale 9 and Lezione 1, 11-12-1766; the lesson on fire is dated 13-12-1767, Parziale 27; on air, 21-5-1767, Parziale 14; on

water, 10-11-1767, Parziale 13; earth, salt and mercury, 7-3-1768, Parziale 15, on sulfur, 19-5-1768, Parziale 16 all in A.C.R.: *Roccati...Lezioni.*

[107]See lessons of 7-3-1768, Parziale 16 and of 19-5-1768, Parziale 15 in A.C.R.: *Roccati...Lezioni*; Leicester, pp. 65, 124.

[108]Lezione 1, 10-11-1767, Parziale 13 in A.C.R.: *Roccati...Lezioni...*; Abbri, pp. 65-90.

[109]Lezione 2, 12-3-1767, Parziale 27 in A.C.R.: *Roccati...Lezioni*; Leicester, p. 124.

[110]Lezione 3, 21-5-1767, Parziale 14 in A.C.R.: *Roccati...Lezioni*; Leicester, p. 124.

[111]For Hales' influence on Boerhaave see Leicester, pp. 124-125, 132. Boerhaave's and Hales influence on Roccati can be found in lectures given in dates other than December 1766 to June 1768 series. Since some of them deal with vapour and effluvia they could belong to the series on meteor given from November 1757 to June 1759; one lecture appears to date from 1752; see Parziale 48 (1752), Parziale 32, Parziale 38, Lezione 3, 21-5-1767, Parziale 14 in A.C.R.: *Roccati...Lezioni*; A.C.R.: " Catalogo novembre 1757-giugno 1758" and " catalogo novembre 1758-giugno 1759 " in *Manifesti....*

[112]Parziale 24, Parziale 25, Parziale 30 (1752), Parziale 45 in A.C.R.: *Roccati...Lezioni.*

[113]There was, at least, another lesson on penduli, which has been lost, see Parziale 51 in A.C.R.: *Roccati...Lezioni*; for Huygens discovery see Boyer, pp. 374-78; Propositions L-LII, Book I, Newton, *Principia.*

[114]Lezione 31-1-1752, Parziale 47, Lezione 15-6-1752, Parziale 44, Parziale 39: no date in A.C.R.: *Roccati...Lezioni*; see Rules of Reasoning in philosophy, Book III, Definitions I to IV, Laws I to III, Corollary I in Axions, or Laws of Motion in Newton, *Principia.*

[115]Parziale 36: on compound motion, Parziale 43: on gravity in A.C.R.: *Roccati...Lezioni*; see propositions I to III and Proposition XX of Book III and Scholium for Laws of Motion in Newton, *Principia.*

[116]Lezione 1, 2-1-1769, Parziale 17, Lezione 2, 9-3-1769, Parziale 18, Lezione 3, 15-6-1769, Parziale 19 in A.C.R.: *Roccati...Lezioni*; Proposition XXIV, Book III, Newton, *Principia*; for a modern assessment of Newton's work on tides see Chandrasekhar, pp. 399-417; accusations that Newton's force of attraction was an occult quality appeared as soon as the *Principia* was published, see Heilbron, pp. 72-73; Eric. J. Arton, " The Vortex Theory in Competition with Newtonian Celestial Dynamics " in *The General History of Astronomy*, Vol. 2, pp. 3-21.

[117]Parziale 50 in A.C.R.: *Rocccati...Lezioni;* for an opinion similar to Roccati see dissertation no. 123 of Vincenzo Riccati on central forces; and a Newtonian influenced work by Francesco Zanotti no. 189 all in Tega ed., *Anatomie Accademiche*, Vol. 1: *I*

Commentari, pp. 279-80, 311-12; for the debate in Italy see Ferrone, pp. 67-75; for Europe see Arton, pp. 3-21; for Roccati's acquaintance with Poleni see Cessi, p. 22.

[118]Parziale 40 and Parziale 35 in A.C.R: *Roccati...Lezioni*;for the debate on live forces, which Roccati never mentions see Iltis, " Madame du Châtelet ', pp. 41-48; Iltis, " The Leibnizian-Newtonian Debates...", p. 355-77; for Poleni's role in the debate see Iltis and Bergia and Fantazzini, pp. 46-60; Corollary I in Laws of Motion, Newton, *Principia.*

[119]A.C.R.: *Angeli Niccolò Lezioni Accademiche no. 10.* For Roccati's failure to qualify see A.C.R.: Ms. *Concordiana* 250: " Giornali..., pp. 551-52, 559, 566-67, 579-80, 597, 607-08, 616-17, 627-28, 630-31; for the catalogues from 1770 to 1838, see A.C.R.: *Manifesti....*

[120]Cessi, pp. 26-29; Lezione 1, 10-1-1774: Parziale 21, Lezione 2, 17-3-1774; Parziale 20, Lezione 3, 10-5-1774: Parziale 22 in A.C.R.: *Roccati...Lezioni....*

[121]Parziale 21, Parz. 20, Parz. 22 in A.C.R.: *Roccati...Lezioni...*; for Buffon's explanation on the formation of the solar system see Jean Seidengart, " Le traitement du problème cosmologique dans l' oeuvre de Buffon " in *Buffon 88*, pp. 309-25; for Newtonian sources see the General Scholium, and Proposition 8, Theorem 8, particularly Corollary IV in Book III, Newton, *Principia.*

Chapter IX

From Learned Ladies to Teachers of Men: Experts without Degrees

Maria Gaetana Agnesi and Anna Morandi Manzolini were also given an opportunity to teach their respective fields of expertise at the University of Bologna by Pope Benedict XIV. Unlike Bassi and Roccati, Agnesi and Morandi were not university graduates, and therefore were not officially qualified to teach at any university. However, Agnesi's publications in natural philosophy and mathematics, and Morandi's works in practical anatomy left few doubts of their learning in their respective fields in the minds of the men who appointed them to their official positions. Morandi was to teach practical anatomy, and the art of anatomical wax modelling at home. Morandi was considered a technician by the university's administrators, and her salary reflected her subordinate position in relation to university lecturers like Bassi. Agnesi was offered a lectureship in mathematics, which reflected her systematic education in natural philosophy and mathematics. However, Agnesi's teaching did not take the public form, but it was perhaps equally effective, for it was accomplished by means of her text in finite and infinite analyses, *Instituzioni analitiche.*

I. *Teaching through the* ***Instituzioni analitiche****: Maria Gaetana Agnesi*

Since the *Instituzioni analitiche* is considered the first important surviving mathematical work by a woman, historians of sciences specialized in the field of mathematics have written a great deal on its author, Maria Gaetana Agnesi (1718-1799). As might be expected, historians interested in women in science, and particularly in

women mathematicians, never fail to provide a biographical sketch of Agnesi. Most of these works discuss Agnesi and her work either in the context of other female mathematicians, or in relation to the development of mathematics in Europe. But Agnesi's education, and the relevance of her *Instituzioni analitiche* are best understood in relation to the tradition of Italian learned women, other learned women contemporaries of Agnesi--specifically Bassi and Borromeo--and the development of mathematics in Italy in the eighteenth-century.[1]

In her 1753 letter to Lady Bute, Lady Mary Wortley Montagu referred to the fact that the greatest Italian families were proud of having produced female writers.[2] What Lady Montagu forgot to mention was how the heads of some of these families used the learning of their daughters to bring attention to themselves, increase their social prestige, and advance their own political interests. The fathers of Piscopia, Fedele, Ardinghelli, Roccati, perhaps Cereta, and others did use their daughters' learning and fame to further their own interests.[3] To this category also belonged Agnesi's father, Pietro Agnesi Mariani. As the Agnesi family's income was derived from trade, Pietro Agnesi did his best to raise the family's social status and enoble it by whatever means at his disposal. To achieve his goals he could entertain, and ingratiate himself with government officials of Austrian controlled Milan; men who dispensed nobility titles for a price. How best to entertain than to run an academy from his residence, in opposition to the academy of Clelia Borromeo, a woman who was known in Milanese circles for her support of the Spanish, and dislike of the Austrian crown.[4]

To compete successfully with Borromeo, who was known for her knowledge of seven languages (Italian, French, English, Latin, Spanish, Arabic and German) and various

subjects which ranged from rhetoric to mathematics, Pietro Agnesi needed to educate at least one of his daughters far beyond what was expected of women.[5] It might help us understand why Maria Gaetana Agnesi was also made to learn from an early age, her own seven languages: Italian, French, Latin, Greek, German, Spanish and Hebrew. In fact, we know from one of her letters to Canon Frisi that she knew no Spanish. The study of the other languages seems to have been confirmed by her surviving study notes. By 1727, when 9 years old, Agnesi was able to display her extensive knowledge in Latin by presenting an oration in that language in which she pointed out that it befitted women to learn the liberal arts.[6] By allowing his daughter to present such an oration in public, Pietro Agnesi was not really demonstrating to be in favour of higher education for all women. Men who used the education of their daughters to enhance their own, and their family's prestige, needed to continue to foster the myth of the exceptional female.

In his eulogy in Agnesi's honour, Frisi stated that she began her scientific studies only in 1737, a year before her *Propositiones philosophicae* appeared in print. This date was either a misprint, or a deliberate attempt by Frisi and the surviving Agnesi family to make Agnesi appear a far quicker study in the sciences than she really was. A few pages further down, Frisi then proceeded to contradict his own statement by referring to one of her teacher's, Francesco Manara's letter from 1733, in which he explained a point of ballistic to her, and then to another letter from 1735, from Count Belloni (one of her academic advisors) in which this latter clarified some of the difficulties Agnesi had encountered with De l' Hôpital's *Conic Sections*. The existence and dates of these letters have been confirmed by Anzoletti and Klens, and indicate that Agnesi was immersed in her studies of physics by 1733 and of Cartesian geometry by 1735. According to

Mazzucchelli , Abbot G. Tagliazucchi, who eventually took up a post at the University of Turin by 1730, instructed her in algebra up to the solution of problems of second degree. It appears also that Francesco Manara and Father Michele Casati, who taught her Euclid's *Elements*, general, particular and experimental physics, and metaphysics entered the scene only after Tagliazucchi's departure; one suspects at approximately the time (around 1731) when rumours of Bassi's philosophical studies and disputations began reaching Milan. Again, if Mazzucchelli is to be believed, the Agnesi academy only began in full force when Agnesi was 14 years old, or after May 16, 1732. By then, Bassi had already successfully published and defended her theses, received her degree, and might have already even been appointed a lecturer at the University of Bologna.[7]

It might be a coincidence that Maria Gaetana began her serious scientific studies only when Bassi's fame as learned spread; however, if one considers that Pietro Agnesi's purpose in educating his daughter was to aggrandize his own and his family's social status, the coincidental factor has to be discarded. Borromeo and her academy might not have represented much of a threat to Pietro Agnesi's plans; the countess never published anything remotely associated with natural philosophy or mathematics; and her academy appeared to have lost much of impetus after the death in 1730 of the organizing brain behind it, Antonio Vallisneri. But Bassi was another matter, her achievements were concrete. If Maria Gaetana Agnesi were to continue to attract important people to her father's academy, she simply had to do better. It explains why, when Agnesi's one hundred and ninety one theses, which ranged from logic to plant physiology, were finally published in 1738, they made Bassi's total of sixty-one theses pale by comparison.[8]

According to Anzoletti and other authors, the Ambrosiana Library has many volumes of manuscripts which represent Agnesi's scientific studies. These manuscript notes are not in her handwriting, but were annotated by her. Therefore, they represent the lessons prepared by her teachers, and sent to her for her instruction. As it turned out, two of Agnesi's teachers, Manara and Belloni, had no fixed residence at Milan, but held teaching and official positions respectively at Pavia. It seems that only Casati remained in Milan until 1739, and thus might have taught Agnesi on a regular basis; otherwise, it appears that Agnesi was left to study her manuscript lessons pretty much on her own, seeking advice only when difficulties arose. It might explain why more than six years had to pass before Agnesi was able to publish the results of her philosophical studies.[9]

According to Frisi, Agnesi defended her theses at home in the presence of ministers, senators, and the learned of Milan with much applause in 1738. By the number of government officials present at the gathering, one can gather that Agnesi's defence of her theses brought much attention upon her father and his family. It brought, however, little advantage to Agnesi personally, for she received no offers of a degree or lectureship from the University of Pavia, the official university of the Duchy of Milan. In fact, these offers did not arrive even after Agnesi wrote her mathematical opus, *Instituzioni analitiche* in 1748. It was Bologna and its institutions of high learning which would recognize Agnesi's achievements in 1748; but even Bologna failed to acknowledge her first foray into the sciences in 1738.[10]

These academic exercises carried out in home academies had the advantage of keeping women informed on the latest scientific debates. However, they could also be sterile exercises, particularly, if they were geared solely to display the knowledge women

had recently acquired to men who probably already had similar knowledge. Furthermore, they did little to encourage women in the actual practice of science. If De Brosses is to be believed, Agnesi seemed perfectly aware of these facts. As De Brosses described one such academic meeting at the Agnesi home: "...j'ai trouve trente personnes de tous les nations de l' Europe...et Mademoiselle Agnesi assise seule avec sa petite seur sur un canapé. " It was not a normal conversation which took place, but " une espèce *d' action* publique "; Count Belloni began to dispute with her in Latin on the origins of fountains, and on the flux and reflux of the seas. De Brosses could also debate with Agnesi in Latin if he wished, but only if he stuck to philosophical and mathematical matters. De Brosses and his companion chose their scientific topics and then took turns debating with Agnesi. At the end, Agnesi told De Brosses how upset she was that his visit had turned into a defense of a thesis. Furthermore, she did not like to discuss [scientific] matters in public because for each person who enjoyed such discussions, twenty others were bored. Finally, he learned of her intention to enter a convent.[11]

As Italian theses were at the time, Agnesi's *Propositiones* consisted essentially of summaries of specific topics, which the author then had to publicly defend; they were brief in nature and provided little detail. As we do not know how Agnesi expanded on a proposition topic in the home academy setting in which she functioned, how intensily she was questioned, or even how she would handle in an oral manner the mathematics inherent in several of the topics, any opinion we might form of her scientific knowledge through the propositions cannot be complete.

Agnesi's *Propositiones* contained initial theses in logic, ontology and pneumatology which were outside the the definitions of physics. The remaining one hundred and fifty

five theses were under the general headings of general physics and particular physics, and thus can be compared with Roccati's surviving lectures in general and particular physics. As the headings indicate, both Agnesi and Roccati covered similar topics in mechanics, optics, the sensible principles and qualities of bodies, gravity, tides, central forces, meteors, and so on. The *Propositiones* and the lessons presented similar levels of difficulty. Roccati discussed certain topics in optics, such as the instruments of catoptric and dioptric, as well as the mechanism of vision and the anatomy of the eye in more detail than Agnesi. Roccati's lessons had the added bonus of geometrical demonstrations. Agnesi's explanations were affected, mostly, by the necessary brevity of each thesis, and could have been expanded in academic debates.[12]

When discussing the sensible principles of bodies, Roccati dedicated six of her lessons to the conventional Aristotelean elements, as well as those elements accepted by the chemists. Agnesi discussed some of the elements, such as air, in purely physical terms; the chemical elements received only passing mention, and were considered mostly in terms of the odour and taste they produced. In fact, Agnesi did not consider either the Aristotelean or the chemical elements as true elements. The Aristotelean elements (water, air, earth, fire) seemed to be four etymological choices of primary qualities. Whereas the active principles of chemistry (salt, mercury, sulfur) could not be considered elements because they could not be elicited from mixtures by analysis; nor were they simple bodies because they could be resolved in heterogeneous parts by fire. Thinking in purely mechanistic terms, Agnesi believed that the true rudiments of bodies were clearly inert, solid, extended mobile particles of a certain shape and size which could not really be known.[13]

Under the aegis of particular physics, Agnesi presented theses on the universe in general and celestial bodies, upon which, having published in 1738, she paid lip service to the Ptolemaic system in the first part of these theses, but actually dealt with the Copernican system in the second part. In this latter section she discussed the Cartesian theory of vortices, Newton's law of gravitation, and the paths of comets, and gave the laws of central forces. Under this general headline of particular physics Agnesi presented also theses on tides, the shape of the earth, the nature of fountains, lightning, rainbows, aurora borealis, vision, sound and hearing, magnetism, crystals, thus covering much of the ground Roccati covered in her lessons on the subjects; and she even disputed similarly against the eternity of the universe.[14] However, needing to show encyclopedic knowledge, Agnesi covered ground never covered by any of Roccati's surviving lessons. Thus, Agnesi had theses on plants, in which, like Hales, she attributed the rise of humour from the roots to the branches to attractive forces similar to those which caused liquids to rise in capillary tubes. However, unlike Hales, she believed in the circulation of the humour in the plant body, similar to blood circulating in animals. It leads one to question whether she ever read the French version of *Vegetable Staticks*, where Hales effectively disproved that sap circulated.[15]

This section contained also seventeen theses on animals such as zoophytes, insects, snakes and fish, in which Agnesi accepted and expounded some of the latest findings by Francesco Redi and Antonio Vallisneri on the transmission of venon, generation, and spontaneous generation. Based on Redi's and Vallisneri's experiments and conclusions, Agnesi disproved of spontaneous generation, and thus, did not accept that zoophytes and insects were born only from the fermentation and putrefaction of matter. Also

influenced by Vallisneri' s writings on generation, she believed in ovum preformism.[16] When discussing the animal parts of men, Agnesi went beyond the anatomy and physiology of the eye, ear and tongue that Roccati covered in her lessons on the senses, to include the anatomy and physiology of the nervous system, the muscles, heart and lungs, as they were generally understood at the time. In the thesis on circulation, Agnesi dismissed the Cartesian belief that the circulation of the blood was caused by the fermentation and bubbling of the blood in diastole, and instead attributed it, as concluded by Harvey, to systolic contractions.[17]

Agnesi's *Propositiones* contained a section on mechanics, which was more extensive and detailed than the several lessons Roccati presented on the subject. These dealt with motion in general, the resisting forces in moving bodies, the laws of composition and resolution of motion, gravity and the motion of heavy bodies, and the laws of heavy bodies. They also explained the principles of ballistic art, principles of geostatic, principles of hydrostatic and the laws of motion of fluid bodies, the equilibrium of solids immersed in fluids, the composition of motion, the communication of motion in inelastic collisions, and the communication of motion in elastic collisions. In spite of a list of impressive titles in the *Propositiones*, it has to be said that Roccati covered several of the topics contained within them in her lessons; and in some cases went beyond what Agnesi had discussed. For instance, Roccati described several simple machines in her lessons on the subject, Agnesi discussed only the lever and the inclined plane.[18]

As Roccati made clear in her lessons, she had to limit herself to topics which could be explained by simple and straight forward geometrical demonstrations to ensure that her audience would understand them. No such limitations affected Agnesi; after all the

purpose of the *Propositiones* was to illustrate the extent of her knowledge. Thus Roccati limited herself to the resolution of motion by means of the parallelogram of forces. Agnesi extended this to cover the resolution of motion through logarithmic curves, circles, parabolas, ellipses, and spiral curves. Agnesi had also a section consisting of one thesis and twenty-three laws, which dealt with the principles of hydrostatic and the laws of motion of fluids, and the equilibrium of solids immersed in fluids (Archimedes' principle) drawn from the Galilean-Torricellian School of fluid mechanics, subjects which were entirely ignored by Roccati in her surviving lessons.[19] These were topics which required a more advanced level of mathematical knowledge, as Newton's *Principia* demonstrate, than the schematic level of the theses would allow. Although Agnesi was not introduced to infinitesimal calculus until Ramiro Rampinelli became her teacher in 1740, she had learned enough synthetic and analytical geometry to carry out all the demonstrations required to illustrate these topics. However, one wonders how Agnesi could handle any mathematical demonstration in the context of the academic discussions in which she had to operate.

Savaris has pointed out that Roccati's lessons were devoid of any experimental basis. In fact, having been at Bologna and at Padua, Roccati had the opportunity to observe at least some of the experiments mentioned in her lessons, and might have tried others herself.[20] Agnesi's *Propositiones* are even more devoid of an experimental basis than Roccati's lessons. There are no indications that she ever observed, or tried any of the experiments that might be implicit in her theses. Her knowledge appears to have been book-learned. Summing up all these points, it can be said that, on the whole, the encyclopedic knowledge demonstrated in the *Propositiones*, with some notable

exceptions, was not much more advanced than the one found in the lessons Roccati was presenting her audience. The most relevant difference rested in the fact that Roccati's lessons aimed to instruct, whereas Agnesi's defence of the *Propositiones* in her father's academy intended to display a knowledge that serious natural philosophers would generally have; a fact that further illustrates the sterility of such an exercise, of which Agnesi was perfectly aware.

De Brosses in his letter to Président Bouhier referred to Agnesi's attachment to Newton's philosophy. Certainly, the influence of Newtonian physics can be detected in her theses. Like Roccati's, Agnesi's optics was decidedly Newtonian in the particulate nature of light, in the explanation of why, when light refracted from a rarer to a denser medium, it bent towards the perpendicular, in the concept that white light rays were composed of heterogeneous particles which differed in size, shape and thus, colour, and also in the fact that rays that differed in colour also differed in refrangibility.[21] Matters are more complex when one looks at her theses in mechanics. In thesis LXXI Agnesi appeared to favour the Cartesian-Newtonian definition of force (mv) as " recognized by experience and conquered by calculation ". However, she was not quite ready to dismiss the Leibnizian definition of force (mv^2) for experiments (Poleni's experiments) coincided excellently with this principle. Furthermore, unlike the Newtonians, Agnesi did not believe that the quantity of motion (momentum) was conserved, nor even in cases of elastic collisions, unless the bodies colliding moved in the same direction before and after collision.[22]

Following Newton, Agnesi stated that the force of gravity varied inversely as the square of the distance from the centre of the earth. Descartes' vortices of fluid matter did

not help planetary motion and those philosophers like Leibniz and others, who attempted to reconcile the doctrine of vortices with Kepler's laws had practically destroyed it. According to Agnesi, the most beautiful theory belonged to Newton who explained planetary motion solely by a force composed of gravity and by motion of projection according to straight lines. In fact, Newton, considering gravitation as action at a distance, defined this action of gravitation in the *Principia* in terms of tangential inertial forces and centripetal gravitation; the centrifugal force was not considered for it implied a contact push force. This latter force was accepted by those philosophers who did not accept a vacuum, and attempted to reconcile Kepler's laws of planetary motion with the vortex theory. In spite of all the compliments paid to Newton, Agnesi brought into play the role of centrifugal force in planetary motion, and thus made gravitation, by default, not an action at a distance.[23]

Agnesi diverged from Newton in her thesis on tides. As Roccati explained in her lesson, Newton's theory of tides was a three bodies problem, for the flux and reflux of the seas arose from the actions of the sun and the moon on the earth. To Agnesi, the flux and reflux of the seas was a two bodies problem, whereby the earth and the moon gravitated towards each other.[24] Agnesi did not accept in her theses Newton's statement that the earth was flattened at the poles; instead she opted for Cassini's experiments, results and measurements which demonstrated the earth to be elongated at the poles. However, in 1741, she no longer agreed with what she had written in the propositions. In a letter to Giovanni Bianchi, Agnesi pointed out that she bowed to the results brought back from the polar expedition by the members of the Paris Academy (Maupertuis and

Clairaut) which were all contrary to Cassini's measurements, and demonstrated Newton's theory to be right.[25]

The fact that Agnesi's *Propositiones* displayed influences from a variety of natural philosophers, and presented no original thought, led Luisa Anzoletti to conclude that they represented only her study program. On the whole, one has to agree with Anzoletti, and it explains why the *Propositiones* had so much in common with Roccati's lessons. Nevertheless, however much Agnesi based her theses on the findings of others, she still made judgement calls, often guided by what she believed to be the best observations of others, on what constituted acceptable hypotheses by her standards, as her change of mind on the shape of the earth appropriately illustrates. Furthermore, the propositions did not lack original material, as found in thesis CXXXI, on the aurora borealis. This was a thesis which the author later expanded, after having consulted the acts from the academies of London, Paris and Bologna, and attempted to have published both in a new edition of Crivelli's *Elements of Physics* and on Jacopo Maria Paitoni's book on physics.

As Agnesi was aware, the general theories placed the aurora borealis in the upper atmosphere where, because of the lightness of their particles, igneous vapours rose and concentrated at the poles, and would produce the phenomenon of the aurora, either due to the attriction, or because of the reflection of sunlight. In 1733, De Mairan presented a novel theory for the aurora borealis, whereby he attributed its origin to particles coming not from the earth, but from the solar atmosphere, which, when they approached the earth, experienced the action of its gravitational force entering thus its atmosphere, where, because of their lightness and the earth's rotation, they concentrated at the pole. Agnesi's thesis, apparently influenced by Mairan's theory, also moved away from

terrestrial effluvia, and attributed the aurora's origins to the rays of the sun (particles to her)which were reflected in the concave surface of the northern earth's atmosphere not only once, but twice, or even three times. The aurora was concentrated in the northern atmosphere, because such an atmosphere had the right disposition that allowed a great quantity of sun rays to reach it; the great difference in density between the medium above and the earth's atmosphere below played a role in the reflection and thus in the phenomenon. Later in a letter to Bianchi, Agnesi believed that two reflections were sufficient to describe all the properties of the aurora borealis.[26]

According to her biographer Frisi, Agnesi was supposed to have stated when she retired from all scientific pursuit, following her father's death in 1752, to dedicate herself to assisting the old and dispossessed that " man has to operate for some purpose, the Christian [has to operate] for the glory of God; until now I hope my studies have served God because they gave pleasure to others, and were carried out in obedience to my father's wishes and inclinations; but now that [obedience] has ceased, I have better ways to serve God and give pleasure to others, and to those I wish to apply myself. "[27] With such a statement on Agnesi's part, one has to conclude that all of Agnesi's efforts directed towards the publication and promotion of her scientific work were undertaken in obedience to her father's commands. It is clear that the *Propositiones* were published under this aegis, for they suited her father's strategies. However, some of her correspondence seems to indicate that she might have been motivated by more than obedience in her efforts to get recognition for her scientific works. Having received from Bianchi his work on the flux and reflux of the sea in November 1741, Agnesi appeared quite proud to send him her own *Propositiones*, almost four years after they had been

published, and to point out to him her own novel explanation on the origin of the aurora borealis, which was then followed by others. Agnesi was also disappointed that her theory on the aurora as contained in thesis CXXI was usurped and published by another in 1740, two years after her publication. Nevertheless, she appeared still determined to have her own expanded dissertation based on her thesis published in Crivelli's, or Paitoni's book, if the author mentioned in the book that she had claim of priority to the theory because of her 1738 publication.[28]

Subservience to her father's wishes cannot completely explain her subsequent decision to publish the all important *Instituzioni analitiche*, and the steps she took to promote it. It might have been her father's idea to dedicate the work to Empress Maria Teresa of Austria (and of the Duchy of Milan) in yet another attempt to gain favours for his family. But the dedication could also remind the reader that if women could reign successfully, as Maria Teresa was daily proving, so could they write a text in mathematics. It was an important point to keep in the minds of the potential readers of the first original major work in mathematics to be published by a woman. Pignatelli had published, of course, a few problems in mathematics in the 1734 *Nova Acta Eruditorum*, which was a coup in itself; but they were minor works in comparison to Agnesi's efforts, and they were published anonymously. Mme. du Châtelet's *Institutions de physique* were mathematical in nature, but did not deal with pure mathematics.[29]

The intent to be useful, so dominant in Agnesi's psyche later in her life, was apparently behind her publication of the *Instituzioni*. As Agnesi stressed to the readers: having begun the work for her own enjoyment, and for the purpose of teaching her younger brothers, she realized how important it was that young people desire to acquire

mathematical skills. Then, she presented, what amounts to a criticism of the conditions of mathematical education in Italy, which modern Italian historians of mathematics woud accept as valid. A young person wanting to learn the latest mathematical skills encountered great difficulties, not finding in their own towns teachers who wished, or could, teach them these skills, forcing them to move to areas, where skilled teachers could be found, which was an option that not all could achieve, as she knew from personal experience.[30]

In fact, it is apparent from her correspondence with Manara, Belloni, and others that Agnesi had learned analytical geometry essentially on her own. It was not until the Olivetan father Ramiro Rampinelli (1697-1759) moved to Milan from Bologna in 1740, that Agnesi had finally the opportunity to learn infinitesimal calculus, so relevant in her *Instituzioni*. Rampinelli himself had learned calculus as a student at Bologna from Bassi's own teacher in the subject, Gabriele Manfredi. Agnesi gave full credit to Rampinelli in her introduction, whose guide and direction enabled her to progress to the limits of her talents.[31]

Agnesi also indicated in the introduction that the book which dealt with integral calculus contained a new method on polynomials by Count Jacopo Riccati, the foremost Italian mathematician of the period. Rampinelli, who had met Riccati at Padua and became one of his students at Castelfranco, was responsible for introducing Agnesi to the mathematician and his sons Giordano and Vincenzo, well known mathematicians in their own right. The Riccatis, particularly Jacopo and Giordano, were responsible, at Rampinelli's request, for the proof-reading and any needed corrections of all of Agnesi's *Instituzioni*, a process which was carried out over a period of more than three years. The

promptness with which the established mathematician, Jacopo Riccati, acceded to her request, the steadfastness with which he carried out his task, and the politeness with which he clarified any of her doubts and accepted her explanations why certain of his suggestions could not be placed in the book, is further proof that, in spite of all the negative rhetoric which existed against women's abilities in Italy, there were men in science quite ready to accept some women within their rank. Agnesi's publication of his new method on polynomials, which Vettori-Sandor describes as more complicated than necessary, was her way of thanking him for his assistance. In book IV, however, Agnesi presented an abstract of one of Jacopo Riccati's recent publications on a problem of osculating rays given as a function of the curve, which he had given her to examine. However, as she pointed out, Riccati's original article was too elegant and very far from the usual style of her own book, and thus, had to be modified, or essentially simplified. Another Riccati, Vincenzo, professor of mathematics at Bologna's Jesuit College, who had seen proofs of Agnesi's book while visiting his father, was undoubtedly responsible for publicizing the book before it appeared in print to the members of Academy of Sciences of Bologna. It must have been through his efforts that Agnesi was made a member of the Bologna Academy of Sciences several months before the *Instituzioni* was printed, and thus, in the book's title Agnesi could claim association with at least one learned institution.[32]

Upon examining the Agnesi-Riccati correspondence, Clifford Truesdell places her mathematical knowledge at the level of a student still in the process of learning. His belief is compounded by the fact that Agnesi did not wish to follow Jacopo Riccati's advice and discuss calculus applied to mechanics in her work. Apparently, unaware of

Agnesi's *Propositiones*, Truesdell assumes that her desire to stay away from applied calculus was motivated by her lack of knowledge in mechanics; whereas the *Propositiones* clearly demonstrate her extensive knowledge in the subject. In fact, Agnesi was quite sure of what she wanted to do, and applied calculus was not in her mandate, as she did not want to go beyond pure analysis and its applications to geometry. As she had stated to J. Riccati as early as 1745, she aimed to facilitate the study of a subject which was difficult and laborious by " reducing it to that order and clarity to which it can be reduced, and which nobody so far had attempted to do ". Although Agnesi left Riccati's polynomial method as was, in deference to his assistance and to the fact that it was never published before, she was quite ready to simplify his article on osculating rays to fit the style of the book. As again she stated to the readers, since Father Reynau had given to the press his *Demonstrated Analysis* in 1708, many important new discoveries in mathematics had taken place which tended to be scattered in different journals , and often in language not always accessible to the beginner. Therefore, Agnesi aimed for clarity and simplicity, and a natural order, by eliminating all that was superflous, while still maintaining all that was useful and necessary.[33]

The *Instituzioni analitiche* was divided into two volumes, or four books. Volume one was entirely dedicated to the analysis of finite quantities. The first chapter of book one taught the basic rules of algebra, such as addition, subtraction, multiplication and division, the computation of fractions, how to find the divisors and the reduction of quantities affected by radical signs. The following five chapters discussed equations and determined plane problems, construction of loci, and indetermined problems not above the second degree, the equations and solid problems, the construction of loci above the

second degree followed by the methods of maxima and minima, of tangents of the curves, of points of inflexion and of rebroussement by making use solely of Cartesian algebra.

The second volume was dedicated entirely to infinitesimal analysis. Book two of that volume gave the principles of differential calculus for the different orders and how to use these principles by applying them to find the tangents, maxima and minima, points of inflexion, rebroussement, evolutes, and osculating rays. Book three dealt with integral calculus; it explained in detail the methods by which one could reduce differential functions of first order composed of a single variable to either algebraic formulas, or to quadratures of the circle and of the hyperbole. It also explained the rules of integration by making use of series, and how these rules could be applied in the retification of curves, in the quadrature of spaces which enclosed them, the development of the surfaces, and the cubature of solids. Book three ended with a chapter on the calculus of logarithmic and exponential quantities. This chapter taught, amongst other things, how to construct curves which were expressed by logarithmic and exponential equations in addition to indicating how such calculus could be applied by providing many examples of problems and their solutions.

Book four discussed the rules encompassed within the inverse method of tangents, rules which led to integration and the construction of differential equations with two variables. Thus the chapters covered the construction of differential equations of first order, without any previous separation of the indeterminates, the construction of differential equations of first order by means of previous separation of the indeterminates, the construction of other more limited equations by means of various substitutions, and the reduction of second order differential equations, and sometimes, even of higher order

differential equations. Dortous de Mairan and De Montigny, who reviewed and provided a summary of the book for the Paris Academy of Sciences ended up their summation by stating that it took skill and sagacity to reduce, as it was done in the book, discoveries dispersed amongst the works of various modern mathematicians, often expounded by methods very different one from the other, to practically uniform methods, and present them with clarity, order and precision.[34]

The book was reviewed favourably not only by the members of the Paris Academy of Sciences, but also by several Italian journals, such as the *Giornale de' letterati di Firenze* (1750), *Novelle della repubblica leteraria* of Venice (1750), *Storia letteraria d' Italia* (Venice, 1753), and a German journal, Leipzig's *Nova acta eruditorum* (1750). This latter journal presented an extensive review of the book recommending it for the order and perspicuity with which everything was exposed, for the clarity and selection of examples with which it was illustrated. All was more remarkable because its author was a most learned woman, who had given abundant proof in the book of being versed in the more recent analytical methods and skills.[35]

In spite of all the compliments De Mairan and De Montigny payed to the book, Agnesi was not made a member of the Paris Academy, but De Montigny offered her the next best thing, an opportunity to correspond with other French mathematicians, if she so desired. Such a correspondence might have been useful to Agnesi had she continued in her field, for some very important work in mathematics was coming out of the Paris Academy at the time, and unlike Ardinghelli who remained attached to synthetic geometry, Agnesi had the mathematical language to carry it through. For all its draw backs, the Paris Academy still acknowledged Agnesi's work far more than the Royal

Society of London ever did, which chose to ignore having received the book altogether. Such a neglect on their part might have been motivated by the fact that its author was a woman, or because Agnesi used Leibniz's annotation, rather than Newton's in the infinitesimal calculus section of the book. We know, however, that the society had received the book because John Colson, Lucasian professor of mathematics at Cambridge University translated it into English before his death in 1760.[36]

The *Instituzioni* would benefit its author more in some parts of Italy. Agnesi had sent her work to various people within Italy, such as Giovanni Poleni of the University of Padua, and as expected, copies were offered to the members of the Bologna Academy of Sciences. Laura Bassi received her own copy, and maybe the work might have motivated Bassi to finally publish two article from her own pen in the 1757 *Commentarii* which illustrated her knowledge in applied finite and infinite analyses. As seen, Bassi's important work on deviations from Boyle's law was not written by her, but received a summary from the academy's secretary, Zanotti. If Bassi's degree might have motivated Agnesi's father to have his daughter learn mathematics and natural philosophy, Agnesi's book might have finally forced Bassi into action as far as publications of her own work were concerned.[37] Most importantly, Agnesi sent a copy of her book to Pope Benedict XIV.

The pope's very positive reaction to her work in 1749, and his offer to Agnesi of a lectureship in mathematics at the University of Bologna have been recorded by Agnesi's biographers ever since. What the biographers have failed to record is the fact that Agnesi had apparently asked for the honorary lectureship to Pope Benedict XIV herself. This remarkable pope, who had not thought of offering the lectureship to Agnesi when he had

first received the book in 1749, was quick to oblige with a request to the senate which merits to be quoted in full:

> The famous Maria Gaetana Agnesi sent us as a gift her work, which received full praise. As it was our duty we thanked her, when a little time later, through the Cardinal our Secretary, she referred of her desire to have an honorary lectureship in her specialty at our famous University of Bologna. We are well informed by ancient examples, and by recent ones (Laura Bassi's lectureship) not to be against the custom of the university to distinguish women also with this mark of honour, when they attain the high degree of knowledge which Agnesi has attained. With great urgency we recommend to you her petition . June 24, 1750 Castelgandolfo.

The senate was quick to oblige, and Agnesi was offered an honorary lectureship in mathematics on July 7, 1750, which she officially accepted on October 5, 1750.[38]

Again, as it is well documented, Agnesi never took up the post of lecturer at the university, in spite of requests that she do so by men like Jacopo Beccari, the president of the Academy of Sciences, who had always backed Bassi in her struggles to insert herself in the academic life of Bologna, and would, no doubts, have done the same for Agnesi. It is possible that Agnesi sought publicity for her book and honour for her achievements at her father's request. Her father's actions in the past, Agnesi's statements to De Brosses in 1739, the motives Agnesi gave for withdrawing from the sciences after her father's death seem to indicate that glory was only sought by the father, and not by the daughter, and biographers like Anzoletti and Tilche expound this thesis.[39] However, to say that is not to do justice to Agnesi, who appeared quite proud of a publication which she believed, as the introduction demonstrated, to have as its inherent value clarity, simplicity, uniform method, was not devoid of novelties, and, moreover, had been motivated by a desire to assist the young. Having produced what she believed to be an achievement, why would Agnesi not seek recognition for the work and its author?

Because Agnesi decided not to act on the honours bestowed, it does not necessarily follow she did not seek them symbolically as a compensation for years of work; and why might she not have been disappointed when more honours were not bestowed on her by academies such as the Paris Academy of Sciences, or the Royal Society?

For all the praises comtemporaries bestowed on Agnesi's *Instituzioni*, modern historians of mathematics, comparing her book with Euler's *Introductio ad analysin infinitorum*, which appeared a few months before the *Instituzioni*, and is generally considered the most influential textbook in modern times, take a more somber view of it. Carl Boyer remarks in its favour that the *Instituzioni* was one of the earliest contributions to analytic geometry to come out from Italy. Moreover, it was a book characterized by clarity, and which had widespread influence. The volume on infinitesimal calculus was a worthy rival to the Marquis de l' Hôpital's *Analyse des infiniments petits* (1696). However, Boyer stresses also the fact that the *Instituzioni* contained essentially no new material. Strong Cartesian influence was found in the geometric construction of algebraic expressions, equations, and loci. Like Mcclaurin's *A Treatise of Algebra* (1741), the *Instituzioni* presented what Boyer describes as the "double standard for curves": these would be plotted by Agnesi from the equation, following Fermat's method; but they were also constructed in the Cartesian manner " through the well-known locus of lines with respect to a circle". Euler chose the Fermatian way. According to Boyer, one can detect in Agnesi's work some of the old errors with respect to negative coordinates, and right and oblique coordinates were used " more or less indiscriminately ". Agnesi continued to splinter the linear equation into numerous different cases, whereas Euler in the *Introductio* tended to generalize analytic methods. Boyer also points out, as Gino

Loria had done before him, that the famous curve known as the " witch of Agnesi " was not really of her invention, but had been rediscovered in 1703 by Guido Grandi, who had named it *versiera*. Of course, Euler made extensive use of polar coordinates, attributed to Newton, to describe transcendental as well as algebraic curves. Polar coordinates did not appear in Agnesi's book; she seemed not to have known them.[40]

Maria Teresa Borgato and Luigi Pepe find useful to compare the *Instituzioni* with the manuscript they printed in 1987 entitled *Principi di analise sublime*, a work which Giuseppe Luigi Lagrange had written for the benefit of his mathematics' students at the Royal School of Artillery of Turin around 1756. Borgato and Pepe point out that in Agnesi's work there appeared no concept of function, although such a concept was present in the works of Leibniz, Johann Bernoulli, and, most importantly, of Jacopo Riccati. The concept was found in the *Principi* derived directly from Euler's *Introductio*, where it was affirmed as a basic concept in differential and integral calculus. Moreover, although Lagrange's *Principi* did not cover as much ground as the *Instituzioni*, it presented superior definitions of differential and integral. Agnesi defined integral calculus as an antidifferential, whereas in Lagrange's *Principi* the path from differential to integral calculus " is followed backward to the level of finite quantity with a geometrical interpretation of integral very similar to the so called [yet to come] 'integral of Cauchy'".[41] In spite of all the virtues contained within Lagrange's treatise, Pepe and Borgato seem to forget that it must have had a very limited readership, for it was meant to serve the students attending Lagrange's classes; therefore the manuscript had limited value in improving the knowledge of infinitesimal calculus in Italy. Agnesi's published work was at the reach of anyone in the country who could get hold of one of its copies,

knew some geometry, and could read Italian. Besides, to have one's work compared with the works of two of the greatest mathematicians of the eighteenth-century and coming out a bit short, was not a bad record for any mathematician, male or female.

In their biography of Agnesi, M. Gliozzi and G.F. Orlandelli state that she studied many plane curves in her *Instituzioni*, some of them quite complex. However, the same argument was taken up by G. Cramer in his *Introduction à l' analyse des lignes courbes algébriques* (1750) with greater originality and organicity. The greatest criticism of Agnesi's *Instituzioni* comes from Clifford Truesdell who feels the book was obsolete the moment it appeared, for there was no single reference to the work in the works of great mathematicians. Langrange was the only important mathematician to mention the *Instituzioni* in his work. As far as Truesdell is concerned, the book was not needed; calculus had diffused in Italy without it. A work in Italian was not needed; all those who studied mathematics at the university knew Latin. Truesdell disputes also Anzoletti's claim that the book ever had wide distribution, in spite of being translated into French and English.[42] Truesdell's claims are the ones which have to be disputed the most.

Firstly, infinitesimal calculus had diffused to a certain extent in Italy through the universities of Bologna, Padua and Pisa in the first part of the eighteenth-century, through the efforts of a few individual mathematicians, such as Gabriele Manfredi, Stancari--who died young--the Riccatis, Poleni, Grandi, Hermann, and in the south, Celestino Galiani. However, these teachers limited the number of students they would take. For instance, Giovanni Bianchi was not accepted as a student by Gabriele Manfredi when studying in Bologna. Jacopo Riccati taught away from the University of Padua, in the small town of Castelfranco in the Venetian Republic. As Palladino demonstrates, while Cartesian

geometry was widely known, Italy lagged behind Central and Northern Europe in the study of infinitesimal calculus; and, as seen in the sections dealing with Ardinghelli and Pignatelli, those natural philosophers who knew, and/or used calculus in their works were few. Therefore a textbook on the subject in Italian could only have helped matters.[43]

Secondly, Boyer has remarked on the rarity of textbooks in finite analysis coming out of Italy prior to 1748; it appears that a beginner's textbook in infinitesimal calculus was even rarer, if at all existent in printed form, and one that combined finite and infinite analysis was unique. Luigi Pepe in his " Infinitesimal Calculus in Italy" lists works on the subject by male Italian mathematicians; many of these works were found in journals and none had the appearance of a textbook in elementary calculus. As Truesdell himself admits, Vincenzo Riccati's and Girolamo Saladini's *Institutiones analyticae* (1765-1767) was the first textbook in calculus by Italians to come from university circles. Those who learned the subject often studied in foreign textbooks, such as De l' Hôpital's *Analyse des infiniments petits* and/or R. Reynau's *Analyse démontrée*, as Agnesi herself had done, and gathered the new discoveries from the various journals which contained them. Thus, an Italian woman, Agnesi, had done what Italian male mathematicians had failed to do, and in this rests her main claim to fame for Italian mathematics. Like Fiorini Mazzanti would do later for *Bryophyta*, Agnesi pioneered in an area of Italian science, where some pioneering was required.[44]

By stating that no great mathematician quoted the *Instituzioni* with the exception of Lagrange, Truesdell seems to misinterpret the purpose for which the book was published, and Lagrange's use of it. No one disputes that the *Instituzioni* had little to teach those mathematicians who were experts in infinitesimal calculus, men like the Bernoullis,

Clairaut, the Riccatis, Euler, Gabriele Manfredi; and no mention of the *Instituzioni* appeared in Lagrange's mature research in mathematics or mechanics. Lagrange referred to the work in his manuscript *Principi di analisi sublime*, written for the benefit of his students at the Artillery School, with the intent to direct these students to specific areas of the *Instituzioni* not covered in detail by his own lessons. Thus, those students who wanted further practice in the recently learned method of the tangent were encouraged to consult Agnesi's *Instituzioni*, De l' Hôpital's *Analyse* and Fontanelle's *Élements.* Those who sought detail on the theory of osculating rays of a circle were again to consult the *Instituzioni*, and finally those who wanted to learn in detail the use of substitution in integral calculus were directed towards Agnesi's book, among others.[45]

As it turns out, there were at least three established mathematicians and natural philosophers, who could not be defined as great, but who, nevertheless, made use of the *Instituzioni*; these were Giambattista Suardi, Gregorio Casali and Francesco Maria Zanotti. Diamante Medaglia's future teacher, Suardi, remarked on and discussed, what he believed to be the never before seen, unusual construction--nowadays found in textbooks--of an ancient Greek curve, the conchoid of Nichomedes. Gregorio Casali in the 1757 *Commentarii* discussed Agnesi's equation for the Torricellian pteroid, which according to him was interchangeable with Grandi's equation for the same curve; he then proceeded to study the curve and provide it with a general equation. F.M. Zanotti in his 1755 article discussed the importance of separating the indeterminates of a differential equation in order to integrate it, and devised a method for such separations which was more general than that of Gabriele Manfredi's. This method was then applied to ten differential equations of first order, four of which were taken from Agnesi's

Instituzioni.[46] Nevertheless, it has to be said that Agnesi's book was not designed with mathematicians in mind, but it meant to benefit mathematics students with knowledge in Euclidean geometry, and none in finite analysis, and differential and integral calculus. It is in this teaching role that the book was to enjoy its greatest success in Italy, as well as in France.

As far as Italy is concerned, there is evidence that the book was used by young men, and at least one young woman, who later became involved in teaching mathematics or physics themselves. As discussed, Cristina Roccati studied at least the first volume of the *Instituzioni*, a book which was also known to her teacher Alberto Colombo. From the correspondence of Teodoro Bonati (1724-1820), who taught hydrostatic at the University of Ferrara in 1753, we learn that as a student he had studied Agnesi's *Instituzioni* on his own, in addition to having daily consultations with Gianfrancesco Malfatti, professor of mathematics at Ferrara.[47]

Sebastiano Canterzani (1734-1819), who lectured first astronomy (1760/61), then optics (1766-1786), and mathematics (1786-1800) at the University of Bologna, and who shared the chair of physics at the Institute of Sciences with Laura Bassi, had received his degree in philosophy at Bologna University in 1756. As a student he had also used Agnesi's *Instituzioni.* In 1793, having received a letter from Agnesi, Canterzani answered her letter in terms that, in spite of her retirement from academic pursuits, must have pleased her nevertheless, for his letter clearly illustrated that her scientific endeavours had not been in vain: " I cannot but tell you how much you honour me with your letters, how dear they are, and always will be to me. I can boast to have been one of your students, since the principal exercises in mathematical matters were

done in your most clear, and truly original *Instituzioni*, of which we increasingly recognize its value. "[48]

Having used the textbook, Canterzani was ready to recommend it to others. Thus, in 1758 he procured a used copy of the *Instituzioni* for Bartolomeo Mozzi of Macerata; or when the mathematician Gianfrancesco Malfatti sought a textbook in Italian for a student, which contained the first elements of algebra, gave some idea of the Newtonian canon and contained equations of second degree, Canterzani was ready to recommend the *Instituzioni*, as late as 1783. According to Canterzani, the first chapters of Agnesi's book covered all his demands, and was the clearest of all. His manuscripts also reveal that he made use of the book in his teaching capacity. A manuscript entitled " Places of Agnesi's [book] Explained at the Request of Someone who Encountered Difficulties in Them " explained in more detail specific examples in the *Instituzioni* which needed further clarification. The examples discussed came all from books two to four which covered differential and integral calculus, and the inverse method of the tangent, and dealt, more specifically, with particular problems in the method of maxima and minima, in the reduction of a second order differential equation to one of first order, and so on.[49]

Like Canterzani, Lagrange (1736-1813) was ready to direct his own students at the Artillery School to Agnesi's *Instituzioni* because it was one of the textbooks had used as a student, and he had found some merit in it. The Baron Maurice de Genève in the *Moniteur universel* of Paris of February 26, 1814 printed what had been Lagrange's mathematical course of study at the University of Turin : from 1752 to 1754 Lagrange had read in specific order Agnesi's *Instituzioni*, Euler's *Introductio*, J. Bernoulli, *Lectiones mathematicae de calculo [methodo] integralium* (1742), Euler's *Mechanica* (

1736), the first books of Newton's *Principia*, D' Alembert's *Traité de dynamique* (1743) and De Bougainville's *Traité du calcul intégral* (1752-1754).[50] One can detect the influence of Agnesi's *Instituzioni* in Lagrange's manuscript textbook, *Principi di analisi sublime* not only in how he had drawn the conchoid of Nichomedes, but also in the equation he used to represent the conchoid. In Lagrange's manuscrit the conchoid appeared in the hitherto unseen shape in the negative part of the y-axis, mentioned by Giambattista Suardi in 1752. Lagrange also chose to represent its equation in rectangular coordinates as Agnesi had done, which in his case was given as $xy = a + y (b^2 - y^2)^{1/2}$; whereas in Agnesi's case the x and y coordinates were reversed and the equation appeared in its extended form as $y = \pm (a^2x^2 - x^4 + a^2bx - 2bx^3 + a^2b^2 - b^2x^2)^{1/2} / x$. The equation for the conchoid in Euler's *Introductio*--a book which Lagrange had also studied--was represented in polar coordinates, and the conchoid itself was drawn in its standard shape, although Agnesi's shape could have been plotted from Euler's polar equation. Lagrange might have decided to stay away from polar coordinates in his manuscript because his students were more familiar with Cartesian ones. As the English version of the *Instituzioni* was responsible, due to a mistranslation, for transforming Guido Grandi's *versiera* into the " witch of Agnesi "--as the curve is now generally known in modern English language textbooks--so the book might have been responsible in its original Italian and translations for the spread of the modern representation in the negative part of its y-axis of the Nichomedes conchoid. As far as it is known, the conchoid appeared in its standard form in Euler's *Introductio*, in Marquis de l' Hôpital's *Analyse des infiniment petits,* as well as J. Bernoulli's *Lectiones mathematicae de methodo integralium*, works published before the *Instituzioni*.[51]

All of Agnesi's biographer have discussed the 1775 French translation of the second volume of the *Instituzioni*, or *Traités elémentaires de calcul différentiel et de calcul intégrel*, which Frisi attributed to the Abbé Bossut, but which Jean Guillaume Garnier, who himself had used the book, attributed to Anthelmy, under Bossut's supervision. What the biographers have failed to mention is the fact that the translation occurred after the event. or in other words: the second volume of the *Instituzioni* appears to have been deliberately translated to fit the new course established in 1772 in the French Mauristes colleges, amongst them the Collège de Sorèze, whose program has been studied by Lemoine. These were secondary education colleges which received boys from 10 to 18 years old. The teaching of mathematics in these colleges went beyond modern day elementary classes in mathematics. In 1772, the Mauristes initiated the " Course of Mlle. Agnesi for differential and integral calculus ". The course consisted of studying the points of inflexion, rebroussement of curves, the calculus of osculating rays, the evolutes of curves and the employment of polar coordinates. Agnesi's Italian *Instituzione* did not deal with polar coordinates, as she was most likely unaware of them; these became established with Euler's *Introductio*, a book she had yet to see by September 1748. However, the French translation of the *Instituzioni* contained an appendix by Bossut which covered polar coordinates. The *Instituzioni*, as presented in its French translation, fitted precisely the Mlle. Agnesi course in differential and integral calculus given by the Mauristes. It has to follow that anyone attending these colleges after 1775, or even earlier, must have been exposed to the second volume of Agnesi's *Instituzioni* at first in manuscript form, and then in print. One assumes some future natural philosophers and mathematicians must have studied in these colleges, perhaps Garnier himself. Thus,

Agnesi was not only responsible for teaching through her *Instituzioni* at least a generation of natural philosophers and mathematicians in Italy, but also in France through the Course of Mlle. Agnesi at the Mauristes colleges.[52]

In 1762, the Marquis Wicardel de Fleury, a member of the recently founded Turin Academy of Sciences (1758), saw fit to send the Acts of the Academy to Agnesi, ten years after her retirement from scientific pursuits. The Acts contained articles from various members, including one by Lagrange, whereby he laid the foundations to his own " calculus of variations", a fundamental chapter in modern analysis. Such a thought from the members of the Turin Academy of Sciences seems to indicate that others, besides Lagrange, had studied her textbook at the University of Turin, and continued to think of its author, their teacher, with esteem. However, by then Agnesi was completely involved in her charitable work. Instead of teaching mathematics, she saw fit to teach catechism in a poor neighbourhood. In 1771, Agnesi accepted the post of visitor and director of a hospice for poor men and women, the Opera Pia Trivulzi. In 1781 she moved into the property as the director of the woman's section of the hospice. Lest one might think that, for all her humility and charitable work, Agnesi did not have high esteem of her own intellectual abilities, perhaps her letter to Archbishop Pozzobonelli might dispel any such ideas, and might serve to illustrate her character's complexity. Having been asked by the cardinal to examine a book, which because of its religious and political implications was placed in the Index, Agnesi answered: "...The author advances many points which can be damaging to the souls of many, particularly because it is written in the vernacular [and thus accessible], it might easily upset the piety of weaker and female minds ". In such a letter Agnesi not only showed her contempt for the average female mind, but also by

default placed her own mind above those of the rest of her gender, since she could read the book without being affected by it.[53]

There was another woman associated with the University of Bologna and its Institute of Sciences, whose expertise in anatomy, and her skill as modeller in wax of human anatomical parts made her also a teacher of men, in a similar vein to Laura Bassi, Cristina Roccati and Maria Gaetana Agnesi. Like Bassi and Roccati, Anna Morandi Manzolini (b. 1716 or 1717) imparted her expertise directly to those students interested in anatomy; and similarly to Agnesi, whose book instructed future natural philosophers, Morandi Manzolini instructed, through her anatomical models, future surgeons, physician, and occasionally midwives in the anatomical skills they required. However, for all her anatomical expertise and the reputation Morandi acquired at home and abroad, the anatomist lacked the extensive and varied education in languages and in the sciences of Bassi, Roccati, or Agnesi, and her social background was considerably lower than that of the three women philosophers.[54] These factors affected her salary, the academic membership she acquired within the Bologna Institute of Sciences, and the post Morandi held at the University of Bologna, which was closer to that of a technician than that of a lecturer.

II. *The Artist as an Expert Anatomist: Anna Morandi Manzolini*

Very little is known of Anna Morandi's early education, except that she was supposed to have studied drawing and sculpture. It was perhaps through these activities that Morandi met Giovanni Manzolini (1700-1755), also an artist who had an interest in arithmetic, geometry, and anatomy. It is generally assumed that Morandi learned

anatomy, dissection, and the skill of anatomical wax modelling exclusively from Manzolini, whom she married in 1740. Manzolini himself had learned anatomy and the art of anatomical wax modelling from another artist, Ercole Lelli, who in 1742 had been asked by Benedict XIV to provide anatomical preparations in wax for teaching purposes to the Institute of Sciences' anatomy rooms. However, a dispute between Lelli and Manzolini forced the latter to abandon his position as assistant after three years, to continue his anatomical and wax modelling activities at home with the assistance of his own wife, Anna Morandi.[55] Had Manzolini continued his activities at the Institute, Anna Morandi might have never acquired the skills in anatomy and wax modelling which made her famous in later years. By having moved his activities from the public to the private sphere, Manzolini offered his wife an opportunity to participate in scientific activities she would have been, otherwise, kept out of, if one considers her social background, and thus her very limited educational opportunities.

To be effective modellers of wax anatomical parts, the artists, Manzolini and Morandi needed to study anatomical texts, dissect bodies effectively, prepare the anatomical parts they desired to reproduce, and then model them in wax, giving these modelled parts forms, textures and colours as close to nature as possible.[56] A list of Morandi's and Manzolini's anatomical library survives, and it shows that they were in possession of important works in anatomy which reflected, to a great extent, their specific anatomical interests. The list also shows that, in spite of what might have been a limited educational background, particularly on Morandi's part, the couple understood Latin.

Raffaele Bernabeo's study of the contents of the Manzolini's library illustrate that the couple had amongst their books such classics as Vesalius' *De humani corporis fabrica,* to

which were added in the same copy Rufus of Ephesus' anatomical and Soranus' gynecological works (Venice, 1604); Gaspar Bauhin's *Theatro anatomico* (Basilea, 1620), which contained the first attempt to put order into anatomical nomenclature; Thomas Bartholin's *Anatomia* (1673), where the author described in an extensive way the lymphatic system; Marcello Malpighi's *De viscerum structura* (Bologna, 1660), in which microscopic research was introduced for the first time; Riolan's *Anthropographia et Osteologia* (Paris, 1626); James B. Winslow's *Anatomy of the Human Body* (Bologna, 1743); William Cowper's *Anatomia Corporum Humanorum* (Lugduni 1739); Georges Lafaye's *Principles of Surgery* (Venice 1751), which contained new knowledge in the fields of pathology, clinical surgery, besides discussing various surgical techniques; and Giovanni Battista Morgani's *Adversaria anatomica prima* (Bologna, 1706) and *Adversaria anatomica omnia* (Padua, 1719), which were precious guides to anatomical research.[57]

The library also contained anatomical works directly connected with their own particular anatomical research, and the parts of the human body they were asked and/ or chose to represent in wax. Thus the couple had Guido Guidi's *De Anatome Corporis Humani* (Venice 1611), which had the best representation for the times of the orthosympathetic system and of the formation of the basis of the brain, and François Mariceau's *On the Diseases of Pregnant Women* (Bologna, 1685), the first treatise to take into consideration the conformation of the pelvis, to study the movement of the foetus and its various positions in the womb, to teach how to handle anomalous fetal positions, as well as discussing the problem of uterine circulation. Most importantly, they also had works which discussed the sensory organs, subjects of great interest to the

couple, such as Giulio Casseri's *De vocis, auditisque organis* (Ferrara 1600),which was the first treatise to provide an exact anatomical description of the ear, and Anton Maria Valsalva's *Opera cum Morgagni* (Venice, 1741) which contained tables that reproduced in great detail the anatomy of the ear.[58]

Because Anna Morandi worked at home as assistant to her husband until his death in 1755, we cannot separate her work from his with any certainty. The couple collaborated closely with surgeons Pier Paolo Molinelli, head of surgery at the Institute of Sciences, and Giovanni Antonio Galli , who held the chair of obstetrics at the same institution. For Galli, who before being appointed to the chair of obstetrics, taught the subject at home to surgeons and midwives, the couple prepared numerous obstetric preparations in wax. These preparations illustrated, in their natural dimensions, foeti in their amniotic sac, two foeti with their circulatory system, the female genital apparatus, and models of the female pelvis. These preparations are usually attributed to husband and wife together; but Ottani and Giuliani-Piccari, and V. Busacchi believe these wax models to have been mostly the wife's productions. To Anna Morandi can be attributed, while her husband was still alive, the model in wax of the womb of a woman who had recently died in childbirth, requested by the surgeon Molinelli.[59]

Again, we cannot say with any certainty how much of a hand Morandi had in the anatomical wax preparations which Manzoloni was supposed to have sent to the King of Savoy, to the Royal Society of London, and Venice's Procurator; or whether she contributed to the anatomical research, based on extensive dissections, her husband carried out on the hearing apparatus, and on congenital deafness. These studies of the hearing apparatus were read respectively in the 1750 and 1751 sessions of the Academy

of Sciences; the first of which looked in detail at the external, middle and internal ear, at a time, as Armaroli points out, when most studies limited themselves to the auricle, the meatus and tympanic membrane. In it, Manzolini disputed several of the findings on the organ Valsalva had illustrated in his *De aure humana tractatus*. In his study on deafness, Manzolini dissected the hearing organ of a man who had been deaf since birth, and demonstrated that there were defects in both the middle ear, where the ossicles were fused as to appear to be a single ossicle, as there were in the internal ear, where the cochlea lacked the spirals.[60]

As with all women who assisted male family members in their scientific endeavours, Morandi's contributions to this endeavour could not be easily separated on several occasions from those of her husband's. Nevertheless, Morandi achieved a considerable reputation in her own right amongst natural philosophers and physicians even before her husband's death. Francesco Maria Zanotti, the secretary of the Academy of Sciences of Bologna, mentioned Morandi's skills in dissections, preparation of body parts, and as a modeller of these parts in wax in the 1755 *Commentarii* (actually printed on June 16, 1754).[61] But the greatest praises lavished on Morandi, while her husband was still alive, came from Laura Bentivoglio Davia's friend, the physician and expert anatomist, Giovanni Bianchi. In a letter from September 1, 1754, published in Florence's *Novelle letterarie* of the same year, Bianchi praised, as Zanotti had done, Morandi's skills in dissections, in the preparation of anatomical parts, and in the modelling of these parts in wax. However, he also claimed that she had made models of different age groups' skeletons, of the muscles of the arm and foot, the eye, ear, nose and organ of the voice and other parts. According to Bianchi, many of these anatomical models were sent to the

kings of Poland, Naples, Sardegna (Savoy) and others. As far as he was concerned, Morandi was the first woman to undertake practical anatomy.[62]

If Bianchi is to be believed--and there is no reason to doubt him, since apparently he knew the Manzolinis and even corresponded with them--Anna Morandi was already an experienced anatomist by 1754, and had modelled in wax many of the anatomical structures which became part of the Manzolinian collection acquired by the Institute of Sciences after her death.[63] Thus, well before Manzolini's death, and perhaps because of his ill-health, much of the anatomical production of the Manzolini household was already in the expert hands of Anna Morandi Manzolini, and acknowledged to be so by the physicians, surgeons, and natural philosophers who knew the couple.

We do not know to what purpose were put the anatomical wax models made by Morandi Manzolini and sent elsewhere in Italy and Europe, but the productions made for Galli served to teach surgeons and midwives, whereas those made for Molinelli taught surgeons at the institute. Thus, like Agnesi who taught through her textbook, Morandi also taught men, and also women through her anatomical productions. But Zanotti indicated that Anna Morandi was engaged in another type of teaching: already before her husband's death, she explained fluently her dissections and preparations of anatomical parts to assemblies of men gathered in her house.[64] Thus, like Bassi and Roccati, she instructed firsthand men, and perhaps women, in the skills she had acquired. One assumes that her audience was mostly male, and might have included artists interested in improving their knowledge of anatomy, or in learning the skills of wax modelling, potential surgeons and physicians in need of more accurate anatomical lessons than the

rest, but perhaps, also the curious, and amongst these there might have been some women.

After her husband's death on April 5, 1755, Morandi, perhaps finding it difficult as a woman to maintain contact with those physicians and surgeons on whose patronage her livehood depended, having been offered a living abroad, and desiring not to go, applied for assistance to Pope Benedict XIV. By then, her reputation was such, that a man like Lambertini, who had already assisted Bassi and Agnesi in their academic struggles, could but not come to her aid. In a letter from November 19, 1755 to Bologna's cardinal legate, Benedict XIV instructed that the Assunteria di Studio, the university's administrative body, find a way to properly remunerate Morandi so that she remained in Bologna. On February 27, 1756 the senate offered Morandi a salary of 300 lire, and instructed her to continue her dissections, the preparation of anatomical human parts in wax, and to demonstrate the result of her studies at public convience at her place and time. Thence she was to be considered a wage worker of the university.[65]

It is important to stress that, for all of Morandi's skills in anatomy, and the lessons she imparted on the subject at home, her pay did not reflect the salary of a lecturer, but that of a technician, or artist within the institution. Being a university graduate, Bassi could command an initial salary of 500 lire, a salary which reached 1200 lire before her death. By the same token, although Morandi referred to herself in her catalogue as honorary academic of the Institute of Sciences, she was not made a member of the Academy of Sciences, but of the Clementina Academy, or the Arts Academy, which was also part of the Institute of Sciences from its inception.[66] Thus, in spite of her fame and her skills, Morandi's status remained lower than Bassi's throughout her career. Her

demand for a rise of 200 lire in 1765 from the senate appears to have led nowhere. However, when Emperor Joseph II of Austria, who wanted to meet her, visited Bologna in 1769, her social condition improved somewhat, no doubts in order to accomodate such an illustrious visitor, and not to shame the town. Morandi, her son, and her collection set up residence in one of the apartments of Senator Count Ranuzzi's palace; he was also responsible for buying the collection, instruments and library, and then, after her death, for selling the whole collection to the Institute of Sciences.[67]

Anna Morandi had humbler origins than Bassi, Agnesi and Roccati, and received far less of a formal education than they had--after all her skills were essentially acquired through practice--but there was nothing humble in the belief she had of her own pratical anatomical knowledge. For instance, in two letters Morandi wrote to the physician Giovanni Bianchi on April 15, 1755 and May 24, 1755, soon after her husband's death on April 7, she did not allow herself to be intimidated by a man with much higher education than her own, who had praised her publicly, and who was known to love controversy, when her practical anatomical knowledge was put into question. Both the Manzolinis at Bologna and Bianchi in Rimini supposedly had examined the same bone brought to them by a Doctor Serra. The Manzolinis had found the bone to be scarred, and produced a model which adequately represented this scarring. Bianchi disputed their findings; the bone he had examined had shown no lesion; then he pointed out that as they were not surgeons, they were unable to pass judgement on the matter. To which Morandi answered that, she and her husband had dissected hundreds of bodies, and had seen many bones damaged either by syphilis or other causes, therefore they knew when a bone was

scarred or not. If the bone he had examined contained no lesion, it was because he had examined a different bone.[68]

Morandi's confidence in her dissecting skills were again illustrated when she disputed Jean Astruc's finding in his *Traité des maladies des femmes* of venous appendices in the womb. The anatomist and physiologist Germano Azzoguidi had never come across these appendices in the wombs he had examined, which according to Astruc's description should have been easily visible. Azzoguidi's consultation with Morandi, who, as the physician put it, would have had many occasion to gaze upon the appendices had they existed, cleared up any doubts he might have had, for she informed him that throughout the dissections of many wombs, she had never come across Astruc's venous appendices.[69]

Morandi's confidence in her anatomical skills arose from a careful study of the books in anatomy at her disposal, and through the careful dissection of many bodies: practice made perfect. She might have been an artist, as her husband and his teacher Lelli were, but, as Armaroli points out, her art was in the service of anatomical research, whereas in Lelli's case, anatomical research was carried out to serve art. That Morandi used art to serve anatomical research is not only obvious in the one hundred and fourteen tables containing the detailed, and properly labelled, preparations in wax of the eye (9 tables), ear (9 tables), nose (7 tables), tongue (10 tables), hand (8 tables), muscles of the face (1 table), the farynx and larynx (11 tables), the arm, leg, and foot (13 tables), male reproductive organs (22 tables) and the skeleton (23 tables), but also in the manuscript catalogue which accompanied these tables. As Armaroli stresses, the tables and the catalogue divided into ten chapters, all based on extensive dissecting experience,

represent in reality one of the most precise treatises in anatomy produced by any member of either the university or the Academy of Sciences at the time.[70] In the oration he presented to the Institute of Sciences at the time of acquisition of her works, Luigi Galvani pointed out the obvious fact that Morandi had studied and prepared in wax the finer and most difficult parts of the human body, such as those belonging to the senses, the organ of the voice, generation, as well as the osteology of the foetus. He singled out for special praise her study and preparations of the eye, the testicles, and the ear for their detailed information and accuracy.[71]

Morandi's anatomical wax preparations and the accompanying catalogue with the descriptions it contained remains her most important contribution to research in the field of anatomy. In them are registered her discoveries, her differences with other anatomists of the period, and occasional physiological remarks, all the result of extensive dissections and study of anatomical texts. For instance, in the section in which Morandi described and illustrated the anatomical preparations of the tongue, she objected to the findings of those authors who stated the tongue to be formed of external, median or Malpighian (reticular in shape), and internal tunics. After many attempts and careful examination, Morandi could only find two tunics in the human tongue: an external tunic, and an internal one. Separation of the two tunics showed how the papillae of the internal tunic insinuated themselves into the internal part of the external tunic.[72]

In the anatomical preparations of the hand, Morandi disputed Malpighi's finding which stated that between the cuticle (epidermis) and the cutis (dermis), there existed a very fine membrane called the reticular body (the germinative, or Malphighian layer of the epidermis). Morandi could not separate this third membrane, and thus, concluded

that what Malpighi had detected was the internal face of the cuticle, or its reverse.[73] In addition, to Morandi the fact that a group of fibres in the plastimemoid (plastima) muscle of the face varied slightly in its direction from the direction of the other fibres of the muscle did not constitute enough reason to perceive this slight variation of direction in the fibres as another muscle, as Santorini had expounded.[74] Of course, Morandi was pleased to announce her discovery, which continued to be attributed to her in the nineteenth-century. Thus, in the section discussing the anterior attachments of the muscles of the globe of the eye, she stressed a fact always found in all the dissections she carried out: that the inferior oblique muscle was not only attached to the nasal apophysis of the jawbone, as all authors believed it to be, but by cutting the bone, she found out that the muscle continued and attached itself to the lacrimal sac.[75]

On occasion, Morandi went beyond simple anatomical descriptions to enter the realm of physiology and explain the function of the part, or to explain why a part had a particular anatomy. Thus, her intent in illustrating all the vessels that contributed to generation in the male in unison, and opened was to show the fluids' path. She took special notice of the very minute blood vessels in the testicles which " are only visible by force of injection. These vessels communicate by means of the tunica albuginea with the substance of the testicles, which together with the spermatic vessels and their liquid mediate the fermentation of the semen "[76] Of course, the main purpose of the anatomical preparations in wax, and the catalogue which accompanied them, was to teach future surgeons detailed anatomical structures not easily visible to the naked eye. Thus, on several occasions, Morandi called the attention of the potential surgeon to particular structures, whose knowledge was essential for a successful surgical outcome.

Consequently, on the anatomical preparation of the foot, she emphasized the arteries, veins and muscles, which were essential guides to a surgeon engaged in operating, or in the amputation of the part.[77]

To Anna Morandi and her husband are also attributed the anatomical preparations in wax of the heart-lung group, with details of the respiratory system, a uterus, a foetus in the amniotic sac, twin foeti in their amniotic sac, and a male foetus connected with its placenta, whose abdominal cavity was opened illustrating the abdominal organs. These pieces belonged to the Solomei collection, into whose family one of Morandi's sons was adopted.[78] However, the pieces and catalogue which the Institute of Sciences acquired in 1777, for the purpose of teaching the male students in surgery and medicine at the institute, contained no reference to the female reproductive organs. Instead twenty-two tables were dedicated to the anatomical preparations of the male's reproductive organs, preparations which were so full of detailed information to be singled out for special praise by the head of obstetrics at the Institute of Sciences, Luigi Galvani, in 1777. With twentieth-century hindsight it is tempting to suggest that it was an expert woman anatomist's answer to male physicians' and surgeons' overwhelming concern with the female reproductive system throughout the centuries, so much so as to eventually create, as Moscucci suggests, a new medical specialization dedicated to the study of women and their diseases: gynecology.[79]

However, it appears that, on the whole, her intent was to encourage, via her wax productions, the study of anatomical parts which were not commonly studied in such details. These parts were difficult to preserve from deterioration for any length of time after dissection; therefore students in anatomy had difficulty perceiving them with any

degree of accuracy, as Galvani himself pointed out at the time of their acquisition by the institute. It explains also why Morandi allotted so much time, skill and effort to the internal structures of sense organs. Furthermore, her preparations of month-by-month development of fetal skeletons allowed surgeons who studied these preparations to determine with some degree of accuracy the age of a foetus at the time of miscarriage.[80] With the acquisition of her anatomical preparation in wax and her catalogue, the Institute of Sciences ensured that Morandi would continue to teach through them the students in surgery and medicine at the institution years after her death, not unlike Agnesi's *Instituzioni analitiche* would continue to teach students mathematics years after its author had retired from scientific pursuits.

Although coming from a long tradition of learned women, Laura Bassi, Cristina Roccati, Maria Gaetana Agnesi, and Anna Morandi Manzolini broke new ground and went further than any women learned in the sciences had gone before. Teodora Danti had taught her own male family members mathematics and astronomy, Bassi, Roccati and Morandi Manzolini, through their official positions, and the latter also through her anatomical preparations, and Agnesi, through her textbook, came to teach the sciences to men who usually were not related to them . The teaching of Roccati and Bassi (1776-1778) was public, whereas that of Morandi remained private throughout.

Bassi was the one woman in the group whose career approached that of a modern woman scientist, for not only she had a degree, but through hard work, determination, and powerful patrons she was able to insert herself into the town's academic life, and thus be productive in the research and teaching of experimental physics. Morandi was

also productive in the research and teaching of her own field of science, anatomy; however, lacking Bassi's formal education and university degree, she never achieved Bassi's lecturer status, or the title of *dottoressa*. Both her salary and academic membership reflected the somewhat lower status of an artist, or technician.

With a degree to her name, like Bassi, Roccati was to find her teaching niche in her home town's Institute of Sciences of the Academy of Concordi. where, again like Bassi, she taught physics. Had family conditions allowed, Roccati might have become involved in research at Padua, as a member of the Academy of Ricovrati. Her move to Rovigo, and her own financial conditions practically destroyed any possibility she had of doing research in a field like physics which required, as Bassi's cabinet illustrate, expensive equipment. However, such a move provided her with an opportunity to teach publicly, an opportunity which she might not have found elsewhere. Most importantly, at her father's instigation, Roccati tested the system of education for women at universities. She moved to an university town, might have attended a few public lectures, was able to study what men studied, and receive a degree. Had more women and their families tested the system as Roccati and her father had done, Italian universities might have opened to women a century earlier.

Agnesi failed to test the system altogether. Given an opportunity to teach, at her own request, by Pope Benedict XIV, she failed to undertake the challange. The fact that Agnesi's father had used her shamelessly to his own advantage in home academies which she did not approve, and brought her little personal advantage, probably served to drive her away from the sciences the moment her father died. But before her retirement from the sciences, Agnesi put her scientific education and her love of mathematics to good use

and published a mathematics textbook, which was not only the first major work on the subject to be published by a woman, but it was, most likely, the first textbook of its nature in Italy. And, in spite of what Truesdell states, it appears that her book taught future mathematicians and natural philosophers not only in Italy, but also in France.

It is important to point out firstly, that if Bassi had not received a degree and been appointed a lecturer, through Lambertini's efforts, we might have still heard of Morandi, but probably never of Roccati, or Agnesi. The education and achievements of the latter two women were a direct consequence of the successes and fame achieved by Bassi. Secondly, the official university positions offered to Bassi, Agnesi and Morandi were the direct consequence of Lambertini's belief that women had taught at the University of Bologna in the past, and therefore could do so again. Thirdly, except for a few occasions--usually once a year in Bassi's case--the Pauline edict which kept women from public speaking in churches, continued to be applied to universities. The regular public teaching achieved by Bassi and Roccati was carried out in relatively new institutions, which did not really have a tradition of keeping women away from such a public undertaking.

[1]For Italian studies on Agnesi prior to 1960 see m. Gliozzi and G.f. Orlandelli, " Agnesi Maria Gaetana ", *D.B.I.*, Vol. 1, pp. 441-43; for historians of mathematics' assessments of her work see Boyer, *History of Analytic Geometry*, pp. 177-82; D.J. Struik, *A Source Book in Mathematics 1200-1800*, pp. 178-80; U. Bottazzini, P. Freguglia, L.T. Rigatelli, *Fonti per la storia della matematica, aritmetica, geometria, algebra, analisi infinitesimali, calcolo delle probabilità, logica*, (Florence: Sansoni, 1992), pp. 191-92; for works on Agnesi and other female mathematicians see G. Loria, " Les femmes mathématiciennes ", *Revue scientifique*, 20, no. 13, (1903), pp. 385-95; Julia Coolidge, " Six Female Mathematicians ", *Scripta Mathematica*, 17, (1951), pp. 21-31; Rora Iacobacci, " Women of Mathematics ", *The Arithmetics Teacher*, 17, (1970), pp. 316-24; Ulrike Klens, *Mathematikerinnen im 18. Jaahrhundert: Maria Gaetana Agnesi, Gabrielle-Emilie du Châtelet, Sophie Germain*, (Pfaffenweiler: Centarus

Verlagsgesellschaft, 1994); for biographies see Tilche, Anzoletti, Carla Vettori-Sandor, " L' opera scientifica e umanitaria di Maria Gaetana Agnesi " in *Alma Mater Studiorum*, pp. 105-118; C. Truesdell, " Maria Gaetana Agnesi ", *Archives for the History of Exact Sciences*, 40, no. 2., (1989), pp. 120-37.

[2]See letter of Mary Wortley Montagu to Lady Bute of October 10, 1753 in Wortley Montagu, *The Complete Letters of Lady M.W. Montagu*, p. 39.

[3]For Roccati see Grotto, pp. 6-11; Piscopia see Bacchini, pp. 151-52, 155-56; Fusco, pp. 25-29, 35-36; Maschietto, p. 23, 37, 90-93, 112-119; for Ardinghelli B.M.S.: Mss. no. 150: Nollet, *Journal du Voyage*...pp. 170v-171r; Vitrioli, p. 7; For Fedele see Fedele, pp. 18-26, 34-42; for Cereta see her letter no. 59 to Nazaria Olimpia in Ceretae, *Epistolae*, pp. 145-154.

[4]Maria Gaetana's mother, Anna Brivio's income had also come from trade. In 1740 Pietro Agnesi bought a feudal title and lands see Anzoletti, pp. 48-51, 79, 84-85; for social mobility in Milan see Carpanetto and Ricuperati, pp. 57-61; for Borromeo see Baldini, " L' attività scientifica nelle accademie lombarde del settecento ", pp. 511-12, 514.

[5]Sassi, col. LXVII.

[6]Since the Ambrosiana Library of Milan, where most of Agnesi's papers are found, has been closed since I have begun my research, I am relying on letters printed elsewhere, or on manuscripts found in other archives. The letter to Frisi dated May 27, 1750 is found in Anzoletti, p. 322, 86-87; A. Masotti, " Maria Gaetana Agnesi ", *Rendiconti del Seminario Matematico e Fisico di Milano*, Vol. XIV, (1940-XVIII), pp. 93-95.

[7]Anzoletti, p. 120, 140-43; Masotti, pp. 94-95; Mazzuchelli, " Agnesi Maria Gaetana ", *Gli scrittori d' Italia*, Vol. I, Parte I, pp. 198-201; Klens, pp. 73-74; Frisi, pp. 8, 18-23, 27; rumours that Bassi might receive a degree began to appear in 1731, after Lambertini was appointed Archbishop of Bologna see Berti Logan, p. 787.

[8]For a summary of Bassi's philosophical theses and those on water see Berti Logan, pp. 790, 793; for Agnesi's see Masotti, p. 96; for more detail on the theses see Klens, pp. 143-176.

[9]For a list of those manuscript lessons see Vettori-Sandor, p. 112; Anzoletti pp. 140-42, 159-63; Masotti, p. 94; for Casati see P. Stella, " Casati Michele ", *D.B.I.*, Vol. 21, pp. 262-65.

[10]Frisi, pp. 25-27.

[11]Letter to M. le Président Bouhier, Milan, July 17 (1739) in De Brosses, Vol. I, pp. 101-03.

[12]See Parziali 5, 6, 7 and 8 in A.C.R.: *Roccati...Lezioni...*; see theses CLXXXII-CXCI in Maria Gaetana Agnesi, *Propositiones philosophicae. Maria Cajetana De Agnesis*, (Milan: Richini, 1738).

[13]See Parziali 11, 13, 14, 15, 16 and 27 in A.C.R.: *Roccati...Lezioni...*; theses XLVI, LXXV-XCI, CLI-CLIII in Agnesi, *Propositiones.*

[14]Parziali 2, 5, 6, 9, 10, 12, 15, 17, 18, 19, 21, 22, 31, 32, 43, 47, 49, 50 in A.C.R.: *Roccati...Lezioni...*; theses CVI-CXVIII, CXXII-CXXX, CXXXV, CXXXVIII-CXLV, CLIV-CLVII, CLXXX-CLXXXVI in Agnesi, *Propositiones.*

[15]Theses CLVIII-CLXII in Agnesi, *Propositiones*; Guerlac, " Stephen Hales ", pp. 38-41; Hales, *Vegetable Staticks*, pp. 200-01.

[16]Theses CLXIII-CLXIX, particularly CLXV, CLXVI; for Redi's experiments to disprove spontaneous generation and his work on vipers see Findlen, " Controlling the Experiment...", pp. 36-64; for Vallisneri's see Vallisneri, " Dialoghi sopra le curiose origine di molti insetti ", I, (1696), pp. 297-322, III (1700), 297-318, 353-72; Vallisneri, *Istoria della generazione dell' uomo*, pp. 66-67, 81-82; for similar experiments on snake venon carried out by the Clelia Academy see Sassi, Coll. LXVIII.

[17]Theses CLXX-CLXXXVI, particularly CLXXIV in Agnesi, *Propositiones*; for the Cartesian mechanism of circulation as compared to Harvey's see Roger French, " Harvey in Holland: Circulation and the Calvinists " in *The Medical Revolution of the Seventeenth Century*, Roger French and Andrew Wear eds., (Cambridge: Cambridge University Press, 1989), pp. 46-86.

[18]Theses LXVIII, Principles of Geostatic 1, and 2, Laws of Heavy Bodies 6 to 9 in Agnesi, *Propositiones*, pp. 41, 44; Parziali 24, 25, 30 in A.C.R.: *Roccati...Lezioni....*

[19]Parziali 35, 36 in A.C.R.: *Roccati...Lezioni...*; Theses LIX and Laws of Proposition and Composition of Motion 1-11, LXX and Principles of Hydrostatic and Laws of Motion of Fluid Bodies 1-3 in Agnesi, *Propositiones*, pp. 31-35, 47-54; for the Galilean-Torricellian school of fluid mechanics and its influence on Newton and Varignon see Dugas, pp. 14-48, 226-227; see Proposition 36, Problem 8, Proposition 41, Theorem 32, Book II, Newton, *Principia*; for its influence in later Italians see Maffioli, pp. 63-105; Savaris, pp. 24, 28.

[20]Parziale 27 in A.C.R.: *Roccati...Lezioni...*; Savaris, pp. 24, 28.

[21]De Brosses, T. I, p. 102, 103n; theses XCVIII-CIV in Agnesi, *Propositiones.*

[22]Theses LXXI, LXXXI, Laws of Communication of Motion in Elastic Collisions, no. 12 in Agnesi, *Propositiones*, p. 62; for the debate on live forces, including descriptions of Poleni's experiments, which convinced many to change sides see Iltis, " Madame du

Châtelet ", pp. 41-48; Iltis, " The Leibnizian-Newtonian Debates ", pp. 355-377; Bergia, Fantazzini, pp. 46-60.

[23]Theses LXVI, The Laws of Heavy Bodies Explained 1-3, CXVI-CXVII in Agnesi, *Propositiones*, p. 40; Zev Bechler, " Newton's Ontology of the Force of Motion " in *The Investigation of Difficult Things: Essays on Newton and the History of Exact Sciences in Honor of D.T. Whiteside*, P.M. Harman, Alan E. Shapiro eds, (Cambridge: Cambridge University Press, 1992), pp. 297-98.

[24]Thesis CXXXVIII in Agnesi, *Propositiones*; Chandrasekhar, pp. 399-411.

[25]Thesis CXXXV in Agnesi, *Propositiones*; see her letter to Bianchi of November 9, 1741 in B.G.R.: Fondo: *Gambetti*, Posizione: Agnesi Mariani Maria; Seymor Chapin, " The Shape of the Earth " in *Planetary Astronomy*, Vol. 2, Part B, pp. 22-34.

[26]Agnesi's letter at the Museo Correr of Venice apparently addressed to Jacopo Maria Paitoni, whom I cannot trace, appears identical to the Agnesi's copy found in the Ambrosiana of Milan, addressed to Giovanni Crivelli as published by Klens, see Agnesi's letter of June 13, 1741 in M.C.V.: *Epistolario Moschini*: Lettera di Agnesi Mariani Maria a P. Jacopo Maria Paitoni; Klens, pp. 53-54; thesis CXXXI in Agnesi, *Propositiones*; Taglianini e Urbinati, " Metereologica ", pp. 254-259; Anzoletti, pp. 158-72. The publication apparently came to naught, see her letter to Bianchi of January 1742 in B.G.R.: Fondo: *Gambetti*, Posizione: Agnesi Mariani Maria.

[27]Frisi, p. 71; also in Anzoletti, p. 336.

[28]Agnesi's letter to Bianchi of January 1742 in B.G.R.: Fondo: *Gambetti*, Posizione: Agnesi Mariani Maria; see letter to Paitoni of June 13, 1741 in M.C.V.: *Epistolario Moschini*: Lettera di Agnesi Mariani Maria A P. Jacopo Maria Paitoni.

[29]" Alla Ceserea Reale Maestà dell" Augustisima Imperatrice Maria Teresa d' Austria " in Maria Gaetana Agnesi, *Instituzioni analitiche ad uso della gioventù italiana di Dna. Maria Gaetana Agnesi milanese dell' Accademia delle Scienze di Bologna*, (Milan: Regia Ducal Corte, 1748), T. I; Boyer, *History of Analytic Geometry*, p. 177; for Pignatelli's work see " Anonymae Napoletanae problemata mathematica ", pp. 28-34; Esther Ehrman, *Mme Du Châtelet Scientist, Philosopher and Feminist of the Enlightment*, (Lemington Spa: Berg, 1986), pp. 47-55.

[30]Agnesi, " Al lettore " in *Instituzioni*; for the slow spread of infinitesimal calculus in Italy see Palladino, pp. 377-405; Pepe, " Il calcolo infinitesimale in Italia...", p. 88.

[31]Agnesi, " Al lettore", *Instituzioni*; for Rampinelli see Paolo Guerrini, " Il maestro di Maria Gaetana Agnesi ", *Commentari dell' Ateneo di Brescia per l' anno 1918*, pp. 68-76; Antonio Brognoli, " Elogio del P.D. Ramiro Rampinelli 1759" in *Elogi di Bresciani...*, pp. 63-88.

[32]For Agnesi's very important correspondence with the Riccatis see Soppelsa, " Jacopo Riccati-Maria Gaetana Agnesi. Carteggio (1745-1751)" , pp. 123-59; from Agnesi's surviving letters to Giordano Riccati, it appears he had a hand proof-reading mostly the section on finite analysis, see B.C.V.J.U.: Ms. 1025: *Commercio di lettere del Co. Giordano Riccati*, Vol. I: *da 16 maggio 1728 sino ai 18 febbraio 1754*, pp. 227-28, 235-38, 271-72, 273, 275-78, Vol. II:, pp. 11, 225; Vettori-Sandor, p. 109; for a summary of Riccati's original article on osculating rays see Tega ed., *Anatomie Accademiche*, Vol. 1: *I Commentari*, p. 182; for Vincenzo Riccati's and Agnesi's membership to the Bologna Academy of Sciences, which Rosen says in Agnesi's case occurred in 1747, see Rosen, pp. 177, 189; for more information on the Riccatis and their world see Piaia and Soppelsa, *Riccati e la cultura della marca nel settecento Europeo*, particularly Soppelsa's article in it, pp. 27-73; for Rampinelli's association with J. Riccati see Guerrini, p. 73.

[33]Truesdell, pp. 132-35; see Agnesi's letter to J. Riccati no. 1: July 20, 1745 in Soppelsa, " Jacopo Riccati-Maria Gaetana Agnesi...", p. 123; Agnesi, *Propositiones*; Agnesi, " Al lettore ", *Instituzioni.*

[34]See " Extrait des registres de l' Academie Royale des Sciences du 6 décembre 1749 ", a copy of which was sent by Agnesi to the secretary of the Bologna Academy of Sciences attached to her letter of January 14, 1750 in A.A.S.B.: *Lettere ricevute*; see also the table of contents of Agnesi, *Instituzioni.*

[35]" Instituzioni analitiche", *Giornale de' letterati pubblicato in Firenze*, (1750), T. VI, parte 1, articolo I, pp. 8-10; " Instituzioni analitiche ", *Novelle della repubblica letteraria per l' anno 1750*, no. 23, (6 giuno 1750), pp. 1800-81; *Storia letteraria d' Italia divisa in tre libri*, Vol. I, (Venezia 1753), pp. 116-17; " Instituzioni analitiche ", *Nova acta eruditorum*, Anno MDCCL, Lipsiae, fac. XIII, octobris, pp. 605-09.

[36]For Ardinghelli's attachment to synthetic geometry see Vitrioli, p. 13; Boyer, *History of Mathematics*, pp. 420-22, 443-53; for De Montigny's letter of December 8, 1749 see A.A.S.B.: *Lettere ricevute*, attached to Agnesi's letter to F.M. Zanotti of January 14, 1750; for a copy of it see Vettori-Sandor, p. 108; for the Royal Society's reception of her book see Anzoletti, pp. 289-90, 294-96.

[37]Anzoletti, pp. 283-89; for the copies Agnesi sent to the Bologna Academy see her letters to Zanotti of June 12, 1749 and July 9, 1749; for the copy sent to Bassi see Frisi, p. 55; for Bassi's publications see Berti Logan, pp. 805-06; Tega ed., *Anatomie Accademiche*, Vol. I: *I Commentari*, pp. 271-73.

[38]This letter, translated by me, which illustrates well Prospero Lambertini's attitude towards women's abilities is found in letter no. 32: June 24, 1750 of Pope Benedict XIV to Senate in B.U.B.: Ms. 279: *Miscellania*; for the Senate's and Agnesi's answer A.S.B.: Fondo: *Senato*, Serie: Vacchetoni, Registro 68, July 7, 1750, ff. 85-86, 112; for Benedict XIV's very positive reaction to the book see his letter to Agnesi of June 22, 1749 attached to Agnesi's letter in A.A.S.B.: *Lettere ricevute*; for all the biographers who recorded Benedict XIV's letters of June 22, 1749 and September 26, 1750, but not his

letter to the Senate see Anzoletti, pp. 270-73; Frisi, pp. 50-51; Vettori-Sandor, p. 108; Masotti, pp. 108-09; Truesdell, pp. 125-27.

[39]Anzoletti, pp. 277-79; Frisi, pp. 67-71; Tilche, pp. 106-08.

[40]Boyer, *The History of Analytic Geometry*, pp. 177-86; Carl B. Boyer, " The First Calculus Textbooks ", *The Mathematics Teacher*, no. 39, p. 167; Boyer, *The History of Mathematics*, pp. 410-11; Agnesi was aware of Euler's *Introductio* by September 4, 1748, but had not seen it yet; anyway, even if she had seen it, it would have been too late to make changes, see her lettter to Jacopo Riccati no. 16 in Soppelsa, " Jacopo Riccati-Maria Gaetana Agnesi ", p. 139.

[41]Maria Teresa Borgato e Luigi Pepe, " Lagrange a Torino (1750-1759) e le sue lezioni inedite nella R. Scuola di Artiglieria ", *Bollettino di storia delle scienze matematiche*, Vol. VII, (1987), fasc. 2, pp. 36-37.

[42]Truesdell, pp. 120-37; Gliozzi, Orlandelli, p. 442.

[43]Palladino, pp. 387-90; Ferrone, pp. 524-44; Pepe, " Il calcolo infinitesimale in Italia ", pp. 88-89; for Bianchi's letter to Leprotti, Bologna, December 11, 1717 in B.G.R.: Sc.Ms. 962; for Riccati see Soppelsa, " Jacopo Riccati-Maria Gaetana Agnesi ", p. 123; for Grandi's school see Giacardi, pp. 195-238.

[44]Boyer, *The History of Analytic Geometry*, pp. 175-77; Boyer, " The First Calculus Textbooks ", pp. 159-67; Pepe, " Il calcolo infinitesimale in Italia ", pp. 43-85, 95-100; Guido Grandi's manuscript on differential and integral calculus circulated to various students, one suspects, see Giacardi, pp. 221-35; Truesdell, p. 137n.

[45]Truesdell, pp. 120-37; Giuseppe Luigi Lagrange, " Principi di analisi sublime " in Borgato e Pepe, " Lagrange a Torino ", pp. 81r, 99r, 107v; see also J.L. Lagrange, *Oeuvres*, (Paris, 1867-1892).

[46]Giambattista Suardi, *Nuovi istromenti per la descrizione di diverse curve antiche e moderne*, (Brescia: G.M. Rizzo, 1752), p. 5; for the modern representation of the curve as found in Agnesi's book see Merrill E. Stranks et al., *Pre-Calculus Mathematics*, (Reading: Addison Wesley, 1965), p. 410; Gregorii Casalii, " De conicarum sectionem facis ", *Commentarii*, T. IV, (1757), pp. 298-310; F.M. Zanotti, " De separandis indeterminatis ", *Commentarii*, T. III, (1755), pp. 261-79, particularly pp. 270, 272, 278-79.

[47]For Rocccati see letter no. 91: VI Id. Aug. 1752 of Colombo to Roccati in A.C.R.: Ms. *Silvestriana* 203; for Bonati see Luigi Pepe, " Una biografia di Teodoro Bonati " in Teodoro Bonati, *Carteggio scientifico Lorgna, Canterzani, Frisi, Saladini, Calendrelli, Venturi*, M.T. Borgato, A. Fiocca, L. Pepe eds., (Florence: Olschki, 1992), pp. 3, 15-16.

[48]It is my translation of Canterzani's answer in B.U.B.: Ms. 2096: *Lettere a Sebastiano Canterzani*, Busta I: " Minute di risposta ad una lettera di Maria Gaetana Agnesi (18 novembre 1793) "; for his position at the institute see Berti Logan, p. 799; at the university see Laura Miani, " Lettere inedite di Gianfrancesco Malfatti conservate presso la Biblioteca Universitaria di Bologna " in *Gianfrancesco Malfatti nella cultura del suo tempo. Atti del Convegno di Ferrara 23-24 ottobre 1981*, p. 266.

[49]See Malfatti's letter no. 35: Ferrara, December 8, 1783 to Canterzani and his answer of December 9, 1783 in B.U.B.: Ms. 2096: *Lettere a Sebastiano Canterzani*, Busta V: " Lettere di Francesco Malfatti (1775-1805)"; see Mozzi's letters to Canterzani of May 6, 1758, May 23, 1758, June 13, 1758, August 15, 1758 in B.U.B.: Ms. 4186: *Canterzani*, Caps LXI; for how Canterzani used the book to teach see B.U.B.: Ms. 4143: *Canterzani*, Cap. IX, 3: " Luoghi dell' Agnesi spiegati ad istanza d' alcuno che vi trovera difficoltà ", ff. 72-76, particularly f. 73v.

[50]Borgato e Pepe, " Lagrange a Torino", pp. 6-10; L.B.M.D.G., " Directions par l' étude approfondé des mathématiques recueillies des entretiens de Lagrange ", *Le moniteur universel*, Paris, (26 février 1814), p. 226.

[51]For the algebraic equations and new conchoid shape see Agnesi, *Instituzioni*, Vol. I, pp. 382-389; Lagrange, " Principi di analisi sublime ", pp. 139-141; for the traditional representation of the conchoid seee Leonhard Euler, *Introductio in analysin infinitorum*, (Lausanne: Bousquet, 1748), pp. 225-26, Fig. 86 Tab. XXI; Marquis De l' Hospital, *Analyse des infiniment petits, pour l' intelligence des lignes courbes*, (Paris: F. Montalant, 1716), pp. 80, 65, 24, 21; Johannis Bernoulli, " Lectiones mathematicae de methodo integralium ..." in *Opera omnia*, T. III (Lausanne and Geneva: Bousquet, 1742), p. 394, Tab. LII, Fig. 5, p. 400, Tab. LIII, Fig. 13; Boyer, *History of Analitical Geometry*, pp. 179-80, 179n; for modern representations of Grandi's *versiera* and Nichomedes conchoid see Stranks et al, pp. 410, 404, 352, 582. Abbé Reynau's *Analyse demontré*, one of the textbooks used by Agnesi as a student contained no conchoid, see Abbé Reynau, *Analyse demontré ou la methode de resoudre les problêmes des mathematiques et d' apprendre facilement ces sciences*, (Venice: Pitteri, 1739).

[52]For references to the French translation see Frisi, p. 57; Anzoletti, pp. 294, 299, 301-02; Truesdell, p. 129; Vettori-Sandor, p. 109; Klens, p. 128; Robert Lemoine, " L' enseignement scientifique dans les collèges Bénédictins " in *L' enseignement classique au XVIIIe siècle: collèges et universités*, Pierre Costabel ed., (Paris: Hermann, 1986), p. 117.

[53]Frisi, pp. 72-97; the letter taken from Anzoletti, p. 360-63, my translation; Mario Checchi, " Maria Gaetana Agnesi, Guido Grandi e la versiera ", *Atti e memorie della Accademia Petrarca di lettere, arti e scienze*, nuova serie, Vol. XLV, (1982), pp. 305-20.

[54]The state of the souls of the Parish of S. Nicolò degli Albari shows Anna Morandi to have lived until her marriage in 1740 with a widowed mother, and a younger brother, and

no servants of any kind, which seems to indicate a lower social level, and little money. For all their financial difficulties, the Manfredi's had at least one female servant, see A.A.B.: *Status animarum della Parrocchia S. Nicolò degli Albari* from 1735 to 1741, casa de' Mazzeai; Fantuzzi gives Morandi's date of birth as 1716, Canon Crespi referred to her being born in 1717. The status animarum of 1735 said she was 21 years old at the time, which made her born in 1717; the death records in 1774, gave her age at her death as 57, which made her born in 1716 or 1717, see Fantuzzi, " Morandi Manzolini Anna ", *Notizie...*, Vol. III, pp. 113-116; Medici, p. 15; Ottani e Guilliani-Piccari, p. 82; Armaroli, p. 53; B.C.A.B.: B. 917: *Necrologia di Bologna*, July 11, 1774, p. 97.

[55]Medici, pp. 4-5, 15; Ottani, Giuliani-Piccari, pp. 82-83; Armaroli, pp. 42-48.

[56]Armaroli, pp. 48-49.

[57]A.S.B.: Fondo: *Assunteria d' Istituto*: Diversorum, Busta 10, anni 1771-1777: " Camere e materiale scientifico ", Fasc. 3: Inventario dei Libri e ferri anatomici venduti dalla Manzolini; found also in B.U.B.: B. 2193: *Catalogo delle preparazioni anatomiche in cera formanti il Gabinetto Anatomico primo della Reggia Università, Anna Morandi Manzolini*; Raffaele A. Bernabeo, " La libreria scientifica di Anna Morandi Manzolini " in *Le cere anatomiche bolognesi*, pp. 36-39.

[58]Bernabeo, pp. 36-39; B.U.B.: B. 2193: *Catalogo....*

[59]Armaroli, pp. 54-55; Ottani, Giuliani-Piccari, p. 83; Vincenzo Busacchi, " Le cere anatomiche dell' Istituto delle Scienze " in *I materiali dell' Istituto delle Scienze*, (Bologna: CLUEB, 1979), pp. 230-32.

[60]Medici, pp. 5-6, 10-15; Armaroli, p. 55; B.P.B.: *Autografi di Medici-Raccolta di Vittorio Putti*, Cat. 135: Manzolini Giovanni: Dissertazione del Sig. Manzolini letta nell' Accademia dell' Istituto li 16 aprile 1750 dal sig. Beccari allora Presidente, and the following dissertation dated: Bologna, 3 maggio 1751; for the structure of the ear see T.I. Storer and R.L. Usinger, *Elements of Zoology*, (New York: McGraw-Hill, 1961), pp. 126-27.

[61]' De re obstetrica', " Medicina ", *Commentarii*, T. III, (1755), pp. 88-89.

[62]" Lettera del Sig. Dottor Giovanni Bianchi da Rimino scritta da Bologna ad un suo amico di Firenze ", *Novelle letterarie pubblicate in Firenze*, T. XV, (1754), pp. 7-8-12.

[63]*Ibid.*, pp. 708-12; for Morandi 's correspondence with Bianchi see her letters of April 15, 1755 and May 24, 1755 in B.G.R.: Fondo: *Gambetti*, Posizione: Morandi Manzolini Anna e Manzolini Giovanni; for the catalogue of the collection sold to the Institute see B.U.B.: Ms. B. 2193: *Catalogo delle preparazioni anatomiche...*; the inventory of the collection was carried out September 11, 1776; the collection came into the possession of the Institute in 1777, see A.S.B.: *Assunteria d' Istituto*, " Diversorum ", Busta 10, anni

1771-1777; Camere e materiali scientifici, fasc. 5: 1775, 1776, 1777, Notizie attenenti allo Studio Manzolini. Acquisto di esso fatto dai ssri dell' Istituto, fasc. 3;

[64]' De re obstetrica', *Commentarii*, T. III, (1755), p. 89.

[65]For Morandi's requests see A.S.B.: *Assunteria d' Istituto*, " Diversorum ", Busta 10, anni 1771-1777, fasc. 5; A.S.B.: Fondo: *Senato*, Serie: Vacchetoni, no. 69, 1753-1755, a di 29 dicembre 1755, f. 253v; A.S.B.: Fondo: *Senato*, Serie : Partiti, Vol. 39, 27 febbraio 1756, ff. 2v-3r.

[66]For her salary see A.S.B.: Fondo: *Senato*, Serie: Partiti, no. 39, 27 febbraio 1756, ff. 2v-3r; for Bassi's salary see Berti Logan, p. 787 and note; for the association of the two academies to the institute see Tega, " Introduzione ", *Anatomie Accademiche*, Vol. 1: *I Commentari*, p. 19; Morandi was made a member of the Clementina Academy on December 3, 1755, see " Le Accademiche Clementine " in *Alma Mater Studiorum*, p. 146; she is not in the list of the Academy of Sciences members, see Rosen, pp. 177-93; for the catalogue see B.U.B.: Ms. B. 2193.

[67]For her attempts to get a rise see her letters to Senator Marcello Oretti nos. 83, 84 and 86 of September 3, 1765 in B.C.A.B.: B. 120: *Lettere di diversi a Marcello Oretti*, T. II. Morandi's name does not appear at the residence of Senator Ranuzzi until 1769, where she lived until her death in 1774, see Parrocchia di San Procolo: *Status animarum*, anni 1765-1774, Palazzo Ranuzzi; Joseph II's visit to Bologna occurred on May 14, 1769 see Medici, pp. 16-17; Luigi Galvani, " De Manzoliniana Supellegtili Oratio in Scientiarum et Artium Instituto cum ad Anatomen in Tabulis ab Anna Manzolina perfactis pubblice tradendam aggrederetur anno MDCCLXXVII " in *Opere edite e inedite di Luigi Galvani raccolte e pubblicate per cura dell' Accademie delle Scienze dell' Istituto di Bologna*, (Bologna : Dall' Olmo, 1841), "Traduzione di Luciana Quadrelli" in *Alma Mate Studiorum*, pp. 94-103.

[68]For her husband's death see Fantuzzi, Vol. II, p. 115; see her letters to Bianchi of April 15, 1755 and May 24, 1755 in B.G.R.: Fondo: *Gambetti*, Posizione: Manzolini Morandi Anna e Manzolini Giovanni.

[69]Germano Azzoguidi, " Medicinae in Academia Bononiensi professori. Observationes ad uteri constructionem " in *Opuscula Anatomica Selectione*, (Lugduni Batavarum: J. Luchtmans , 1788), p. 34; Astruc was professor of medicine at Montpellier in the 1710s and 1720s, see French, " Sickness and the Soul ", pp. 103-04.

[70]B.U.B.: Ms. B. 2193; Armaroli, pp. 56-57.

[71]See Translation by Quadrelli of Galvani, " De Manzoliniana Supellegtili ", p. 99.

[72]" Preparazione anatomica della lingua costrutta da A.M.M. ", Table 7, Figure 2 in B.U.B.: Ms. B. 2193, p. 45r.

[73]" Preparazione anatomica della mano costrutta da Anna Morandi Manzolini ", Table 8 in *Ibid.*, p. 57r; Storer and Usinger, pp. 18-19.

[74]" Preparazione anatomica dei muscoli della faccia e di alcuni ancora aspettanti al collo...", Figura 18 in B.U.B.: Ms. B. 2193, p. 63v.

[75]" Preparazione anatomica dell' occhio costrutto da Anna Morandi Mazolini ", Table 5, Figure 3 in *Ibid.*, pp. 7r-v; Medici, p. 20.

[76]" Preparazione anatomica delle parti dell'uomo alla generazione destinate ", Table 20 in B.U.B.: Ms. B. 2193, pp. 116v-118r.

[77]Preparazione del bracio, gamba e piede costrutta da Giovanni Manzolini e Anna Morandi Manzolini " in *Ibid.*, pp. 92v-93v.

[78]" Le cere di Anna Morandi (Bologna 1716-1774) e di Giovanni Manzolini (Bologna 1700-1755) " in *Le cere anatomiche bolognesi*, pp. 87-90, 95-96; Medici, p. 21.

[79]" Preparazioni anatomiche delle parti dell' uomo alla generazione destinate " in B.U.B.: Ms. B. 2193, pp. 96-119r; see Quadrelli's translation of Galvani, " De Manzoliniana Supellegtili ", p. 100; Ornella Moscucci, " Hermaphroditism and Sexual Differences: The Construction of Gender in Victorian England " in *Science and Sensibility*... Benjamin ed., pp. 174-99; for the preoccupation with female reproductive organs by physicians and surgeons of eighteenth and nineteenth century Bologna see Olimpia Sanlorenzo, *L' insegnamento di ostetricia nell' Università di Bologna*, (Bologna: Alma Mater Studiorum Saecularia Nona, 1988).

[80]See Quadrelli's translation of Galvani, " De Manzoliniana supellegtili ", pp. 94-103; " Preparazione anatomica dello scheletro costrutto da Anna Morandi Manzolini " in B.U.B.: Ms. B. 2193, pp. 124r-127v; Armaroli, p. 55.

Epilogue

Between 1796 and 1815, during the revolutionary and Napoleonic periods, the University of Bologna conferred six other degrees on women, five of these degrees were in the health sciences, and one was in law.[1] Such an unusual number of degrees awarded to women in a relatively short time period might seem to indicate a university more open to women's education and participation in the sciences. In truth, the *Piano degli Studi* approved by the vice- president of the Italian Republic, Francesco Melzi, on October 31 1803, which reformed the universities of the republic, and affected the University of Bologna and the Institute of Sciences, ensured that these women were even more dissociated from the higher seats of scientific learning than Bassi, Morandi, Roccati, Agnesi and Pignatelli had ever been. Furthermore, the fact that most of the degrees awarded to women were in the health sciences indicate a desire by the members of the Ministry of Public Instruction, and the government in Milan to reform medicine and health care at all levels, and not a concern on their part for women's higher education.[2] The proofs of such statements can be found in the careers the women who received degrees were allowed to follow after graduation. Thus, Maria Dalle Donne (1778-1842), who had been groomed by a group of natural philosophers and physicians from the University of Bologna and the Academy of Sciences to replace Laura Bassi, lost her position of Benedettina Academic, her pension, and any opportunity she had of doing research after October 31, 1803, when the local elite lost control over the university and the Institute of Sciences. In spite of being officially qualified to teach at the university, the physician Maria dalle Donne was put in charge of training practically illiterate

midwives. The other women were allowed to receive degrees in their respective fields by the Ministry of Public Instruction. However, the same ministry determined these women's career paths. Furthermore, none of the women were associated even remotely with academies of sciences, or were involved in any research. Nevertheless, the fact that the ministry allowed them to become university graduates indicates that the tradition which recognized that a few properly instructed women were deserving of degrees like men, had not disappeared with the reforms.

I. *Women Physicians: Maria Dalle Donne and Maria Mastellari Colizzoli Sega*

Two women received degrees in medicine from the University of Bologna, Maria Dalle Donne and Maria Mastellari Colizzoli Sega. The first of these women, Dalle Donne, received her degree in 1799, prior to the university reforms of 1803, and therefore followed a system of education, and examination (defence of theses) similar to those undertaken by Bassi and Roccati earlier in the century. Graduating in 1806, Mastellari's education and examinations were affected by the Melzi reforms. Dalle Donne received her licence to practice medicine after she defended successfully three sets of theses. Mastellari would only be given her licence to practice after she practiced medicine under supervision for a year, and passed another series of examinations. This added difficulty of needing to practice medicine under supervision might have prevented Mastellari from receiving her licence.

Maria Dalle Donne, the daughter of day labourers from Roncastaldo Bolognese, was brought up by a priest, her father's cousin, who began teaching her Latin from an early age. Dalle Donne's early education drew the attention of the physician Luigi Rodati, who,

when he moved his practice to Medicina took the young girl along. Rodati then proceeded to teach her the classics, and to speak and write Latin with the hope of recuperating Laura Bassi, as he himself put it to a friend in 1789. Rodati eventually moved to Bologna with Dalle Donne to take up teaching positions at first in botany, and then general pathology and legal medicine at the university. When in Bologna, Rodati engaged the head of physics at the Institute of Sciences, Sebastiano Canterzani, to teach her philosophy; and as her fame spread others, such as the experimental physicist Giovanni Aldini, the pathologist Gaspare Uttini, and the anatomist, surgeon and obstetrician, Tarsizio Riviera, volunteered to teach her. Pushed to ask for a degree by her own teachers, Dalle Donne had her public examination on December 19, 1799 at the university's anatomical theater, when she, accompanied by the lecturer of Elements of the Greek Language at the university, Clotilde Tambroni, had to dispute on two theses presented to her four hours earlier, the first on the forty-second text of Aristotle, and the second on the twentieth aphorism of Hippocrates. The degree was to follow on the same day.[3]

On May 23 and May 24 1800, Dalle Donne presented and defended in the Church of San Domenico a set of sixty theses in anatomy and physiology and a set of sixty theses in universal medicine respectively, and on May 29, another set of theses in obstetrics, which did not survive, in order to be licenced to practice and to teach at the university. However, the principal instigator of teaching positions for women at the university, Prospero Lambertini, had been dead for several decades, and a teaching position for Maria Dalle Donne at the university never materialized. She was offered, nevertheless, by the Imperial Provisory Austrian Regency--the government in power at the time--like

Laura Bassi had been offered, an extraordinary membership to the Benedettina Academy on May 31, 1800. If the Benedettina membership did not allow her to teach, it still provided her with the funds and laboratory facilities to carry out scientific research, and the means to present this research as dissertations on an annual basis to the Academy of Sciences. Further aid was provided to Dalle Donne, at that time, by Count Prospero Ranuzzi Cospi, an amateur physicist, who offered her an annuity of fifty sequins, to be doubled at the time of his death, and who bequeathed his physics cabinet to her in his will.[4] Thus, by 1800, although prevented from teaching at the university, Maria Dalle Donne could, nevertheless, begin a career dedicated to scientific research.

Dalle Donne presented four dissertations to the Academy of Sciences, the first two presented while her teacher Riviera was still alive, dealt with medical topics, such as cancer. After Riviera's death, no longer under his influence, Dalle Donne appeared to move away from medicine to enter the field of chemistry with dissertations such as " On Combustion which Took Place in Vacua ", and " On the Use of Albumen Found Recently in the Porretta Spa ". As none of the dissertations she presented to the academy were ever published, or survived in manuscript form, we have no idea where Dalle Donne stood researchwise. Her scientific stand cannot really be deduced from her published theses, which represent her study program under Riviera, and as such were heavily influenced by her teacher. For instance, rejecting the new concept of animal electricity, expounded by Galvani, Riviera believed in Haller's theory of muscle irritability and nerve sensitivity, as he illustrated in *Compendio di anatomia* (1799); Dalle Donne's theses XIV and XV of *Ex anatomia et physilogia* did likewise. Dalle Donne, like Riviera, believed that the egg was fertilized in the ovary, that the foetus had a life of its

own, only receiving nutrition from the placenta, and that birth defects arose from mechanical causes, and not by suggestions from the mother, as popular belief would have it. There are many other such coincidences between Dalle Donne's theses and Riviera's published works, which indicates that the theses represented Riviera's opinions on medical matters, and not necessarily Dalle Donne's, just like Bassi's philosophical theses represented Tacconi's opinions on the matter, and not Bassi's.[5]

Although her principal teacher Tarsizio Riviera had sworn allegiance to the revolutionary French government which had occupied Bologna from June 16, 1796 to June 1799, Dalle Donne had received her degree, memberships to the Academy of Sciences, and to the Benedettina Academy, perhaps coincidentally, during the Austrian Regency of the town, which lasted from June 30, 1799 to June 28, 1800. However, she did not lose her position of Benedittina academic with the return of the French to Bologna after June 28, 1800; the French reconfirmed her appointment and pension, in view of the fact that she had already presented dissertations to the Academy of Sciences. Nevertheless, the reorganization of the university and the Institute, during the Napoleonic period with the Decreto Melzi of October 31, 1803, cut short Dalle Donne's scientific career.[6]

Since the second half of the seventeenth century Bologna's intellectual elite had attempted to reform the teaching at the university. Reformers like Anton Felice Marsili and his brother Luigi Ferdinando Marsili wanted to introduce the new experimental philosophies to a university curriculum which was largely dominated by Aristotelean philosophy. The foundation of the Institute of Sciences in 1711, partly addressed these demands. The Institute had facilities to teach students the experimental sciences a few

hours each week. However, the institute was administered separately from the university, and its teaching had not to compete in any way with the teaching at the university. Eighteenth century women philosophers had found the Institute of Sciences, and its Academy of Sciences far more accessible than the university. They had become members of the institute's Academy of Sciences; Bassi had taught experimental physics at the institute, and both Bassi and Dalle Donne had become members of its research-oriented Benedettina Academy. The Melzi reforms of 1803 did for the University of Bologna what reformers in the late 1600s and early 1700s had failed to do: they eliminated Aristotle from the university curriculum, and incorporated into it the experimental sciences, by incorporating the Institute of Sciences and its laboratories to the university. They also eliminated women from Bologna's Institute of Sciences. After October 31, 1803, the University of Bologna took over the Institute of Sciences with its courses and its scientific cabinets; the Benedettina academy was dissolved, and all those members--male or female--who did not have an official teaching position at the Institute, found themselves without a job, and without a pension. Therefore, with the reforms, Dalle Donne lost any possibility to use the scientific cabinets, now belonging to the university, as well as the opportunity to present her dissertations to the Academy of Sciences. However, the republican government in Milan had no intention of leaving Dalle Donne destitute since they offered her the directorship of the school for midwives, which was to be located outside of the university precinct, preferably in one hospitals of the city.[7]

With a limited income at her disposal, and her opportunities to do reseach severely curtailed, if not completely eliminated, Dalle Donne had no alternative but to accept the

position offered her, stating that she was entirely ready to provide theoretical and also practical instruction extended up to cases of difficult birth; in these cases she felt that the practiced hand of a surgeon was required. Such a statement on her part clearly indicates that the thirty theses on surgical medicine, which were part of her *Theses ex Universa Medicina* defended on May 24, 1800 and which covered surgical procedures on different types of wounds, on gangrene, tumours, fractures , cataracts, tonsils, breast cancer, herniae and so on, were apparently not based on practice, but were most certainly part of her study program, and may have involved, perhaps some observation of the procedures, but not practice.[8] Dalle Donne needed not to have worried about her lack of surgical practice since hospital facilities for the school of midwives failed to materialize due to lack of funds, and/or perhaps will. Consequently, Dalle Donne was confined to teaching at home for the next thirty-six years; but unlike Bassi and Morandi, her students were not potential natural philosophers, mathematicians, surgeons, or physicians, but ill-educated women. In fact, a perusal of the reading and writing records of these women, for the period in which they were kept, shows them to have been, to a great extent, illiterate.[9] Thus, in spite of her qualifications in natural philosophy and medicine, and her degree, the Melzi reforms of the university and institute ultimately reduced the learned Dalle Donne to the level of the *maîtresses sage-femmes* who had their training at the Maternité de Paris, a level of instruction which was far below her own, and the levels achieved by Bassi, Agnesi and Roccati in their lifetimes. As expected, the course on Surgical and Obstetrical Institutions, taught at the university, was given by a male professor, and was exclusively destined for the instruction of male students. Maria Dalle Donne might train potential midwives, but, again as expected, the same male professors of the Faculty of

Medicine and Surgery were the ones who decided, through an oral exam, whether the women were sufficiently trained to merit the midwife's diploma and the licence to practice.[10]

Dalle Donne 's course for midwives, which probably began towards the end of 1805, consisted, at least in later years, of a whole year of theoretical instruction, within which six months were also dedicated to practice under an experienced midwife of Dalle Donne's choosing. At the end of the course, the students were provided with a certificate of completion by the teacher which allowed them to be examined by the appropriate teaching members of the Faculty of Medicine and Surgery. The original intent of government officials who organized the school was to have literate midwives, either married, or single,[11] and perhaps during the Napoleonic period such standards were followed, because the number of students Dalle Donne trained was rather small. She taught one or two women a year, most of them from the city of Bologna, where the literacy for women from the lower classes might be assumed to have been higher than in the countryside. Whereas a few single women appeared amongst the trainees during the Napoleonic period, they essentially disappered from the ranks after the restoration of the papal government. The greatest majority of women then were either married or widowed, their average age was thirty-eight years old, but could range from as young as 18 years old and single to 66 years old and widowed, and in three cases out of four came from the surrounding countryside. Perhaps because the papal government lowered the midwives' standards of literacy, Dalle Donne 's school seems to have really taken off only during that period. Then her school averaged six students per school year, to whom Dalle Donne taught the elements of obstetrics, such as recognition of the external and

internal reproductive parts of women, true and false labour, the different foetal positions, what was the normal foetal position at birth, what to do in case of abnormal foetal position during delivery, or in the case of twin births, how to carry out pelvic examinations, to recognize the placenta , what to do in case of internal hemorrhage and, most importantly, in which of the cases a midwife needed to call the expert hand of a surgeon.[12]

In 1824, the papal government again reopened the Benedettina Academy, but Dalle Donne does not seem to have been reinstated as a member. Nevertheless, her name unfailingly appeared in the list of licenced physicians printed by the government for the town of Bologna. Had Dalle Donne desired to establish a private practice, she could have legally done so without impediment. Thus, if the Melzi reforms kept her away from the practice of scientific research, they did not keep her away from the practice of medicine. In fact the lists of licenced health practioners which the government published, advertised the fact that she was a properly licenced physician.[13]

The other woman to receive her medical degree during the French period, Maria Mastellari Colizzoli Sega, never appeared in the lists of physicians licenced to practice in Bologna. We do not know why Mastellari failed to complete her year of practice. It might have been her decision, or perhaps she failed to receive the permission needed to carry out her year of practice from the Ministry of Public Instruction in Milan, to which all the women had to petition for degrees.[14]

Maria Mastellari Colizzoli Sega, the daughter of a master mason from Bologna, was already a thirty-three or thirty-four years old widow of a physician (Giovanni Andrea Colizzoli Sega), and the mother of two children, when she was admitted without exams

into the second year of medicine at the university in 1803. Nothing is known of her education prior to 1803; but, obviously, it must have been equivalent to that of a first year medical student, since it allowed her to be admitted to the medical school's second year without exams. It is possible she received her earlier instructions from her husband, who died in 1793 or 1794; but it is more likely that she was one of the two female students--the other being Dalle Donne--being taught by Tarsizio Riviera shortly before his death in 1801.[15]

One and a half years after her admission, on June 14, 1805, Mastellari passed her advancement exam, undertaken by medical students at the end of the third scholastic year. On June 2, 1806 she took her fourth year exam, where according to the new rules, she did not present theses to be defended, but had to answer four questions, not known beforehand, in pathology, clinical medicine, *materia medica*--the formal study of nature as a medical entity--and on another unexpected medical topic. At the same time she was dispensed from having to pursue the fifth year of medicine--the practice year--prescribed for physicians who wanted a free licence to practice. The degree awarded to her on June 5, 1806 declared that Mastellari could benefit from the rights and prerogatives of all those who had received such a degree. However, without her fifth year of practice and the ensuing exam, Mastellari never really qualified to practice medicine, and her name was absent form all the lists of physicians in Bologna empowered to do so. The fact that Mastellari never practiced medicine, at least officially, was also confirmed by Canonici Fachini in the biographical sketch she presented of the physician in her *Prospetto biografico delle donne italiane.* Since Mastellari was admitted into the second year of medical school, one is almost tempted to say that she might have attended regular classes

at the university, a fact which would make her unique amongst the woman covered so far. However, we have no proof that she actually attended any courses; and, most likely, Mastellari studied privately with a university professor, such as Germano Azzoguidi, professor of physiology and compared anatomy at the medical faculty at the time, and the promoter of her degree.[16]

II. *Women Surgeons: Zaffira Ferretti and Maria Maddalena Petracini*

Two women, a mother and daughter are known to have received degrees in surgery from Italian universities during the late eighteenth and early nineteenth centuries. On November 20, 1808 and on May 16, 1810, Zaffira Ferretti (1785-1817) received respectively a degree in surgery and her licence to practice from the University of Bologna. Ferretti came from a family of surgeons; her father Francesco Ferretti was the head surgeon of the hospital of the town of Bagnacavallo in Romagna, where he not only practiced surgery, but also taught the art to students, including his wife, son and daughter. Zaffira's own mother, Maria Maddalena Petraccini (1759-1791) from Florence, apparently had studied surgery at first under her husband, then in Florence in 1788 with professors Lorenzo and Angelo Nannoni, who also taught her obstetrics. If Canonici Fachini is to be believed, Petraccini's degree in surgery did not come from Florence University as might be expected, but from the University of Ferrara, perhaps in 1789 at the time when she published her only work, *Memorie per servire alla fisica educazione de' bambini*, based on the raising of her own children, but directly influenced by Rousseau's *Emile*, and thus in favour of breast feeding, daily bathing for the child, exercise, and against bindings of any kind. It is also clear from her book that after her

return from Florence in December 1788, she saw patients, apparently children, independently from her husband.[17] Petraccini's degree from Florence or Ferrara, indicates perhaps that there were other Northern Italian universities, besides Bologna, awarding degrees in the health sciences to women, of whom we have no knowledge.

Since Maria Petraccini died while Zaffira Ferretti was still a child, the latter's surgical studies were undertaken under the supervision of her father, at the hospital of Bagnacavallo. As his student Zaffira might have acted as her father's assistant at the hospital. For instance, she probably assisted Francesco Ferretti when he undertook the massive vaccination against smallpox of Bagnacavallo's population, at the government's request in May 1806. Zaffira Ferretti and her father applied for her degree directly to Ministry of Public Instruction in Milan, where Francesco Ferretti, as the principal health official of Bagnacavallo and its surrounding areas was probably well known to officials of the new Kingdom of Italy. The order to the Medical Faculty of the University of Bologna to set up the exam and subsequent degree for Ferretti came directly from Director General of Public Instruction at Milan on September 19, 1808, with a clause which stated that a decison would be made on whether Ferretti would be allowed to pursue her licence to practice after the results of her exam were known.[18]

Having received instruction from the Ministry of Public Instruction to set up Ferretti's exam, the Medical faculty had no choice but to comply; however, the same faculty could still make the exam difficult to pass. During the exam, set for November 14, 1808, Ferretti was questioned by the appropriate professors on their specific fields such as high surgery, surgical institutions and obstetrics, anatomy, *Materia medica*, legal

medicine, and pharmaceutical chemistry. As seen above, Mastellari, trained by members of the Medical Faculty, was not questioned as extensively for her degree in medicine. As it turned out, Ferretti was able to scrape through the exam, getting just the two third majority needed for a degree. To a certain extent, the Melzi reforms may had made degrees in surgery harder to get than degrees in medicine. However, the fact that Ferretti was not instructed by any members of the Faculty of Medicine, but by a hospital surgeon, might have played a role in the difficulties she encountered in her exam.[19] One suspects that surgeons from the Medical Faculty, intent on keeping control over the profession, felt that it was their office to teach surgeons, and not the office of a hospital surgeon. Once Ferretti passed under the supervision of surgeons from the Medical Faculty, she was able to sail through the supposedly more difficult exam needed to receive the licence to practice.

Having received approval from Milan, on May 15 and May 16, 1810 Ferretti presented herself for the exam which entitled her to practice surgery and obstetrics. The exam was divided into two parts; the first part on May 15, consisted of having to perform specified surgical operations on bodies and obstetrical ones on machines; these she performed with precision and singular dexterity, according to the examiners, professors Atti and Termanini. On May 16, Ferretti underwent the oral exam, where again she was questioned by all the eleven professors present, on their own respective fields. This time, Ferretti received complete approval from the professors who questioned her. However by then, she had spent a whole year at the University of Bologna, practicing under the supervision of the professor of Surgical Clinic at the University, Giuseppe Atti. One presumes she could have carried out this required year of practice in her hometown,

under her father's supervision, but one doubts that the results of her exams would have been so splendid.[20]

Little is known of Ferretti's activity after she received her licence to practice, but documentation at her hometown points to her assisting her father at the hospital, probably like her mother had done before her death. Unfortunately, her father's illness (a stroke apparently) forced the Bagnacavallo's Podestà to substitute him at the hospital and at the school, and not with Zaffira Ferretti, who apparently found herself without employment and in financial difficulties by July 31, 1812. According to Canonici Fachini, assistance came from the central government at Milan: Ferretti was sent to Paris--perhaps for further training--and then took up residence at Ancona where she was supposed to set up a school to train midwives. However, many problems led her to abandon Italy and move to Turkey, living a few years at Petrasso, where she died in 1817.[21] Attempts to trace her school at Ancona led nowhere; there are no records in the state archives that a school for midwives directed by Ferretti ever existed. As discussed above, for all the support Dalle Donne, being a native of Bologna, had from her friends in the Medical Faculty and in the government, her school for midwives only became established after the return of the papal government, when standards of literacy were dropped for trainees; besides, Dalle Donne was never able to get the school to operate from a hospital, as originally planned. A surgeon like Ferretti really needed to function within hospital bounderies. One suspects, firstly, that Ferretti was probably never allotted hospital space at Ancona. Secondly, it is also possible that very few midwives turned up for training, because the Melzi reforms had imposed high standards of literacy. These two factors might have prevented the school from ever taking off. A woman might receive equal training to a

man in the health sciences during the Napoleonic period, but she was guaranteed not to be able to follow a career similar to his own in the field, no matter how many exams she passed and how competent she proved to be. Further proof that this statement is accurate can be found in the career the pharmacist Sabina Baldoncelli was allowed to follow after her degree.

III. *Women Pharmacists: Sabina Baldoncelli and Margarita Trippi*

The University of Bologna also awarded two degrees in pharmacy during the revolutionary period respectively to Margarita Trippi, and her student Sabina Baldoncelli. They practiced their profession in the pharmacy of the institution they both belonged, the Orphanage of the Putte dei Mendicanti. In spite of their education, degree, and licence to practice, the role the Ministry of Public Instruction allotted them was like the role Galileo's daughter, Maria Celeste, had in her seventeenth century convent: Trippi and Baldoncelli could only practice pharmacy within the orphanage's walls.

Sabina Baldoncelli, born Sabbatina Balducelli in Bologna in 1781 or 1782, was supposedly an orphan residing at the orphanage of the Putte dei Mendicanti di Santa Catterina di Strada Maggiore of Bologna. In reality, problems arising in the family after her father's death and the remarriage of her mother forced Sabina into the orphanage of S. Catterina by the age of twelve or thirteen, where she changed her name and lived thereafter.[22] The orphanage had a pharmacy for the use of the residents, but also, one suspects, to provide extra income to the institution, not unlike Maria Celeste's drugstore at the Arcetri convent. The orphanage's pharmacy had been run since 1796 by Margarita Trippi, who had been examined in the pharmaceutical arts by the College of Medicine of

the University of Bologna, under the old rules, on April 14, 1796. Trippi received her degree and licence to practice on April 28 of the same year in a ceremony at the church of S. Matteo with no imposition placed at that time on her degree, or her practice.[23]

We do not know who were Trippi's teachers, but we know that Trippi was to be Baldoncelli's first teacher in pharmaceutical chemistry. She taught the subject to Baldoncelli for three years, and then passed her to the care of Francesco Maria Coli, professor of Pharmaceutical Chemistry in the Faculty of Medicine. Coli was responsible for teaching her both pharmaceutical chemistry and general chemistry, Prof. Ungarelli taught her *Materia medica*, and prof. Scannagatta, botany. These were the courses students in pharmacy had to complete in two years in order to receive their degrees; and thus, one has to conclude, as she herself stressed in her 1807 petition to the Royal Directorate of Public Instruction at Milan, that Baldoncelli had received privately the equivalent education potential male pharmacists received at the university. One could also point out that she had, in addition, three years of practical experience under Trippi's supervision, which most male students probably lacked.[24]

Permission was granted from Milan that Baldoncelli be admitted to the exams in pharmacy, considering the particular circumstances of the petitioner--an orphan living in an orphanage--but only if it were clearly established that she was to practice pharmaceutical chemistry only in the orphanage's pharmacy, and not in secular pharmacies.[25] Thus, had Baldoncelli desired to leave the orphanage to practice her profession elsewhere in the city she would have not been allowed to do so. One doubts that male pharmacists were ever pigeonholed in such a drastic manner. Since Baldoncelli received her degree during the Napoleonic period, to obtain her licence to practice she

did her obligatory year of practice after her degree at the orphanage's pharmacy under the supervisions of Trippi and Colli. Baldoncelli carried the experimental part of her exam, which consisted of five chemico-pharmaceutical experiments, on December 18, 1808 at the chemical laboratories of the university in the presence of her teacher Coli, and another pharmacist. The oral part of the exam took place on December 22, when she was made to answer, according to the rules, previously unknown questions in botany, *Materia medica*, chemistry, pharmaceutical chemistry and practical pharmacy from the professors present. From that moment on Baldoncelli was able to practice her profession in the orphanage's pharmacy, and her name, together with that of her teacher, Trippi, appeared regularly in the list of qualified pharmacists for the Province of Bologna.[26]

Only one degree was given to a woman after the return of the papal government to Bologna, after 1815. It was a degree in dental surgery given on April 16, 1818 to the widow of a dental surgeon, Teresa Passerini Monari of Bologna, but resident at Imola, who, as expected, had been taught the profession by her husband. Passerini had *de facto* taken over her husband's practice during the last years of his life, when Monari was too sick to practice. She had been so successful in the enterprise that there was a general demand at Imola that she continue her practice after her husband's death. Her petition for admittance to the exam and for the awarding of the eventual licence to practice was accompanied by letters of recommendation from local physicians and surgeons, and most importantly, from the area's Professor of Obstetrics and honorary physician to Pope Pius VII, who had seen her operate on patients, with practically no discomfort to them, using skilfully all the modern instruments and their modifications.[27]

It appears that no other women, besides the ones mentioned above, qualified to practice in the health fields in Bologna until 1884, when Giuseppina Cattani received her degree in medicine from the university. But Cattani did not fit the mould of the women studied so far, for she attended high school, did not receive a private education, but attended regular classes at the university, and for a period also taught publicly a course of bacteriology at the institution: the university by then was finally and truly opened to women.[28] Of course, as Maria Petraccini Ferretti had received a degree in surgery from the University of Ferrara, or Florence, there might have been other women being awarded degrees in the health sciences, or other scientific subjects, from other universities, but to find them would require the examination of the archival material for each university for each different field, a daunting task to say the least, and beyond the scope of this thesis.

The degrees awarded to women in the health sciences discussed above differed greatly from the degrees awarded to Piscopia, Bassi and Roccati, respectively, in the seventeenth and early part of the eighteenth centuries, and to Dalle Donne in 1799. Maria Dalle Donne's degree was not really intended to be used in the practice of medicine, but was a means to allow her into the Benedettina Academy, where she could do research and regain the prestige and fame lost by the town with the death of Laura Bassi. These degrees were meant to reward, as men believed, exceptional learned women for their learning. They garnered the women who received them considerable fame. With the notable exception of Dalle Donne, the women who graduated during the revolutionary period immediately sunk into obscurity. The later degrees were sought by the women and the men, who had educated and encouraged them, because of a belief on their part that in order to practice in their fields of expertise in the health sciences, women

needed to be officially qualified. This sentiment was also shared by the Ministry of Public Instruction in Milan, which allowed these degrees to take place. At a time when all the sciences were becoming increasingly professionalized, the health sciences were no exception. It was no longer acceptable to governments, surgeons, pharmacists, and dental surgeons alike for someone to study surgery, pharmacy, or dental surgery without obtaining a degree and licence which officially declared the competence and right to practice of the bearer. Like the men, women needed these qualifications to be considered professionals. Since the Ministry of Public Instrution was not really intent on promoting the professionalization of women in all health fields, except midwifery, it limited the women graduates' career paths.[29] Nevertheless, the fact that government officials were willing to permit women to graduate from universities is indicative they were bowing to the Italian tradition of giving degrees to a few women. Had more women and their teachers petitioned for degrees, perhaps more degrees would have been conceded.

The return of Bologna to papal control did not entail the return of conditions as they had existed in the eighteenth century. Although a thorough search of all the exams in scientific subject has not been undertaken, the surviving lists of graduates from the period--which might be incomplete--do not show any women graduates in science until 1884, excepting for the dental surgeon, Teresa Passerini Monari. In 1824, the papal government reorganized the Benedettina Academy, but it appears that Maria dalle Donne was not reinstated as a member. Twenty one years had passed since she had last presented a dissertation to the Academy of Sciences. Dalle Donne would had found it difficult to begin again. [30] We do not know why there were no women associated with Bolognese scientific institutions of higher learning at the time. Perhaps the papacy did not

allow women graduates. Perhaps Bolognese men did not bother to educate them in science, as they had done in the past. That is not to say that there were no women associated with scientific institutions of higher learning in Italy during that period. To find these women one had to go to Rome, where, for instance, Caterina Scarpellini was on the staff of the Campidoglio Observatory and directed its meteorological station, and Elisabetta Fiorini Mazzanti was an ordinary member of the Academy of Lincei, or to Florence, where both Scarpellini and Mazzanti were members of the Academy of Georgofili, or even to Turin, where Mazzanti was made a member of the Academy of Sciences. The golden age of Italian women in the sciences was over, as far as Bologna was concerned, until after the opening of the university to women.

[1]For Margarita Trippi's degree in pharmacy which actually took place on April 28, 1796, a few months before the French troops entered Bologna on June 16, 1796, see A.S.B. : *Archivio dello Studio* no. 295: Acta Collegiorum Medicinae et Philosophiae 1789 ad 1798; for Maria Dalle Donne degree in Medicine see *Gazetta di Bologna*, no. 102 (21 Dicembre 1799), pp. 819-20; A.S.B.: *Archivio dello Studio*, no. 228: Secondo libro segreto di filosofia 1712-1800, p. 172; for the other degrees see A.S.B.: *Archivio dello Studio*, no. 435: Elenco delle ammissioni e dei gradi conferiti dalla Università di Bologna 1800-1824; amongst these degrees there is one on dental surgery conferred on Teresa Passerini Monari on April 16, 1818, after the restauration of the Papal government , see Luigi Simeoni, *Storia della Università di Bologna*, Vol. II: *L' età moderna (1500-1888)*, (Bologna: Zanichelli), pp. 139, 179.

[2]For some of the reforms in medicine and health care during the revolutionary and Napoleonic periods in France see Toby Gelfand, *Professionalizing Modern Medicine Paris Surgeons and Medical Science and Institutions in the 18th Century*, (Westport, Connecticut: Greenwood Press, 1980), pp. 131-191; and how they affected women involved in midwifery see Phyllis Stock-Morton, " Control and Limitation of Midwives in Modern France: The Example of Marseille ", *Journal of Women's History*, Vol. 8, no. 1, (Spring 1996), pp. 60-94; for reforms at the University of Bologna during the period see Simeoni, pp. 139-178; for the Institute see E. Bortolotti, " L' Accademia delle Scienze dell' Istituto di Bologna ", *Atti e Memorie. Deputazione di storia patria per le provincie di Romagna*, XXV, (1935), series IV, pp. 113-165.

[3]Clotilde Tambroni was named lecturer of the Elements of the Greek language in 1793, while the university was still under papal control; however, she did all her teaching at home; the teaching of Greek was cancelled in 1808, during the Napoleonic period, and Tambroni was pensioned off, see Simeoni, pp. 118, 152, 157; for biographies of Maria Dalle Donne see Raffaelo Buriani, " Necrologia della Dottoressa Anna Maria Dalle Donne ", *Almanaco statistico bolognese dell' anno 1842 dedicato alle donne gentili*, Anno XIII, (Bologna: N. Salvardi, 1842), pp. 125-30; Laura Nicolini Burgatti, *Maria dalle Donne (1776-1842)*, (Loiano, 1971); Olimpia Sanlorenzo, " Maria Dalle Donne ' in Sanlorenzo, *l' insegnamento...*, pp. 53-61; Olimpia Sanlorenzo, " Maria Dalle Donne e la Scuola di Ostetricia nel secolo XIX " in *Alma Mater Studiorum...*, pp. 147-156; for the archival material relating to her education and degree see Luigi Rodati's letter no. 5 to Nicola Fabri of May 4, 1789 and her letter to Nicola Fabri no. 10: postridie kal. april. 1792 and no. 14: IX kal. jun. (1792) all in B.C.A.B.: B. 309: *Clarorum virorum...Epistolae*; A.S.B.: *Archivio dello Studio*, no. 228: Secondo libro segreto di filosofia 1712-1800, p. 172; A.S.B.: *Archivio dello Studio* no. 235: Nomina Doctorum omnium incipiendi ab anno 1480 usque ad 1800, December 19, 1799; A.S.B.: *Archivio dello Studio*, no. 306: Diario Rusconi 1790-1800, 6 xbris (1799); *Gazetta di Bologna*, no. 102 (sabato 21 dicembre 1799), pp. 819-20.

[4]Rosen places her membership to the academy of sciences to December 18, 1800, which would have been during the French period, however, her theses, which one assumes were printed by the time of her defence of them in May 1800, referred already to her membership to the academy, see Simeoni, pp.146-47, 179; Rosen, p. 181; see the front page of Dalle Donne, *Theses ex Anatomia, et Physiologia*; for her membership to the Benedettina Academy see " Agregazione della Dott.a Maria Dalle Donne ', May 31, 1800 in A.S.B.: Fondo: *Assunteria di Istituto*, Serie: Diversorum, Busta 13, 1800; *Gazetta di Bologna*, no. 43 (Sabato, 31 maggio 1800), p. 337; for her annuity see Buriani, pp. 127-29; Sanlorenzo, " Maria Dalle Donne..." in *Alma Mater Studiorum...*, p. 151; for the advantages of being a Benedettina academic see Berti Logan, pp. 788, 801.

[5]Her dissertations were February 6, 1800: On Cancer; February 3, 1801: Medicine; March 24, 1802: On Combustion which Took Place in Vacua; April 6, 1803: On the Use of Albumen Found Recently in the Porretta Spa, see Rosen , pp. 303, 305, 307, 309; for the coincidences between Dalle Donne theses and Riviera's works see theses XIV, XV, XX, XXVIII, XXIX, XXX, XXXI, XXXII in Dalle Donne, *Theses ex Anatomia et Physiologia*; Tarsizio Riviera, *Compendio di Anatomia e Fisiologia*, (Bologna: S. Tommaso d' Aquino, 1799), pp. 23-26, 51-53, 87- 93; Riviera, *Storia di un monocolo*, pp. 24, 48, 69-73, 82, 85, 88-93; for the school of mechanical causation of deformities see Richards, pp. 377-411; for Riviera's support of Haller and rejection of Galvani's theory see Bernardi, pp. 69-75.

[6]Simeoni, pp. 146-47, 179; A.S.B.: Fondo: *Assunteria di Istituto*, Serie : Diversorum , Busta 14, 1800; Buriani, pp. 127-29; Sanlorenzo, " Maria Dalle Donne..." in *Alma Mater Studiorum*, p. 151.

[7]Bortolotti, pp. 122-24; Sanlorenzo, *L'insegnamento...*, pp. 64-65 ; for her confirmation as Benedittina by the French-controlled government see letter from Bologna 24 Pratile anno IX in A.S.B.: Fondo: *Assunteria d' Istituto*, Serie: Diversorum, Busta 13; for reforms at the university and institute see also A.S.B.: *Archivio dello Studio*, no. 468: Titolo II, Musei e Stabilimenti scientifici...; for the order that she be appointed to the obstetrics school see dispatch no. 1599; Repubblica Italiana Milano 8 febbraio 1804 in A.S.B.: *Legazione e Prefettura di Bologna*, T. 13: Istruzioni, R. 11, 1804, parte 1a; Rosen, pp. 35-57, 151-62; Cavazza, *Il settecento inquieto*, pp. 85-117.

[8]See theses VII to XXXVI in Dalle Donne, *Theses ex Universa Medicina...*; see document no.699: Sessione tenuta in casa del citt.o Professor Testa Rettore dell' Università Nazionale di Bologna ...24 febbraio 1804 Anno III della Repubblica Italiana coll' intervento dei sottonotati citt.i Professori in detta università e della Citt.a Dottoressa Maria Dalle Donne. in A.S.B.: *Legazione e Prefettura di Bologna*, T. 13, R. 11, 1804, parte 1a.

[9]By April 22, 1805 the course had not yet begun, yet by February 12, 1806, the first midwife trained by Dalle Donne received her diploma and licence to practice. The last midwife trained by her, received her licence on April 21, 1842; she actually died on January 9, 1842; for her death see document no. 99: Letter of Dalle Donne's parish priest to the university's administration of January 12, 1842 in A.S.B.: *Archivio dello Studio*, no. 915: 1824-1859, Titolo 2o., Funzionari e Impiego; for her first students see A.S.B.: *Archivio dello Studio*, no. 435; for her last students see A.S.B.: *Archivio dello Studio*, no. 1208: Esami...Infimi operazioni, 1841-1842; the university kept the records for the potential midwives' literacy from 1824-1825 to 1829-1830, and then not always regularly, see A.S.B.: *Archivio dello Studio*, nos. 993 (1824-1825), 1005 (1825-1826), 1015 (1826-1827), 1027 (1827-1828), 1039 (1828-1829), 1051 (1829-1830) in their appropriate *fascicoli*, usually under *infimi operazioni.*

[10]Stock-Morton, p. 64; Sanlorenzo, *L' insegnamento...*, pp. 64- 70.

[11]The course appeared to have been shorter during the Napoleonic period, at least from the intended rules, see " Interno Ministro 28 gennaio: Piano per una scuola di ostetricia " and document no. 699 in A.S.B.: *Legazione e Prefettura di Bologna*, T.13, R. 11, 1804, parte 1a.; the longer course occurred, again in the intended rules, during the papal restoration, see A.S.B.: *Archivio dello Studio*, no. 874, 1824-1831, Capsula D, fasc. 5 " Projetto di regolamento per l' approvazione delle levatrici "; Sanlorenzo, *L' insegnamento...* ", pp. 59-60.

[12]I based my summary of what might have been taught in the course by the questions asked to the potential midwives during the exams, see for instance A.S.B. *Archivio dello Studio*, no. 1005, 1825-1826 : Esami...levatrici, fasc. 10 and 11; see also A.S.B.: *Archivio delle studio*, no. 1167, anni 1838-1839 : Esami, fasc. 3; the statistics are based roughly on my study of the exams undertaken by the midwives, and the documentation provided for these examinations and comparing them with the Elenco of graduates from 1800 to 1824, see A.S.B.: *Archivio dello Studio*, no. 435: Elenco...1800-1824, and A.S.B.:

Archivio dello Studio, Esami, nos. 550 (1806-1807), 557 and 558 (1807-1808), 567 (1808-1809), 573 (1809-1810), 580 (1810-1811), 588 (1811-1812), 597 (1812-1813), 603 (1813-1814), 610 (1814-1816), 618 (1815-1816), 623 and 624 (1816-1817), 629 (1817-1818), 634 (1818-1819), 640 (1819-1820), 647 (1820-1821), 655 (1821-1822), 663 (1822-1823), 673 (1823-1824), 993 (1824-1825), 1005 (1825-1826), 1015 (1826-1827), 1027 (1827-1828), 1039 (1828-1829), 1051 (1829-1830), 1060 (1830-1831), 1070 (1831-1832), 1082 (1832-1833), 1097 (1833-1834), 1111 (1834-1835), 1121 (1835-1836), 1137 (1836-1837), 1153 (1837-1838), 1167 (1838-1839), 1182 (1839-1840), 1196 (1840-1841), 1208 (1841-1842).

[13]Dalle Donne might have seen patients at her house, as it was her right, but no documentation came my way that she did so. See the list of physicians for 1803 , and the list of physicians, surgeons, midwives, dentists, pharmacists and veterinaries for 1821 in A.S.B.: *Archivio dello Studio*, no. 451: Elenchi degli abilitati ad arti salutari nella provincia di Bologna (1802-1821); see also the list for 1833; the 1829 list did not contain her name, but it was an oversight, the list was far from complete; both lists are in A.S.B.: *Archivio dello Studio*, no. 847: Elenchi degli abilitati alle arti salutari 1824 al 1859; for the reorganization of Benedettina academy see Bortolotti, pp. 136-37; Buriani seems to attribute her aggregation to the Benedettina Academy to after the return of the papal government to Bologna, but he was mistaken, see Buriani, p. 129.

[14]The rule of one year of practice applied to other fields besides the health sciences, see Simeoni, pp. 158-159.

[15]Information on Mastellari's family is found in A. P. S.M.M.: *Stati d' anima*; 1791-1802, Box 8: Borgo Paglia Sinistra, casa dei P.P. di S. Domenico; see also B.C.A.B.: B. 729: *Alberi geneologici delle famiglie di Bologna del Co. Baldassare Carrati*, Vol. 33, no. 24: Mastellari; B.C.A.B.: B. 905: *B. Carrati--Matrimoni*, T. VI: Parrocchia di S. Maria Maddalena 1792-7 Kal. Junii; A.S.B.: *Archivio dello Studio*, no. 528: Ammissioni: Corso Medico Chirurgico e Farmaceutico (1803-1804), fasc. 66, li 20 dicembre 1803 Anno II della Repubblica Italiana; Canonici Fachini appeared to confuse Mastellari with Dalle Donne, see Canonici Fachini, p. 244; for Riviera's female students see Gaetano Gandolfi, *Elogio di Tarsizio Riviera*, (Bologna: U. Ramponi, 1806), p.XIII.

[16]For her admission to the faculty and her exams and degree see A.S.B.: *Archivio dello Studio*, no. 528, fasc. 6; A.S.B.: *Archivio dello Studio*, no. 435; Elenco delle ammissioni e dei gradi...; A.S.B.: *Archivio dello Studio*, no. 438: Registro dei laureati e graduati nella Nazional Università nella Facoltà Medica dalli 18 giugno 1804 anno 3 a tutti li 21 dicembre 1811, medici; A.S.B.: *Archivio dello Studio*, no. 445: Registro dei risultati degli esami di lauree mediche 1804-1806; A.S.B.: *Archivio dello Studio*, no. 446: Registro dei risultati degli esami di lauree mediche 1806-1809; for her absence from lists of qualified physicians see A.S.B.: *Archivio dello Studio*, n. 450: Registro dei diplomati nelle arti salutari 1801-1824, medici; A.S.B: *Archivio dello Studio*, no. 451: Elenco degli abilitati...1802-1821. My definition of *Materia medica* is a sixteenth-seventeenth century definition of the term. I do not know what the early nineteenth-century course

encompassed, the text used then was a translation of Cullen, *Trattato di materia medica* see Findlen, *Possessing Nature...*, p. 245; Simeoni, p. 162.

[16]For Ferretti's degree and licence to practice see letter from November 20, 1808 in A.S.B.: *Archivio dello Studio*, no. 566: Esami di corso di lauree mediche e chirurgiche e gradi farmaceutici-droghieri 1808-1809, Fasc.: Ferretti Zaffira; A.S.B.: *Archivio dello Studio*, no. 574: Esami 1809-1810: Libere pratiche di medicina, chirurgia e farmacia, fasc. 6; for her father school at Bagnacavallo see Francesco Ferretti's letter of September 12, 1800 in B.G.T.B.: Archivio 1806: *Istruzione pubblica e sanità*, C. 19, Sanità no. 10; see also document no. 930: April 30, 1812 from P. Vitelloni to Ferretti in B.G.T.B.: Archivio 1812, Carteggio: *Sanità*, C.61; most of the information comes from Maria Petraccini Ferretti's book; however, she does not mention the university from which she received her degree, that information comes from Canonici Fachini, and I do not know if it is accurate, see Maria Ferretti, *Memorie per servire alla fisica educazione de' bambini offerte al merito singolarissimo della nobile donna Contessa Barbara Papini-Corbici da Maria Ferretti Bagnacavallese*, (Ferrara: G. Rinaldi, 1789), pp. IV, VI, , X, XIII, XVIII-XIX, XXI-XXIII, XXIX-XXXVI; Rousseau , *Emile* (Bloom translation), pp. 40-61.

[18]Ferretti's documentation for her exam and degree are found all in A.S.B.: *Archivio dello Studio*, no. 566, see particularly the dispatch from Milan from September 19, 1808 and her petition to the university; see also dispatch no. 3498 from Milan in A.S.B.: *Archivio dello Studio*, no. 446: Registro dei risultati degli esami...1806-1809, Ferretti Zaffira; for the program of vaccination see B.G.T.B.: Archivio 1806: *Istruzione pubblica e sanità*, C. 19: Sanità: Letter by the Podestà Graziani of May 20, 1806.

[19]For her exam and results see document dated Bologna 14 novembre 1808 and dispatch no. 2130 in A.S.B.: *Archivio dello Studio*, no. 566, fasc.: Ferretti Zaffira. In France revolutionary reforms had made surgery predominate over medicine, and that appears to have been also true of Bologna, where a year of practice was required before the physician received his licence to practice; Dalle Donne did not have to do her practice, but defend new sets of theses; for France see Gelfand, p. 187; Simeoni, p. 158.

[20]The documentation for Ferretti's licence to practice, including her exam are in A.S.B.: *Archivio dello Studio*, no. 574, 1809-1810: Libere pratiche...; Simeoni, pp. 135, 156, 165, 169, 190.

[21]See Zaffira Ferretti's letter from July 31, 1812 to the Podestà of Bagnacavallo and dispatches no. 1074, 1606, 930 and 419 in B.G.T.B.: Archivio 1812, Carteggio: *Sanità*, C.61; Canonici Fachini, pp. 216-17.

[22]Sabbattina changed her name to Sabina after the first child of her mother and stepfather was born, while she was still living with her mother in 1794. By 1795 she had moved to the Putte dei Mendicanti, but continued to be registered with her family in the *Status animarum*, with a statement that she lived in the orphanage. Her sister Gertrude, six years younger than Sabina, was also placed in an orphanage, but a different one, when

she reached the age of twelve. Parrocchia di S. Maria delle Muratelle di Bologna: *Status animarum* 1785-1800, Via Collegio di Spagna, no. 370, Casa delle M.M. Della SS.ma Trinità.

[23]A.S.B.: *Archivio dell Studio*, no. 295: Acta Collegiorum medicinae et Philosophiae 1789 ad 1798, April 14, 1796 and April 1796 , no. 8; A.S.B.: *Archivio dello Studio*, no. 306: Diario Rusconi 1790-1800 , 28 Apri. h. 16½, anno 1796 for the ceremony, p. 26.

[24]Baldoncelli's documentation, as well as all her teachers' certificates of her studies, and the actual examination are in A.S.B.: *Archivio dello Studio*, no. 549: Esami di corso, gradi e lauree in Medicina, Chirurgia e Farmacia 1806-1807, fasc. no. 15; Simeoni, p. 158; see the plans for the university in 1819 for an idea of what was taught in the two years course needed to achieve the degree in A.S.B.: *Archivio dello Studio*, no. 874, Capsula D, Fasc. no. 1.

[25]See dispatch no. 1830 / 431: Milan, June 16, 1807 in A.S.B.: *Archivio dello Studio*, no. 549, fasc. 15.

[26]The documentation for her licence to practice are in A.S.B.: *Archivio dello Studio* no. 567: Esami 1808-1809: Libere pratiche in Medicina, Chirurgia e Farmacia, Fasc. no. 1.; for the appearance of her name in the printed lists of qualified pharmacists see A.S.B.: *Archivio dello Studio*, no. 451: Elenchi degli abilitati ad Arti salutari...(1802-1821); A.S.B.: *Archivio dello Studio*, no. 847: Elenchi degli abilitati alle Arti salutari 1824 al 1829; Baldoncelli's name does not appear in the 1829 list, only her teacher Trippi; this list was far from complete, and her name was passed over as an oversight. Her name and her teacher's are in the 1833 list. By 1846 both disappeared from the lists.

[27]Her documents are found in A.S.B.: *Archivio dello Studio*, no. 629 (1817-1818): Gradi di Medicina e Chirurgia, Farmacia, Veterinaria, Infime Operazioni, Fasc. 50; see also A.S.B.: *Archivio dello Studio*, no. 435: Elenco delle ammissioni...1800-1824.

[28]Maria Zanotti, " Giuseppina Cattani e la ricerca battereologica sul tetano ", *Alma Mater Studiorum...*, pp. 175-180. There might have been women receiving degrees in other scientific fields from the University of Bologna prior to 1874 of whom we are simply not aware. Once again one is faced with the daunting task of looking through each individual file for each scientific subject for each scholastic year from 1825 to 1874. From the surviving lists of the period, which might have been incomplete, no other degrees were allotted to women in any field see "Allegato: elenco di figure femminili collegate alla Storia dell' Università di Bologna", *Alma Mater Studiorum*, pp. 207-214, particularly note 3 on page 213.

[29]Mastellari might have never intended to use her degree, but since the documentation which would include her petition,and the permission granted was lost for the year 1805-1806, and the information I have used was taken from alternative sources, we do not know if that was the case, or whether she was not allowed to take her practice year by the government at Milan. See Rodati's letter no. 5 to Nicola Fabri of May 4, 1789 in

B.C.A.B.: B. 309; Gelfand, pp. 131-91. For the unlicenced women healers at Bologna prior to the French occupation see Pomata, pp. 151-83.

[30]Simeoni, pp. 179-80.

Conclusion

The survey of Italian women in science undertaken here, which covers, in general terms, a period ranging from the Middle Ages to 1874, clearly illustrates that Mozans's picture of an Italy in which women were awarded university degrees and lectureships is too rosy indeed. Yes, women were awarded the occasional degree, but their education, usually at par with men, was given privately. One cannot find a single woman, whom one can say with certainty had attended regular classes at a university prior to 1874. It is true that lectureships were awarded, but, if the woman decided to teach, her teaching was done at home on a regular basis, or given publicly at the university only occasionally and always when requested by the university administration, as Bassi's case illustrates so well. Eventually, Bassi and Roccati were able to teach publicly at Institutes of Sciences. These institutes may have been associated with universities, as, for instance, the Bologna's Institute of Sciences was, but they were also relatively new institutions with no tradition of excluding women. In a similar vein, women who had given proof of being active in the sciences were made members of academies of sciences, and were able to participate at their public meetings, because literary and philosophical academies, from which various scientific academies would spring, had not been completely adverse to welcoming women in their midst; it makes sense that the scientific academies would follow suit.

Often enough women would come to their initial scientific education involuntarily: fathers, brothers, husbands and teachers used the scientific education of their women relatives, or students to further their own interests. However, whether a woman would continue to pursue the sciences later in life was not solely dependent on social circumstances, but also on

her own interests. The Manfredi sisters were learned in astronomy, not because they particularly loved the subject, but because their astronomer brother needed assistants in his research. Anna Morandi Manzolini became an expert anatomist not due to an initial interest on the subject, but because her husband needed help in his work. Had Francesco Ferretti had another profession, it is unlikely that Zaffira Ferretti, and her mother would have been surgeons of their own accord. Bassi did not choose her initial education, neither did Roccati, Ardinghelli or Agnesi. Ardinghelli and Roccati loved science, but the careers they were able to follow were determined by the places in which they practiced their science. The scientific career Bassi was able to follow after her degree was due, to a great extent, to her determination to succeed. For all her mathematical talents, and the opportunity Benedict XIV offered her to continue to pursue them, Agnesi chose to retire from all kinds of scientific activities after her father's death, her interests lay elsewhere.

To see Italian women's learning in the sciences, degrees, memberships to scientific academies, and university lectureships solely as the product of the Enlightenment is to ignore the role tradition played in their scientific education, in the granting of degrees, memberships and lectureships, and even in the scientific activities some women felt they were entitled to follow. Both male teachers and their female students were aware, and believed that Italian learned women of centuries past had been systematically introduced to some natural philosophy and mathematics, and therefore there was no reason why they should not be in the present, if the woman was exceptional, and raised above her sex. In fact, the myth of the exceptional woman, allowed certain women to go further than the rest of their sex, and even conservative men tolerated their pursuits. When attempting to found her own scientific academy, Borromeo mentioned as a precedent Veronica Gambara's philosophical academy at

Correggio. The belief Benedict XIV had that women had played a role at the University of Bologna in past centuries was pivotal in his decisions that they should do same in the eighteenth-century, as his letter to the Bologna Senate at the time of the granting of a lectureship to Agnesi clearly illustrates. There were plenty of women who had received some level of scientific education in the past. The science to which they were exposed depended on the century in which they lived. Some knowledge of Aristotelean-Ptolemaic cosmology, of Pliny's *Natural History*, and of the medicinal properties of various plants was fairly widespread in the past. Women who had studied mathematics, astronomy, philosophy, logic and/ or mechanics were rarer, but they existed nevertheless, and women like Bassi and Caminer Turra were perfectly aware of them. These learned women of the Renaissance and Baroque provided an excuse for their eighteenth-century sisters to move forwards in their chosen paths. However, tradition played less of a role in the scientific publications eighteenth and nineteenth centuries women increasingly produced. These publications were the result of the increased popularity of the sciences, the number of journals which catered to scientific articles, and the specialization of many scientific subjects in the nineteenth-century. Women of past centuries wrote little on exclusively scientific subjects. After all scientific subjects were only a small part of most of those women's education, and, usually, not an important part of it.

Not to come to terms with the women's scientific knowledge is to present an incomplete picture of their lives. Such a study indicates that there were more women receiving some kind of scientific education than previously thought, than the women's surviving publications indicate, or this thesis has covered. If anything this thesis has shown that scientific material entered convents, of which we know very little. The study has also shown that, as generally

known, throughout the centuries, women were followers, and not leaders, of scientific trends. However, there were some notable exceptions at local and national levels. Scarpellini was the only scientist in Rome to carry out ozonometric measurements, and the first one in Italy to publish a meteor catalogue. Agnesi's *Instituzioni analitiche* was the first textbook of its kind to come out of Italy. Morandi's discovery of the extension of the inferior oblique muscle of the eye beyond the nasal apophysis continued to be attributed to her in the nineteenth-century. Bassi's school of experimental physics, provided with an extensive cabinet, and given on a daily basis during the scholastic year, was far more relevant to eighteenth-century physics' education than the classes on the subject given at the Institute of Sciences. The school attracted students from across Italy and from abroad. In addition, Bassi's work on deviations from Boyle's Law remained relevant more than a century after its publication. Fiorini Mazzanti was the first Italian to publish a work entirely dedicated to mosses. Her work on *nostoc* and *collema* preceded similar works on the subject coming out of Germany, and her morphological studies of the lichen was at par with German works. These examples illustrate that Italian women were not simply followers of scientific trends, but that some of them could also be leaders in the Italian context.

Abbreviations

A.A.B. = Archivio Arcivescovile di Bologna
A.A.P.N.L. = Atti dell' Accademia Pontificia dei Nuovi Lincei
A.A.S.B. = Archivio dell' Accademia delle Scienze di Bologna
A.C.R = Accademia dei Concordi di Rovigo
A.E.A.G.F. = Accademia Economico-Agraria dei Georgofili di Firenze
A.P.S.M.M. = Archivio della Parrocchia di Santa Maria Maddalena
A.S.B. = Archivio di Stato di Bologna
A.S.I.A.U.B = Archivio della Specola dell' Istituto di Astronomia dell' Università di Bologna
A.S.M.N.F. = Archivio di Santa Maria Novella di Firenze
B.A.V. = Biblioteca Apostolica Vaticana
B.C.A.B. = Biblioteca Comunale del Archiginasio di Bologna
B.C.A.M.B. = Biblioteca Civica Angelo Mai di Bergamo
B.C.B.G. = Biblioteca Civica di Bassano del Grappa
B.C.B.Ge. = Biblioteca Civica Berio di Genova
B.C.F. = Biblioteca Comunale di Foligno
B.C.V.J.U. = Biblioteca Civica V. Joppi di Udine
B.G.R. = Biblioteca Gambalunga di Rimini
B.G.T.B. = Biblioteca G. Taroni di Bagnacavallo
B.M.C.V. = Biblioteca del Museo Correr di Venezia
B.M.S. = Bibliothèque Municipale de Soissons
B.N.C.V.E.R. = Biblioteca Nazionale Centrale Vittorio Emanuele II di Roma
B.N.F. = Biblioteca Nazionale di Firenze
B.O.P. = Bibliothèque de l' Observatoire de Paris
B.P.B. = Biblioteca Putti di Bologna
B.R.F = Biblioteca Riccardiana di Firenze
B.U.B = Biblioteca Universitaria di Bologna
B.U.G. = Biblioteca Universitaria di Genova
Collez. Aut. = Collezione Autografi
Commentarii = *De Bononiensi Scientiarum et Artium Instituto atque Academia Commentarii*
C.S. = Corrispondenza Scientifica
D.B.I. = Dizionario Biografico degli Italiani
D.S.B. = Dictionary of Scientific Biography
E.L = Europa Letteraria
G.E. = Giornale Enciclopedico
N.G.E. = Nuovo Giornale Enciclopedico
N.G.E.I. = Nuovo Giornale Enciclopedico d' Italia
O.P.D.B.B. = Opera Pia Davia-Bargellini di Bologna
P.A.S.C.V. = Pontificia Academia Scientiarum della Città del Vaticano
R.A.F.S.R = Rubiconia Accademia dei Filopatridi di Savignano sul Rubicone

BIBLIOGRAPHY

Primary Sources:

Manuscript Material:

A.A.B.: *Libro dei Battezzati,* anni 1689, 1738, 1745.

A.A.B.: *Status animarum:* Parrocchia S. Nicolò degli Albari, 1735-1741, Parrocchia di San Barbaziano, 1738-1778, Parrocchia di San Lorenzo di Porta Stiera, 1732..

A.A.S.B.: *Catalogo de' lavori dell' Antica Accademia raccolti sotto I singoli autori.* Piani, Domenico ed.: 15-17, 137-38.

A.A.S.B.: *Dissertazioni*: De Martino Pietro : December 11, 1732.

A.A.S.B: Tit. II, sez I: *Lettere ricevute.*

A.C.R.: *Angeli Niccola--Lezioni Accademiche no. 10*

A.C.R.: *Manifesti con elenco soci e lezioni accademiche.*

A.C.R.: *Ms. Concordiana* 250: Giornale dell' Accademia dei Concordi 18 gennaio 1697-12 ottobre 1793.

A.C.R.: Collez. Aut. *Ms. Conc.* 376, lettere B, C: Caminer Turra Elisabetta.

A.C.R.: *Ms. Concordiana* 381 (109): Roccati Cristina no. 46 lettere, con 8 poesie...

A.C.R.: *Ms. Silvestriana* 195: Lettere di Cristina Roccati a Girolamo Silvestri.

A.C.R.: *Ms. Silvestriana* 203: Lettere 177 autografe a Cristina Roccati.

A.C.R.: *Ms. Silvestriana* 381: Index librorum latinorum Joa. Baptistae Roccati Rhodig. Anno...1749.

A.C.R.: *Raccolta Concordiana* 338 / 50: Grillo-Borromeo, Cont. Clelia di Milano

A.C.R.: *Raccolta Concordiana* 360/ fasc. 32, pos. 10/II, 12/II, 17/I.

A.C.R.: *Roccati Cristina--Lezioni Accademiche no. 51.*

A.E.A.G.F.: *Archivio storico:* Inventario 1753-1911, Vol. 4: Indice alfabetico. Firenze, 1917.

A.E.A.G.F.: *Archivio storico:* Busta 37, no. 5149: Partecipazione della morte di Elisabeta Fiorini Mazzanti.

A.E.A.G.F.: *Archivio storico:* Busta 81, ins 1378: 5 settembre 1852, cc. 6: " Memoria letta dalla sig. Contessa Elisabetta Fiorini di Roma, socia corrispondente, nell' adunanza ordinaria del di 5 7bre 1852 "

A.P.S.M.N.: *Status animarum dal anno 1734 al 1752; 1791-1802 .*

A.S.B.: *Archivio Aldrovandi Marescotti*, Busta no. 430: Inventario delle macchine componenti il gabinetto già appartenente alla signora dottoressa Laura Bassi Veratti...

A.S.B.: *Archivio Bentivoglio Manzoli*, serie II, no. 101, fasc. 26.

A.S.B.: *Archivio dello Studio:* Collegio di Medicina, nos. 213, 214, 228, 235, 236, 295, 306 : Diario Rusconi.

A.S.B.: *Archivio dello Studio:* no. 435: Elenco delle ammissioni e dei gradi conferiti dalla Università di Bologna 1800-1824; no. 438: Registro dei laureati e graduati ...Facoltà Medica...giugno 1804...dicembre 1811, medici; no. 445: Registro dei risultati degli esami di lauree mediche 1804-1806; no. 446: Registro dei risultati degli esami di lauree mediche 1806-1809; no. 450: Registro dei diplomati nelle arti salutari 1801-1824, medici..

A.S.B.: *Archivio dello Studio*: no. 451: Elenchi degli abilitati ad arti salutari nella Provincia di Bologna (1802-1821); no. 847: Elenchi degli abilitati ad arti salutari 1824 al 1859.

A.S.B.: *Archivio dello Studio*: no. 468: Titolo II, Musei e Stabilimenti Scientifici.

A.S.B.: *Archivio dello Studio*: Esami...Infimi operazioni: nos. 550 (1806-07), 557 and 558 (1807-08), 567 (1808-09), 573 (1809-10), 580 (1810-11), 588 (1811-12), 597 (1812-13), 603 (1813-14), 610 (1814-15), 618 (1815-16), 623 and 624 (1816-17), 629 (1817-18), 634 (1818-19), 640 (1819-20), 647 (1820-21), 655 (1821-22), 663 (1822-23), 673 (1823-24), 993 (1824-25), 1005 (1825-26), 1015 (1826-27), 1027 (1827-28), 1039 (1828-29), 1051 (1829-30), 1060 (1830-31), 1070 (1831-32), 1082 (1832-33), 1097 (1833-34), 1111 (1834-35), 1121 (1835-36), 1137 (1836-37), 1153 (1837-38), 1167 (1838-39), 1182 (1839-40), 1196 (1840-41), 1208 (1841-42).

A.S.B.: *Archivio dello Studio*: no. 549 (1806-1807): Esami...medicina, chirurgia, farmacia; no. 566: Esami ... lauree mediche, chirurgiche e gradi farmaceutici 1808-1809; no. 567: Esami (1808-1809): Libere pratiche in medicina, chirurgia, farmacia; no. 574: Esami (1809-1810): Libere pratiche di medicina, chirurgia e farmacia..

A.S.B.: *Archivio dello Studio*: no. 874, 1824-1831, Capula D, fasc. 5: " Projetto di regolamento per l' approvazione delle levatrici "

A.S.B.: *Archivio dello Studio*: no. 915: 1824-1859, Titolo 2o., Funzionari e Impiego.

A.S.B.: *Assunteria di Istituto*, Serie: Diversorum, Busta 9: no. 1 e no. 18 : Accademia Benedettina; Busta 10: Anni 1771-1777, Camere e materiale scientifico, fasc. 3 e fasc. 5; Busta 13: Anno 1800; Busta 15: no. 42.

A.S.B.: *Assunteria di Studio*, Serie: Atti: Vol. 23: anni 1735-43; Vol. 24: anni 1744-1752.

A.S.B.: *Assunteria di Studio*, Serie: Requisiti dei lettori, Busta 57: (1738), (1743).

A.S.B.: *Legazione e Prefettura di Bologna*, T. 13; Istruzioni., R. 11, 1804, parte 1a.

A.S.B.: *Senato*, Serie: Diario, anni 1714-1741.

A.S.B.: *Senato*, Serie: Partiti, Vol. 35, Vol. 39.

A.S.B.: *Senato*, Serie: Vacchetoni, Registri: no. 60 (1732); no. 68 (1750); no. 69 (1753-55); no.71 (1759-60-61); no. 79 (anno 1776).

A.S.I.A.U.B.: *Eustachio Manfredi: Introductio in Ephemerides*, Cartone VI.

A.S.M.N.F.: *Diario dall' anno 1575 fino all' anno 1586 e varie memorie, Suor Fiammetta Frecobaldi.*

B.A.V.: *Autografi Patteta*: cart. 45: Lettere di Laura Bassi a P. Beccaria; cart. 48: Lettere di P. Beccaria a Laura Bassi e Giuseppe Veratti.

B.A.V.: Barb. Lat. 245: *Don Joseph de Triplici Figura Demonis, Cacodemonis et Coelesti auctore Don Joseph de Tertiis ad Illustrissimam et Eccellentissimam Madamam Colonnam.*

B.A.V.: Vat. Lat. 9036: *Lettere a Giovanni Amaduzzi.*

B.C.A.B.: B. 43: *Miscellanea di cose spetanti a Bologna.*

B.C.A.B.: B. 120: *Lettere di diversi a Marcello Oretti*

B.C.A.B.: B. 159: *Lettere a Giampietro Zanotti.*

B.C.A.B.: B. 160: *Lettere di diversi a Francesco Maria Zanotti,*

B.C.A.B.: B. 163: *Lettere famigliari e a diversi di Giampietro Zanotti.*

B.C.A.B.: B. 178 I: *Lettere di Eustachio Manfredi a diversi e alcune rime.*

B.C.A.B.: B. 198: *Lettere di Eustachio Manfredi a Giampietro Zanotti.*

B.C.A.B.: B. 309: *Clarorum virorum ...Epistolae.*

B.C.A.B.: B. 317: "Memoria di Madama Colonna ", Cartaccio in fol. della seconda metà del sec. XVIII.

B.C.A.B.: B. 382: *Lettere di Giampietro Zanotti al Padre Giampietro Riva.*

B.C.A.B.: B. 517: *Amadei, Gio: Giacomo.* Libro delle cose che vanno accadendo in Bologna...

B.C.A.B.: B. 709, Vol.12, no. 72: Manfredi; B. 728, Vol. 32: no. 92: Manfredi; B. 729, Vol. 33, no. 24: Mastellari: *Alberi geneologici delle famiglie di Bologna del C. Baldassare Carrati.*

B.C.A.B.: B. 905: *B. Carrati--Matrimoni.*

B.C.A.B.: B. 917: *Necrologia di Bologna.*

B.C.A.B.: B. 2024: *Lettere autografe scritte da illustri italiani e stranieri alla celebre dottoressa bolognese Laura Maria Caterina Bassi e al marito di lei Giuseppe Veratti.*

B.C.A.B.: B. 2727: *Pubblica Accademia di lettere avutasi nel Collegio Montalto...*

B.C.A.B.: Collez. Aut.: VI: 1614-1628; VI: 1710-1739; VI: 1741-1754; VIII: 2254-2328; X: 3016; XII: 3666-3764; XII: 3827; XVI: 4705-4722; XXIII: 6546-6778; XXIX: 7992-8054; XXXVII: 10.054; LXVI: 17.923-17.963; CV: 23. 843; CVIII: 24.111.

B.C.A.B.: *Bassi Laura*: Due cartoni contenendo autografi, scritti e documenti biografici, diplomi ed elogi della Bassi. Sec. XVIII.

B.C.A.B.: Mss. *Gozzadini* 87-17: Le geste di alcune donne letterate Bolognesi...

B.C.A.B.: *Ms. Scarselli* , I, 3-17.

B.C.A.B.: *Ms. Tognetti*: *Notizie e scritti riguardanti Francesco Albergati.* Cartone III.

B.C.A.M.B.: *Archivio Calepio, Carteggio dal 1749 ottobre 22 al 1763 novembre.* Vol. II: Lettere di Clelia Grillo Borromeo a Pietro Calepio.

B.C.B.G.: *Epistolario di Giambattista Brocchi*, II. 22. 599-609: Lettere di Elisabetta Fiorini.

B.C.B.G.: *Epistolario Gamba:* IV. C. 17.613, V. A. 43, XVI. A. 3, XVI. A. 26: lettere 2520-22.

B.C.B.Ge.: M.R. VII. 5. 8: *Catalogo de' libri bottanici legato della Msa. Clelia Durazzo Grimaldi alla Biblioteca Civica Berio, 1837.*

B.C.F.: M 21/11: *Lettere di Caterina Scarpellini 1865-1867.*

B.C.V.J.: Ms. 1025: *Commercio di lettere del Co. Giordano Riccati,* Vol. I and Vol. II.

B.G.R.: Fondo: *Gambetti:* Posizione: Agnesi Mariani Maria; Posizione: Bassi Verati Laura; Posizione: Davia Bentivoglio Laura; Posizione: Leprotti; Posizione: Manzolini Morandi Anna e Manzolini Giovanni.

B.G.R.: Sc. Ms. 962: *Lettere autografe del Dott. Giovanni Bianchi a Leprotti dal 1717 al 1732.*

B.G.R.: Sc.Ms. 963: *Lettere autografe di Giovanni Bianchi a Mons. Leprotti 1733 al 1745.*

B.G.R: Sc.Ms. 965: *Janno Planco. Minute di lettere di anno incerto e dal 1717 al 1730.*

B.G.R.: Sc. Ms. 966: *Giano Planco. Minute di lettere dal 1731 al 1760.*

B.G.R.: Sc. Ms. 967: *Giano Planco. Minute di lettere dal 1728 al 1735.*

B.G.T.B: Archivio 1806: *Istruzione pubblica e sanità*, C. 19, Sanità no. 10.

B.G.T.B: Archivio 1812, Carteggio: *Sanità*, C. 61

B.M.C.V.: *Epistolario Moschini*: Lettere di Agnesi Mariani, Maria a P. Jacopo Maria Paitoni.

B.M.C.V.: *Raccolta Cicogna 3195-3196:* Epistolario G.M. Ortes, lettere a lui dirette, B.5

B.M.S.: Mss. no. 150: Jean Antoine Abbé Nollet, *Journal du Voyage de Piemont e d' Italie en 1749.*

B.N.F.: *Conventi sopressi,* C.2.504: Frescobaldi Suor Fiammetta, " Prato fiorito nel quale come risplendenti fiori sono poste molte attioni eroiche, ca. 1575 ".

B.N.F.: Ms. Tordi 542, 14: *Caminer Turra Elisabetta, lettere no. 2.*

B.O.P.: Lettres Autographes A B 4-11.

B.P.B.: *Autografi di medici:* Raccolta di Vittorio Putti, Cat. 135: Manzolini Giovanni: Dissertazione.

B.R.F.: *Carteggio Giovanni Lami*, Vol. 3, seg 370, f. 76.

B.U.B: *Aldrovandi* Ms. 35, XII: Lettera di Ulisse Aldrovandi a Mons. Teseo Aldrovandi (1576).

B.U.B.: *Aldrovandi* Ms. 96: Ulyssis Aldrovandi Lexicon rerum inanimetarum, Volumi 5.

B.U.B.: *Aldrovandi* Ms. 110: I-III: Catalogus virorum....

B.U.B.: Ms. 79 A, Vol. I: *Eruditorum epistolae ad Marsilium*, XII, 119.

B.U.B.: Ms. 80 A, Vol. II.

B.U.B.: Ms. 80 B: *Libro di moltissime lettere scritte l' año 1702 al G. Marsili da più soggetti*, no. 60.

B.U.B.: Ms. 279, no. 32: *Lettera scritta al Senato di Bologna dal Papa Benedetto XIV* (1750).

B.U.B.: Ms. 770: *Memorie antiche manoscritte di Bologna et accresciute sino ai tempi presenti del Canonico Antonio Francesco Ghiselli, Nobile Bolognese*, Vol. XXXIV-LXXXX, (1663-1724).

B.U.B.: Ms. 2086: *Carteggio Ranzoni*, lettere A-B, no. 37.

B.U.B.: Ms. 2096: *Lettere a Sebastiano Canterzani*, Busta I, Busta V

B.U.B.: Ms. 2193: *Catalogo delle reproduzioni anatomiche in cera formanti il gabinetto anatomico primo della Reggia Università. Anna Morandi Manzolini.*

B.U.B.: Ms. 3832: *Diario di ciò che va succedendo giornalmente in Bologna del di 7 agosto 1750 al tutto di 1754 scritto di nuovo da Ubaldo Zanetti.*

B.U.B.: Ms. 4143, Caps IX: *Manoscritti di Sebastiano Canterzani*, no. 3.

B.U.B.: Ms. 4174, Caps XLVIII: *Manoscritti di Sebastiano Canterzani.*

B.U.B.: Ms. 4183, Caps LVIII, no. 2: *Notizie biografiche scritte da F.M. Zanotti.*

B.U.B: Ms. 4186, caps. LXI: *Manoscritti di Sebastiano Canterzani.*

B.U.B.: Ms. 4207: Montefani Caprara, *Delle famiglie bolognesi*, Vol. XXIX.

B.U.G.: Msc. VI. 36: *Coppia di lettere (7) esistenti nella R. Biblioteca Universitaria di Pavia della March. Clelia Durazzo Grimaldi al Pa. Nocca Domenico.*

O.P.D.B.B.: *Archivio della famiglia Davia:* Inventario della Biblioteca Davia fatto l' anno 1741.

O.P.D.B.B: *Archivio della famiglia Davia:* 1769 Davia Index librorum Bibliotheca Deviana seu Index librorum.

Parrocchia dei SS. Francesco e G.V.M. in Rovigo: no.8: *Morti dal 1746 al 1803.*

Parrocchia di S. Maria delle Muratelle di Bologna: *Status animarum 1785-1800.*

Parrocchia di S. Procolo di Bologna: *Status animarum 1765-1774.*

P.A.S.C.V.: " Fiorini Mazzanti Elisabetta "

R.A.F.S.R: *Lettere a Giovanni Amaduzzi,* Vol. I.

Published Material:

" Adunanza ordinaria del di 5 settembre 1852 ", *Rendiconti delle adunanze della R. Accademia Economico-Agraria dei Georgofili di Firenze*, Vol. I-triennio I, An. 1851-52-53. Florence: Galileiana, 1853.

Agnesi, Maria Gaetana. *Instituzioni Analitiche ad uso della gioventù italiana di Dna. Maria Gaetana Agnesi Milanese dell' Accademia delle Scienze di Bologna.* T. I e II. Milan: Regia Ducal Corte, 1748.

_____ *Propositiones philosophicae. Maria Gaetana de Agnesis.* Milan: Richini, 1738.

Aldrovandi, Ulisse. *De Reliquis animalibus exanguibus libri quator, post mortem eius editi. Nempe de mollibus, crustaceis, testaceis, et zoophytis. Ad illustrissimum Senatum Bononiensem.* Bologna: Battista Bella Gamba, 1606.

Alfò, Ireneo. " Diego Pascal " in *Memorie degli scrittori e letterati parmigiani raccolte dal Padre Ireneo Alfò.* T.VII. Parma: Ducale tipografia, 1833.

Algarotti, Francesco. " Dialoghi sopra l' ottica Newtoniana ' in *Illuministi italiani*, T. II: *Opere di Francesco Algarotti e di Saverio Bettinelli*, Ettore Bonora ed. Milano: R. Riccardi, 1969.

Amoretti, Carlo. " Elogio letterario del Sig. Alberto Fortis ", *Memorie di matematica e di fisica della Società Italiana delle Scienze*, T. XIV, parte 1a. (Venice 1809), pp. XVII-XXVI.

" Anonymae Napoletanae problemata mathematica ", *Nova Acta Eruditorum*, (January 1734), Lipsia, pp. 28-34.

Antoniano, Silvio. *Tre libri della educatione christiana dei figliouli.* Verona: S. dalle Donne e G. Stringari, 1584.

Aristotele. *Opere*, 3: *Del cielo*, tr. Oddone Longo; 5: *Parti degli animali. Riproduzione degli animali*, tr. D. Lanza and M. Vegetti. Bari: Laterza, 1990.

Aristotle. *The Works of Aristotle*, Volume I: " On Interpretation ", tr. A. J. Jenkinson, " Posterior Analytic ", tr. G.R.G. Mure in *Logic*; *Metaphysics*, tr. W. D. Ross.; *Physics*, tr. R. P. Hardie and R.K. Gaye. Chicago: William Benton, 1952.

Argelati, Philippi Bononiensis. *Bibliotheca scriptorum mediolanensium seu acta et elogia*. Tomus primus. Milan: Palatini, 1745.

Atti dell' Accademia Pontificia dei Nuovi Lincei. Rome, Vol. 6-7: (1852-1854) to Vol. 32-33 : (1878-1880).

Atti della Reale Accademia dei Lincei pubblicati conforme alle decisioni accademiche del 22 dicembre 1850, T. XXIV (1870-1871), pp. V-VI, 125-28, T. XXVI (1872-1873), p. 568.

Avvisi di Bologna, no. 8, 25 febbraio 1778.

Azzoguidi, Germano. " Medicinae in Academia Bononiensi professori: observationes ad uteri constructionem pertinentes " in *Opuscula anatomica selectione.* Lugduni Batavarum: J. Luchtmans, 1788.

Bacchini, Benedetto. *Helenae Lucretiae (Quae & Scholastica) Cornelae Piscopiae...Opera.* Parma: H. Rosati, 1688.

Barbarigo, Girolamo. " Lettera del P.D. Girolamo Barbarigo...alla Sig. ra Elisabetta Caminer Turra..." *Opuscoli scelti sulle scienze, sulle arti*, T. III (1779), pp. 313- 15

Bargagli, Girolamo. *Dialogo de' giouchi che nelle vegghie senesi si usano di fare.* Siena: Accademia Senese degli Intronati, 1987 (1572).

Bassi, Laura. " De problemate quodam hydrometrico ", *Commentarii*, Vol. IV (1757), pp. 61-73.

_____ " De problemate quodam mechanico ", *Commentarii*, Vol. IV (1757), pp. 74-79.

_____ *D.O.M. Laura Maria Catherina Bassi Civis Bononiensis Academia Instituti Scientiarum Socia Se Suaque Philosophica Studia Humiliter D.D.D.* Bologna: Lellio della Volpe, 1732.

_____ *Theses: De aqua corpore naturale elemento aliorum corporum. Parte universi D.D.D.* Bologna: Lellio della Volpe, 1732.

Beccaria, Giambattista. *Elettricismo atmosferico: lettere di Giambattista Beccaria.* Bologna: Colle Ameno all' Insegna dell' Iride, 1758.

Bergalli, Luisa ed. *Componimenti Poetici delle piu illustri Rimatrici d' ogni secolo raccolti da Luisa Bergalli.* Venice; Amore, 1726.

Bernouilli, Johannis. *Opera omnia.* T. III. Lausanne and Geneva: Bousquet, 1742.

Bertoloni, Antonio. *Elogi del Cavaliere Ippolito Durazzo e della Nobil Donna Clelia Durazzo Grimaldi.* Bologna: S. Tommaso d' Aquino, 1840.

Bianchi, Giovanni. *Breve storia della vita di Catterina Vizzani romana che per ot' anni vesti abito da uomo in qualità di servidore....* Venice: Simone Occhi, 1744.

_____ *De conchis minus notis liber cui accessit specimen aestus reciproci maris superi ad littus portumque Arimini.* Venice: Pasquali, 1739.

_____ " Lettera del Sig Dottor Giovanni Bianchi da Rimino scritta da Bologna ad un suo amico di Firenze ", *Novelle letterarie pubblicate in Firenze*, T. XV (1754), pp. 708-12

_____ *Se il vitto pittagorico di soli vegetabili sia giovevole per conservare la sanità e per la cura di alcune malatie.* Venice: Pasquali, 1752.

Bocage, Anne Marie du. *Recueil des oeuvres de Madame du Bocage*, Vol. 3, Lyon, 1764.

Bonati, Teodoro. *Carteggio scientifico Lorgna, Canterzani, Frisi, Saladini, Calandrelli, Venturi.* Borgato, M.T. et al. eds. Florence: Olschki, 1992.

Brognoli, Antonio. " Elogio della Signora Diamante Medaglia Faini " e " Elogio del P.D. Ramiro Rampinelli " in *Elogi di Bresciani per dottrina eccellenti del secolo XVIII scritti da Antonio Brognoli patrizio bresciano.* Brescia: Vescovi, 1785.

Bronzini, Cristoforo. *Della dignità et nobiltà della donna.* Florence: Pignoni, 1624

Brosses, Charles de. *Le Président De Brosses en Italie. Lettres familières écrites d' Italie en 1739 & 1740, par Charles de Brosses.* Paris: Les oeuvres représentatives, 1929.

Bruni, Leonardo. " De studiis et litteris liber " in *Il pensiero pedagogico dell' umanesimo*, Eugenio Garin ed. Florence: Giuntine e Sansoni, 1968, 147-171.

Budrioli, Andrea, ed. *Rime di poeti illustri viventi.* Faenza: Maranti, 1724.

Buriani, R. " Necrologia della Dottoressa Anna Maria Dalle Donne " in *Almanaco Statistico Bolognese per l' anno 1842. dedicato alle donne gentili.* Bologna: N. Salvardi, 1842.

Caldani, L.M.A. " Sull' insensibilità e irritabilità di alcuni parti degli animali. Lettera scritta al ...Signore Haller..." in *Opuscoli di vari autori raccolti da Giacinto Bartolomeo Fabri.* Bologna S. Tommaso d' Aquino, 1757.

Canonici Fachini, Ginevra. *Prospetto biografico delle Donne Italiane rinomate in letteratura dal secolo decimo quarto fino a ' giorni nostri di G.C.F. con una risposta a Lady Morgan risguardante alcune accuse da lei date alle donne italiane nella sua opra L ' Italia.* Venice: Alvisopoli, 1824.

Capacius, Julius Caesar. *Illustrium mulierum et illustrium letteris virorum Elogia.* Naples: Carlinum et Vitalem, 1608.

Caprieli, Helio. *Chronica de rebus Brixionorum.* Brescia, 1505.

Cartesio. *Opere filosofiche.* 3: *I principi della filosofia.* Bari: Laterza, 1986.

Casali, Gregorio. " De conicarum sectionem facis ", *Commentarii*, Vol. IV (1757), pp. 298-310.

_____ " De ictu pulveris pyrii ", *Commentarii*, Vol. V, pt. 2a. (1767), pp. 357- 71.

_____ " De quorumdum vitrorum fracturis..", *Commentarii*, Vol. V, pt. 2a (1767), pp. 169-85.

Castiglione, Baldassare. *Il libro del cortigiano con una scelte delle opere minori*, Bruno Maier ed. Turin: Unione tipografica-editrice torinese, 1964.

Castracane, Francesco. " Cenni biografici della Contessa Elisabetta Fiorini Mazzanti ", *A.A.P.N.L.*, Vol. XXXII, (1878-1879), pp. 263-88.

Castreca Brunetti, Enrico. " Specimen bryologiae romanae auctore Elisabetta Fiorini Mazzanti...", *Giornale arcadico di scienze, lettere ed arti*, T. XCII (1842), pp. 47-50.

Cenerelli, G. ed. *Lettere inedite alla celebre Laura Bassi scritte da illustri italiani e stranieri con biografia.* Bologna, 1885.

Cereta, Laura. *Laurae Ceretae Brixiensis Feminae Clarissimae Epistolae jam Primum è MS in lucem productae à Jacobo Philippo Tomasini.* Padua: Sebastiano Sarali, 1640.

Chiesa della, Francesco Agostino. *Teatro delle donne letterate con un breve discorso della preminenza e perfettione del sesso donnesco del Signor Francesco Agostino della Chiesa Dottore di Leggi di Saluzzo.* Mondovi: Gio. Gissardi. 1620.

Chioccarelli, Bartholomaei. " Illustres scriptores Regni Napoletani ", Ugo Baldini, Pier Daniele Napoletani eds., *Bollettino di storia delle scienze matematiche*, Anno XI, no. 1, (June 1991), 59-60.

Coconato Rudianti, Marianna di. " Memoria sul grano carbone che i Francesi chiamano *bled noir* e dai contadini milanesi si chiama *grado* ", *Opuscoli scelti sulle scienze, sulle arti*, T. XII (1789), pp. 95-98.

Compagnoni, Giuseppe. *La chimica per le donne.* Venice: G. Pasquali, 1805.

Coronedi Berti, Carolina. " Appunti di botanica bolognese ", *La Rivista Europea*, anno VI, Vol. IV, fasc. I (1875), pp. 36-46.

_____ " Appunti di medicina popolare bolognese ", *Rivista di letteratura popolare*, Vol. I, fasc. I (1877), pp. 1-12.

Corrispondenza Scientifica, Caterina Scarpellini, Erasmo Fabri Scarpellini eds. Rome, 1847-1863.

Cortese, Isabella. *I secreti delle signore di Isabella Cortese nei quali si contengono cose minerali et medicinali artificiose et alchimiche, et molte dell' arte profumatoria appartenenti a ogni gran Signora.* Venice: Nicolà Tebaldini. 1603.

Cosmopolitae, Simonis. *Epistola Apologetica pro Jano Planco ad anonymum Bononiensem.* Rimini: Albertini, 1745.

Dalle Donne, Maria. *Theses ex anatomia, et physiologia depromptae quas defendendas proponit Maria Dalle Donne philosophiae, et medicinae doctrix Bononiensis Academiae Scientiarum Instituti socia.* Bologna: S. Tommaso d' Aquino, 1800.

_____ *Theses ex universa medicina depromptae quas defendendas proponit Maria Dalle Donne.* Bologna: S. Tommaso d' Aquino, 1800.

Danti, Ignazio. *Trattato dell' uso et della fabbrica dell' Astrolabio di F. Egnatio Danti dell' or. di S. Domenico con l' aggiunta del Planisfero del Roias.* Florence: Giunti, 1569.

" De aere compressione ", *Commentarii*, Vol. II, pt. 1a. (1745), pp. 347-53.

" De immixto fluidis aere ", *Commentarii*, Vol. VII (1791), pp. 44-47.

Della Torre, Giovanni Maria. *Scienza della natura di P. Gio: Maria Della Torre C.R. Somasco professore di fisica nel Liceo Arcivescovile, membro della Accademia Reale Napoletana.* Venice: Recinti, 1750.

De Martino, Nicola. *Elementa sectionum conicarum conscripta ad usum Faustinae Pignatelli Principis Colubranensis et Tolvensis Ducatus Haeredis....* Naples : F Mosca, C. Ellice, 1734.

" De re obstetrica--Medicina ', *Commentarii*, T. III (1755), pp. 88-89.

Desa, Massimiliano. *Vita di Helena Cornara Piscopia.* Venice: Casamara, 1687.

Descartes, Renato. *I principi della filosofia di Renato Descartes. Tradotti del francese al confronto del latino in cui l' Autore gli scrisse di Giuseppa Eleonora Barbapiccola tra gli Arcadi Mirista.* Turin: Mainesse, 1722.

Descartes, René. *Les principes de la philosophie écrits en latin par René Descartes et traduits en François par un de ses Amis.* Rouen: Bensongue, 1698.

Diario Bolognese Ecclesiastico e civile l' anno 1777. Bologna, 1777.

Discorsi Accademici di varj autori viventi intorno gli studj delle donne; la maggior parte recitati nell' Accademia de' Ricovrati di Padova dedicati alla Sig.ra Elisabetta Cornaro Foscarini. Padua: Manfrè, 1729.

Doglioni, Nicolò. *L' anno dove si ha perfetto et pieno raguaglio di quanto può ciascun desiderare, si d' intorno alle cose del moto celeste, et elementare, come d' intorno à quele de' tempi et del calendario. Et insegna anco à sapere le Feste mobili e il fà della Luna perfetamente secondo le reforma gregoriana.* Venice: Rampezeto, 1587.

Dondi Orologio, Marchese Antonio. " Lettera del S. Marchese Antonio Dondi Orologio...al P. Gio: Battista de San Martino ", *Opuscoli scelti sulle scienze e sulle arti*, T. XII (1789), pp. 285-88.

Doria, Paolo Mattia. *Ragionamenti di Paolo Mattia Doria indirizzate alla Signora D. Aurelia d' Este, Duchessa di Limatola ne' quali si dimostra la donna in quasi*

che tutte le virtù più grandi non essere dell' uomo inferiore. Francfort, 1716.

Durazzo Grimaldi, Clelia. *Catalogue des plantes cultivées dans le jardin de Madame Durazzo de Grimaldi à Pegli. Département et arondissement de Gènes.* Genoa: Bonardi, 1812.

Euler, Leonhard. *Introductio in Analysin Infinitorum.* Lausanne: Bousquet, 1748.

Europa letteraria, D. Caminer and E. Caminer eds. Venice, 1768-1773.

Fantuzzi, G. *Elogio della Dottoressa Laura Maria Caterina Bassi Verati scritto da Giovanni Fantuzzi. Aggiunsesi un' orazione del Dott. Matteo Bazzani.* Bologna: S. Tommaso d' Aquino, 1778.

_____ *Notizie degli scrittori bolognesi.* Bologna, 1786-89.

Fedele, Cassandra. *Fidelis Cassandrae Venetae Epistolae et Orationes Posthuma numquam antehoc editae I ac Phillipus Tomasinus.* Padua: Francesco Bolzettano, 1636.

Ferretti, Maria. *Memorie per servire alla fisica educazione de' bambini offerte al merito singolarissimo della nobile donna Contessa Barbara Papini-Corbici da Maria Ferretti Bagnacavallese.* Ferrara: G. Rinaldi, 1789.

Fiorini, Elisabetta. " Appendice al Prodromo della Flora Romana ", *Nuovo Giornale de' letterati*, T. XVII: *Scienze*, (1828), pp. 110-32.

_____ " Notizia sopra poche piante da aggiunsersi al Prodromo della Flora Romana ", *Giornale arcadico di scienze, lettere ed arti*, T. XVIII (1823), pp. 161-68.

Fiorini Mazzanti, Elisabetta. " Botanica: Sopra una nuova diatomea ", *A.A.P.N.L.*, T. X (1856-1857), pp. 1-11.

_____ " Cenno sulla vegetazione delle Marmore in una rapida escurzione di luglio...", *A.A.P.N.L.*, T. XXII (1868-1869), pp. 143-44.

_____ " Communicazione sulla malattia del calcino...", *A.A.P.N.L.*, T.XI (1857-1858), pp. 432-36.

_____ " De novis microphyceis...", *A.A.P.N.L.*, T. XIII (1859-1860), pp. 259-60.

_____ " Florula del Colosseo, communicazione della Sig. Contessa Elisabetta Fiorini Mazzanti ", *A.A.P.N.L.*, T. XXVIII (1874-1875), T. XXI (1875-1876), T. XXX (1876-1877), T. XXXI (1877-1878).

_____ " Microficee osservate nell' acque minerali di Terracina...", *A.A.P.N.L.*, T.

XIV (1860-1861), pp. 233-40, T. XVII (1863-1864), pp. 631-33, T. XX (1866-1867), pp. 133-34.

_____ " Nota critica sull' anormalità di un organismo crittogamico della sig. Contessa E. Fiorini Mazzanti ", *A.A.P.N.L.*, T. XXIV (1870-1871), pp. 190-92.

_____ " Nota della Contessa Elisabetta Fiorini Mazzanti, riguardo agli avvertimenti che precedono [sulla crittogama degli olivi...] ", *A.A.P.N.L.*, T. XII (1859-1860), pp. 202-03.

_____ " Osservazione sulla materia colorante delle *Calothrix jantiphorae* e diagnosi di una nuova microficea...", *A.A.P.N.L.*, T. XVII (1863-1864), pp. 101- 03.

_____ " Retificazione di una nuova diatomea ", *A.A.P.N.L.*, T. XV (1861-1862), pp. 83-84.

_____ " Sopra due nuove specie crittogamiche...", *A.A.P.N.L.*, T. XXVII (1873-1874), pp. 101-03.

_____ *Sovra due nuove alghe delle acque albule della Sig.ra Elisabetta Fiorini Mazzanti.* Roma: G. Menaconti, 1857.

_____ " Sovra una nuova specie di *Palmodityon* e sovra un singolare organismo di alga unicellulare...", *A.A.P.N.L.*, T. XVIII (1864-1865), pp. 377-79.

_____ " Specimen bryologia romanae ", *Giornale arcadico di scienze, lettere ed arti*, T. LI (1831), pp. 3-26.

_____ *Specimen bryologiae romanae auctore Elisabetta Fiorini Mazzanti Academiarum Horticult. Bruxellen. Reg. Scientiarum Taurinensis aliorumque socia.* Rome: Crispini Puccinelli, 1841.

_____ " Sulla identità del nostoc con il collema. Osservazioni di Elisabetta Fiorini Mazzanti ", *A.A.P.N.L.*, Vol. XI (1857-1858), pp. 1-0, 103-13.

Fontanelle, B. de. " Eloge de E. Manfredi ", *Histoire de l' Academie Royale des Sciences Année MDCCXXIX*, Paris, 64-65.

Fonte, Moderata. *Il merito delle donne*, Adriana Chemello ed. Venice: Eidos, 198 (1600).

Frisi, Antonio Francesco. *Elogio della Donna Maria Gaetana Agnesi Milanese dell' Accademia dell' Istituto delle Scienze e lettrice onoraria di matematiche nell' Università di Bologna.* Milan: Galeazzi, 1799.

Gadbury, John. *A Diary Astronomical, Astrological, Meteorological for the Year of Grace 1671.* London: Company of Stationers., 1670.

Galen. *On the Affected Parts.* Translated by R. E. Sigel. Basel: S. Karger, 1976.

_____ *On the Usefulness of the Parts of the Body.* Translated by Margaret Tallmage May. Ithaca, N.Y.: Cornell University Press, 1968.

Galilei, Galileo. *Discorsi e dimostrazioni matematiche intorno a Due Nuove Scienze,* Adriano Cerugo e Ludovigo Geymond, eds. Turin: Boringheri, 1958 (1638).

_____ " Discorso intorno alle cose che stanno in su l' acqua ", (1612), *Opere,* Arrigo Pacchi ed. Naples: Rossi, 1969, 69-169.

_____ *Epistolario.* Livorno: F. Vigo, 1872.

_____ *Le Opere.* Edizione Nazionale. Florence: Barbera, 1900.

_____ *Il Saggiatore*, Libero Sosio ed. Milan: Feltrinelli, 1965 (1623).

Galvani, Luigi. *Opere edite e inedite di Luigi Galvani raccolte e pubblicate per cura dell' Accademia delle scienze dell' Istituto di Bologna.* Bologna: Dall' Olmo, 1841.

Gambara, Vittoria. *Le Rime*, Alan Bullock, ed., Italian Medieval and Renaissance Studies, 6. Florence: Olschki, 1995..

Gandolfi, Gaetano. *Elogio di Tarsizio Riviera già Professore di Chirurgia nell' Università di Bologna.* Bologna: U. Ramponi, 1807.

Garin, Eugenio ed. *Il pensiero pedagogico dell' umanesimo.* Florence: Sansoni, 1968.

Gazetta Di Bologna, no. 102 (21 dicembre 1799), pp. 819-20.

Genovese, Antonio. *Autografia, lettere e altri scritti.* Savarese, Gennaro ed.. (Milan: Feltrinelli, 1962.

Gimma, Giacinto. *Idea della storia dell' Italia letterata esposta.* T.II. Naples : F. Mosca, 1723.

Giornale dei letterati pubblicato in Firenze, (1750), T. VI, parte 1a.

Giornale di Roma, (3 aprile 1854), no. 76, 513.

Giornale enciclopedico, Elisabetta Caminer ed. Venice 1774-1777; then Vicenza, 1777-1782; then *Nuovo giornale enciclopedico*. Vicenza, 1782-1789; then *Nuovo giornale enciclopedico d' Italia*. Venice 1790-1797.

Giustiniani, Lorenzo. *Breve contezza delle accademie istitute nel Regno di Napoli.* Naples, 1801.

Gozzi, Gaspare. *La Gazzeta Veneta*, no. LXXXV, (26 novembre 1760), Antonio Nardi ed. Florence: Sansoni, 1967.

Grandi, Guido. *Flores geometrici ex Rhodonearum et Cloeliarum curvarum descriptione resultantes, atque excellentissimae dominae D. Cloeliae Grillo-Borromeae.* Florence : Tartini & Franchini, 1728.

_____ *Sectionum conicarum synopsis d. vir. D. Guidonis Grandis.* Florence: G.P. Giovanelli, 1750.

Grillo, Luigi. *Elogi di liguri illustri.* T. III. Turin: Fontana, 1846.

Grotto, Giuseppe. *Delle lodi della Dottoressa Cristina Roccati. Orazione di Giuseppe Grotto recitata per ordine della letteraria Accademia de' Concordi di Rovigo nell' esequie a lei celebrate nel Tempio della B.V. del Soccorso il di 26 marzo 1814.* Venice: Fracasso, 1815.

Guazzo, Stefano. *The Civile Conversation of M. Steeven Guazzo. The First of Three Books Translated by George Pettie, Anno 1581 and the Fourth by Barth Young, Anno 1586, with an Introduction by Sir Edward Sullivan.* New York: AMS Press Inc, 1967.

Hales, Stefano. *Emastatica o sia Statica degli Animali. Esperienze idrauliche fatte sugli animali viventi del Sig. Stefano Hales della Società Regale delle Scienze, Ministro di Teddington nel contado di Middlesex e Rettore di Farringdon. Tradotto dall'Inglese nel Franzese e commentato dalla Sig. M.A.A. Edizione terza accresciuta e corretta da alcuni errori nelle antecedenti edizioni trascorsi.* Naples: Gaetano Castellano, 1776.

_____ *Esperienze ed osservazioni intorno a' calcoli della vescica, ed i reni, e allo specifico di Giovanna Stefens contro questo male del Signor Stefano Hales della Società delle Scienze, Ministro di Teddington nel contado di Middlesex e Rettore di Faringtón. Aggiuntavi del dottor Hartley altre osservazioni intorno alla stesso soggetto. E due mediche dissertazioni del Sig. Sauvages intorno alla teoria dell' Infiammazione della Febbre. Tradotta nell' Italiano idioma della Sig. M.A.A. e accresciuta e corretta da alcuni errori nelle antecedenti edizioni.* Naples: G. Raimondi, 1756.

_____ *Statica de' vegetabili ed analisi dell' aria. Opera del dottore Stefano Hales della Società Regale delle Scienze. Tradotto dall' Inglese con varie annotazioni.* Naples: G. Raimondi, 1756.

_____ *Statica de' vegetabili ed analisi dell' aria.... Tradotto dall' Inglese....* Naples: Gaetano Castellano, 1776.

Hales, Stephen. *La statistique des vegetaux et l' Analyse de l' air...Ouvrage traduit de l' Anglois par M. De Buffon....* Paris: Debure, 1735.

_____ *Vegetable Staticks.* London: Mc Donald, 1969.

Hecker, Johannes. *Motuum Coelestium Ephemerides ab Anno 1666 ad 1680. Ex observationibus correctis nobilissim. Tychonis Braheri & Joh. Kepleri hypothesibus Physicis Tabulisque Rudolphinis. Ad Meridianum Uraniburgiam....* Gedoni: Pliniger, 1662.

Hippocrates. *Oeuvres complètes d' Hippocrete,* E. Littrè edn. Amsterdam: A.M. Hakkert, 1962 (1851).

Hospital, Marquis De l'. *Analyse des infiniment petits, pour l' intelligence des lignes courbes.* Paris: François Montalant, 1716.

King, Margaret L and Rabil Albert Jr. eds. *Her Immaculate Hand. Selected Works By and About The Women Humanists of Quattrocento Italy.* Binghamton, N.Y.: Medieval & Renaissance Texts and Studies, 1983.

Index librorum prohibitorum usque ad diem 4 junii Anni MDCCXLIV regnante Benedicto XIV D.O.M. Rome, 1744.

Laghi, T. " De rubentibus lignorum cineribus ", *Commentarii*, Vol. II, pt. 3a (1747), pp. 392-402.

Lagrange, Giuseppe Luigi. *Oeuvres.* Paris, 1867-1892.

_____ " Principi di analisi sublimi " in Bergato, Maria Luisa e Pepe Luigi. " Lagrange a Torino (1750-1759) e le sue lezioni inedite nella R. Scuola di Artiglieria ", *Bollettino di Storia delle Scienze Matematiche*, Vol. VII, (1987), fasc. 2, 45-200.

Lalande, Joseph Jerome de. *Voyage en Italie fait dans les annés 1765 et 1766*, Vol. VI. Paris: Desant, 1769.

Lami, Jo. ed. *Memorabilia Italorum eruditione praestatium quibus vertens saeculum.* Florence: Centauri, 1742.

Lattanzi, Carolina. *Schiavitù delle donne*, Gilberto Zacchè ed. Mantua: Edizioni lombarde, 1979.

Lavoisier, Antoine. *Elements of Chemistry*. Translated by Kerr, Robert. New York: Dover Publications, 1965.

Leggi dell' Accademia de' SS' Gelati di Bologna col catalogo degli accademici viventi MDCC. Bologna: Benacci, 1700.

Lena Perpenti, Candida. " Descrizione di una nuova campanula ", *Biblioteca italiana*, T. V (gennaio 1817), pp. 133-34.

_____ " Sulla filatura dell" amianto ", *Giornale della società d' incoraggiamento delle scienze e delle arti*, no. 10 (ottobre 1808), pp. 328-34.

" Lettera prima dell' abate Giovenedi di S. Vito Diocesi di Rimino al dott. Bianchi. Lettera seconda del sudetto al medesimo, lettera terza dell' Abate Pesci di Rimino ad un suo amico. Breve spiegazione dell' Aurora Boreale ", *Raccolta di opuscoli scientifici e filologici*, XXVI (1741), pp. 187-203.

Lettere di vari illustri italiani del secolo XVIII e XIX ai lor amici, e di massimi scienziati e letterati nazionali e stranieri al celebre Abate Lazzaro Spallanzani... Vol. VI. Reggio: Torreggiani e Compagni, 1842.

Luca, Cardinale Giambattista de. *Il cavaliere e la dama*. Bologna: De Longhi, 1700.

Lugano, P.D. Placido Tommaso ed. *I processi inediti per Francesca Bussa dei Ponziani (Santa Francesca Romana) 1440-1453.* Vatican City: Biblioteca Apostolica Vaticana, 1945.

Mancini Colonna, Maria. *Discorso astrosofico delle mutationi dei tempi ed altri accidenti mondani dell' anno MDCLXXII di Madama Maria Mancini Colonna: Principessa Romana, Duchessa di Paliano, di Tagliacozzo, di Marino ecc. e Gran Contestabilessa del Regno di Napoli.* Modena, 1671.

Manfredi, Eustachio. *Compendiosa informazione di fatto sopra i confini della communità Ferrarese di Ariano con lo Stato Veneto*, (1735).

_____ *Elementi della geometria plana e solida e della trigonometria.* Bologna: Lelio della Volpe, 1755.

_____ *Ephemerides Motuum Coelestium ex Anno MDCCXV in Annum MDCCXXV e Cassinianis Tabulis*, T. 1. Bologna: Pisari, 1715.

Manfredi, Muzio. *Per Donne Romane rime di diversi raccolte et dedicate al Signor Giacomo Buoncompagni.* Bologna: A. Benacci, 1572.

Marinelli, Giuseppe. *Commentaria in Hippocratis coi medicorum omnium facile principis Opera.* Venice, 1575.

_____ *Le medicine pertinenti alle infermità delle donne.* Venice: G. Valgisio, 1574.

Marinelli, Lucrezia. *La nobiltà et eccellenza delle donne, et i difette, e mancamenti degli huomini.* Venice; Giovan Batista Ciotti, 1600.

Masetti-Zannini, G. Ludovico. "Una canonichessa erborista: Semidea Poggi (sec. XVI-XVII)", *Strenna storica bolognese*, Anno XLV (1995), pp. 390-98.

Mazzacurati, Giambattista. *Istoria del Signor Dottor Giambattista Mazzacurati intorno l' infermità, morte e sezione del fu giovanetto Giulio Galli da Pesaro. Osservazioni sovra l' antecedente storia, e sezzione scritte in una lettera del signor Pietro Ghigi d' Arimino.* Rimini: Albertini, 1731.

Mazzuchelli, Giammaria. *Gli Scrittori d' Italia cioè notizie storiche e critiche intorno alle vite e gli scritti degli letterati italiani*, Vol. I, parte I e II. Brescia: G. Bassini, 1753.

Medaglia Faini, Diamante. *Versi e prose di Diamante Medaglia Faini con altri componimenti di diversi autori e colla vita dell' autrice. Il tutto insieme raccolto, e dato alla luce da Giuseppe Pontera.* Salò: B. Righetti, 1774.

Melli, Elio ed. *Studi e inediti nel primo centenario dell' Istituto Magistrale Laura Bassi.* Bologna: STEB, 1960.

Memorie, imprese, e ritratti de' Signori Accademici Gelati di Bologna. Raccolta nel Principato del Signor Conte Valerio Zani. Bologna: Manolessi, 1702.

Miani, Laura. " Lettere inedite di Gianfrancesco Malfatti conservate presso la Biblioteca Universitaria di Bologna " in *Gianfrancesco Malfatti nella cultura del suo tempo.* Atti del Convegno di Ferrara 23-24 ottobre 1881, pp. 265-99.

Le Moniteur universel, Paris, 26 février 1814, 226.

Montefeltre, Battista de. " Lettere inedite. Nota di A. Fatti e B. Felici Angeli ", *Rendiconti della Reale Accademia dei Lincei: Classe di scienze morali, storiche, e filologiche*, serie 5a. Vol. XXVI, (1917), 201-212.

Montesquieu, Albert de. *Correspondence de Montesquieu publiée par François Gebelin.* Bordeaux: Gounouilhon, 1914.

_____ *Voyages de Montesquieu publiés par le Baron Albert de Montesquieu.* Bordeaux: Gounouilhon, 1894.

Morata, Olimpia. " Epistolario (1540-1555) ", Lanfranco Caretti ed., *R. Deputazione di Storia Patria per l' Emilia e la Romagna Sezione di Ferrera*, Vol. XVIII, (1940).

_____ *Olympiae Fulviae Moratae Foeminae doctissimae ac plane divinae Opera Omnia cum eruditorum testimonis.* Basileae: Pernae, 1580.

_____ " Opere, Volume secondo: Orationes, Dialogi et Carmina ", Lanfranco Caretti ed., *Deputazione provinciule ferrarese di Storia Patria. Atti e memorie, nuova serie,* Vol. XI, parte II, (1954).

Morgan, John. *The Journal of Dr. John Morgan of Philadelphia from the City of Rome to the City of London, 1764; Together with a Fragment of a Journal Written at Rome, 1764.* Philadelphia, 1907.

Newton, Isaac. *Mathematical Principles of Natural Philosophy and His System of the World.* Florian Cajori ed. Berkeley: University of California Press, 1934.

_____ *Opticks.* Chicago: Encyclopaedia Britannica, 1952.

Nocca, Domenico. *Ticinensis Horti Academici plantae selectae qua descriptionibus illustravit observationibus auxit Domenico Nocco.* Fasciculus Primus. Ticino: Galeati, 1800.

Nollet, Abate. *Lettere intorno all' elettricità nelle quali si trovano esaminate le scoperte fatte in questa materia dall' anno in appresso, e le conseguenze che se ne possono dedurre. Del Sig. Abate Nollet dell' Accademia delle Scienze. Tradotto dal Francese.* Napoli: G. Raimondi, 1761.

Nollet, Abbé. " Extracts of Two Letters of the Abbé Nollet F.R.S. to Mr. William Watson F.R.S. Relating to the Extracting Electricity from the Clouds ", *Philosophical Transactions*, Vol. XLVII, (1751-1752), 553-58.

_____ *Lettres sur l' electricité dans lesquelles on trouvera les principaux phenomenes qui ont été découvert depuis 1760.* Paris: Durand, 1770.

_____ *Lettres sur l' electricité M. l' Abbé Nollet*, première partie. Paris: H.L. Guerin, L.F. De la Tour, 1754.

Nova Acta Eruditorum. anno MDCCL Lipsiae, fasc. XIII-octobris.

Novelle Letterarie, no. 35 (29 agosto 1750).

Novelle della Repubblica Letteraria di Venezia, (1750), no. 23, 180-181, no. 28, 221- 22; (1751), no. 7, 49-51.

Oldoini, Augusto. *Athenaeum Augustum uniquo perusinorum scripto Publice exponantur studio.* Perugia: Ciani & Residi, 1578.

Orbaan, J.A. F. *Documenti sul Barocco in Roma.* Rome: Società alla Biblioteca Valliscelliana, 1920.

Oresme, Nicole. *Le livre du ciel et du monde*, A.D. Menut and Alexander Denomy eds. Madison: University of Wisconsin Press. 1968.

Orlandi, Antonio Pellegrino. *Notizie degli scrittori bolognesi e dell' opere loro stampate e manoscritte.* Bologna: Pisani, 1714.

Ottonelli, P. Gio: Domenico. *Della pericolosa conversatione con le donne, ò poco modeste, ò ritirate, ò cantatrici, ò academiche. Opera del P. Gio: Domenico Ottonelli di Fanano, sacerdote della Compagnia di Giesu.* Florence: L. Franceschini e A. Logi, 1646.

Pagani, Marietta. " Pratiche municipali che osserva nell' alievo de' cavalieri la Nob. Sig. Marietta Pagani nobilissima dilettante di Belluno, da essa pubblicate con esatezza tanto le univoche quanto le discordanti dagli importanti ricordi dati in luce dal chiariss. nob. sig. Conte e Cav. Enrico Mazzi ", *Nuovo giornale d' Italia spetante alle scienze naturali, e principalmente all' agricoltura, alle arti e al commercio*, T. I, no. 3 (Venezia 1789), pp. 22-24.

Paracelsus. *The Hermetic Writings of Aureolus Philippus Theophrastus Bombast of Hohenheim, Called Paracelcus the Great*, Vol. I: *Hermetic Chemistry*, A.E. White ed. Berkeley: Shambhala, 1976.

Passi, Giuseppe. *I donneschi diffetti nuovamente informati e posti in luce.* Venice: Somasato, 1601.

Piccolomini, Alessandro. *Della instituzione morale di M. Alessandro Piccolomini Libri XII. Ne' quali egli levando le cose soverchie et aggiungnendo molte importanti et à miglior forma et ordine ridotto tutto quello che già scrise in sua giovineza dell' Institutione del' homo nobile.* Venice: G. Zilotti, 1560.

_____ *Lettura del S. Alessandro Piccolomini infiammato fatta nell' Accademia degli Infiammati MDXXXXI.* Bologna: A. Forni, 1926-1930.

_____ *De la sfera del mondo di M. Alisandro Piccolomini, divisa in Libri quatro, i quali non per via di tradutione, ne e quel si voglia particolare scrittore obligati, ma parte di nuovo producendo, contegono in se tutto quel ch' intorno à cosi facil modo di dimostrare, che quel si voglia poco esercitato ne gli studi di mathematica*

potrà agevolossimamente, et con prestezza incederne il tutto, di nuovo ricoretta et ampliata. Venice, 1553.

_____ *De le stelle fisse, Libro uno con le sue figure et con le sue tavole, dove con meravigliosa agevolezza potrà ciascuno conoscere qualunque stelle delle quarantotto imagini del cielo stellato, & le favole loro integralmente & sapere in ogni tempo dell' anno à qualsivoglia hora di notte in che parte del cielo si havino non solo le dette imagini, ma qualunque stella di quelle.* Venice, 1553.

Pizan, Christine de. *The Book of the City of Ladies, Translated by Earl Jeffrey Richards. Foreword by Marina Warner.* New York: Persea Books, 1982.

_____ *The Epistle of Othea Translated from the French Text of Christine de Pisan by Stephen Scrope*, F. Buhler ed. London: Oxford University Press, 1970.

_____ *Le Livre du Chemin de Long Estude*, Robert Peschel ed. Geneva: Skatline Reprints, 1974.

_____ *Le livre de la Mutacion de Fortune,* Susanne Solente ed. Paris: A. Picard, 1966.

_____ *La vision--Christine, Introduction and Text.* A Dissertation Submitted to the Faculty of the Graduate School of Arts and Sciences of the Catholic University of America in Partial Fulfilment of the Requirements for the Degree of Doctor of Philosophy by Sister Mary Louis Towner, M.A. Washington; Catholic University of America, 1932.

Platone. *Timeo*, tr. Giovanni Reale. Milan: Rusconi Libri, 1994.

Plinio. *Storia Naturale*, tr. A. Barchiesi, R. Centi, M. Corsari, A. Marcone, G. Ranucci. Libri 1-37. Turin: G. Einaudi, 1982.

Priestley, Joseph. " An Account of Further Discoveries in Air by the Rev. Joseph Priestley, L.L.D., F.R.S. in Letters to Sir John Pringle, Bart. F.R.S. and the Rev. Dr. Price, F.R.S. ", *Philosophical Transactions*, Vol. LXV, (1775), part I, 384-94.

_____ *The History and Present State of Electricity.* New York: Johnson Reprints, 1966.

_____ " Observations on Different Kinds of Air ", *Philosophical Tansactions*, Vol. LXII (1772), pp. 210-24.

Prose de' Signori Accademici Gelati di Bologna. Bologna: Manolessi, 1671.

Rabil, Albert Jr. *Laura Cereta Quattrocento Humanist.* Binghamton, New York: Center for Medieval & Early Renaissance Studies, 1981.

Renaldini, Carlo. *Geometria Promotus.* Padua: Frambotti, 1670.

_____ *De Resolutione et Compositione Mathematica.* Padua: Frambotti, 1668.

Renzi, Salvatore De ed. *Collectio Salernitana, ossia documenti inediti e trattati di medicina appartenenti alla Scuola Medica di Salerno.* T. II, Naples: Filiatre-Sebezio, 1853.

Reynau, Abbé. *Analyse demontré ou le methode de resoudre les problèmes des mathematiques et d' apprendre facilement ces sciences.* Venice: Pitteri, 1739.

Riviera, Tarsizio. *Compendio di Anatomia e Fisiologia.* Bologna: S. Tommaso d' Aquino, 1799.

_____ *Sopra l' indole morale e fisica delle donne.* Bologna; S. Tommaso d'Aquino, 1796.

_____ *Storia di un monocolo. Con alcune riflessioni.* Bologna: S. Tommaso d' Aquino, 1793.

Robbio di San Raffaele, Benvenuto. *Disgrazia di Donna Urania, ovvero degli studi femminili.* Florence: Stamperia Granducale, 1798.

Roberti, Tiberio. *Alcune lettere inedite di G.B. Brocchi dirette alla Contessa Fiorini Marzanti* (it should read Mazzanti). Feltre: Castaldi, 1902.

Robin, Diana. *Laura Cereta: Collected Letters of a Renaissance Feminist.* Chicago: University of Chicago Press, 1997.

Rossi, Giovanni Vittorio. *Janii Nicii Erythraei Pinacotheca imaginum illustrium doctrinae vel ingenii laude qui auctore superstite obierunt, editio nova.* Leipzig: T. Futsch, 1712.

Rossi, Ottavio. *Elogi Historici di Bresciani Illustri.* Brescia, 1620.

Rousseau, Jean-Jacques. *Emile or on Education. Introduction, Translation and Notes by Alan Bloom.* New York: Basic Books, Inc., 1979.

Sacrobosco, Giovanni. *La Sfera di M. Giovanni di Sacrobosco Tradotta da Pier Dante de Rinaldi, con le Annotazioni del medesimo et con l' aggiunta delle Figure & d' altre Annotazioni.* Perugia: Rastelli, 1574.

Sacrobosco, John of. *The Sphere of Sacrobosco and Its Commentators*, Lynn Thorndike ed. Chicago: University Press, 1949.

Sarrocchi, Margherita. *La Scanderbeide. Poema Heroico della Signora Margherita Sarrocchi, dedicato all' Illma ed Eccma. Sig. D. Costanza Colonna Sforza, Marchesa di Caravaggio con privilegio per Anni XX.* Rome: Levido Eacri, 1606.

Scarpellini, Caterina. " Biografia dell' astronomo Don Ignazio Calandrelli "*Giornale arcadico di scienze, lettere e arti*, CXCII, (1864), 204-217.

_____ *Bullettino delle osservazioni ozonometriche e meteorologiche del 1870 al 1872.* Rome: Belle Arti, 1873.

_____ *Catalogo degli uranatmi (o sia stelle cadenti) osservati alla privata stazione meteorologica di Roma (sul Campidoglio) negli anni 1861, 1862, 1863, 1864, 1865, 1866, 1867.* Rome: Tipografia delle Belle Arti, 1868.

_____ " Il grande eclisse solare del 18 luglio 1860 osservato da Caterina Scarpellini sul Campidoglio ", *C.S.*, Vol. VI, no. 25 (13 agosto 1860), 229-31.

_____ " Influenza della luna nei terremoti ", *C.S.*, Vol. VI, no. 25, (13 agosto 1860), 233-39.

_____ " Osservazione ozonometriche istitute in Roma nell' agosto 1856 di Caterina Scarpellini all' altezza di metri 60, 43 sul livello del mare ", *C.S.*, Vol. V, no. 32, (17 gennaio 1859)-no. 26, (21 novembre 1860), Vol. VI, no. 35, (11 aprile 1862)-no. 48, (5 agosto 1863).

_____ " Osservazioni ozonometriche...", *Giornale arcadico di scienze, lettere e arti*, no. 145, (novembre-dicembre 1856), 177-84.

_____ " Osservazioni ozonometriche...", *Giornale delle strade ferrate*, anno I, no. 10, (29 agosto 1857)-no. 52 (19 giugno 1858), anno II, no. 1, (26 giugno 1858)-no. 52, (18 giugno 1859).

_____ " Osservazioni sulle stelle cadenti periodiche del 10 agosto 1866. Lettera di Caterina Scarpellini all' eccmo. commendatore dott. Benedetto Trompeo a Torino ", *Giornale arcadico di scienza, lettere ed arti*, no. 192, (1864), 230-33.

_____ " Scienza nello stato papale ", *C.S.*, Vol. V, no. 30, (26 giugno 1857), 44-55.

_____ *Stazione meteorologica- Scarpellini in Roma (Campidoglio). Altitudine 60, 43 sul livello del mare- anno XVI.. Meteorologia medica dei mesi di Aprile, Giugno, Novembre, Decembre 1871, e Gennajo, Febbrajo, Marzo del 1872.* Rome, 1873.

_____ " Sulle osservazioni fenologiche: regno animale e regno vegetale ", *Giornale arcadico di scienze, lettere ed arti*, no. 195, (1865), 167-69.

_____ " Sulli terremoti avvenuti in Roma negli anni 1858 e 1859 ", *C.S.*, Vol. VI, no. 25, (13 agosto 1860), 230-31.

_____ *Uranatmi o stelle cadenti visti in Roma ed in Civitavecchia nel periodo di agosto del 1869. Privata stazione.* Rome: Tipografia delle Belle Arti, 1869.

_____ *Gli uranatmi ossia stelle cadenti del periodo di novembre 1868 osservati in Roma e Civitavecchia. Stazione meteorologica di privata istituzione in Roma Anno IX.* Rome, 1868.

Schimper, W.H. ed. *Bryologia Europeae seu genera muscorum europearum.* Stuttgart: Schweizerbart, 1836-85 .

Sforza, Isabella. *Della vera tranquillità dell' anima.* Venice, 1544.

Somerville, Mary. *Geografia fisica.* Florence: Barbèra, Bianchi e Comp., 1856.

Soppelsa, Maria Luisa. " Jacopo Riccati-Maria Gaetana Agnesi. Carteggio (1745-1751) ", *Annali del' Istituto delle Scienze di Firenze*, Anno X (1985), fasc. 1, pp. 117- 59.

Spallanzani, Lazzaro. *Epistolario.* Vol.I to V. Biagi, Benedetto ed. Florence: Sansoni, 1962.

Storia letteraria d' Italia divisa in tre libri, Vol. I, Venice 1753.

Suardi, Giambattista. *Nuovi Istromenti per la descrizione di diverse curve antiche e moderne.* Brescia: G.M. rizzo, 1752.

Tarabotti, Arcangela. *Che le donne siano delle spezie degli uomini*, Letizia Panizza ed. London: Institute of Romance Studies, 1994, (1651).

_____ *L' inferno monacale*, Francesca Medioli ed. Turin: Rosenberg & Sellier, 1990.

Tega, Walter ed. *Anatomie Accademiche.* Vol 1: *I Commentari dell' Accademia delle Scienze.* Bologna: Il Mulino, 1986.

Tenca, Luigi. " Cinque lettere di Clelia Borromeo del Grillo al matematico Grandi ", *Archivio storico lombardo*, anno LXVIII-LXXIX 9 1953), pp. 220-226.

Tenca, Luigi. " Lettere di Carlo Rinaldini ", *Atti dell' Accademia delle Scienze dell' Istituto di Bologna. Classe di Scienze Fisiche. Rendiconti*, serie XI, T. III, 1-12.

Thorndike, Lynn ed. *The Herbal of Rufinus.* Chicago: University of Chicago Press, 1946.

Tiraboschi, Girolamo. *Biblioteca Modenese.* Modena: Società tipografica, 1783

Tomini Forresti, Marco. *Rime dedicate a sua eccellenza la signora contessa D. Clelia Grillo Borromea.* Bergamo: P. Lancellotti, 1751.

Trompeo, Benedetto. *Intorno alla vita e alle opere del Professore Cavaliere D. Feliciano Scarpellini.* Rome: Salviucci, 1841.

Vallisneri, Antonio. *De' corpi marini che su' monti si trovono; della loro origine; e dello stato del mondo avanti 'l Diluvio, nel Diluvio e dopo il Diluvio.* Venice: Domenico Lovisa, 1721.

_____ " Dialoghi sopra la curiosa origine di molti insetti...primo dialogo e secondo Dialogo ", *La Galleria di Minerva,* I (1696), pp. 297-322 and III (1700), pp. 297-318, 353-72.

_____ *Epistolario.* Dario Generali ed. Milan: F. Angeli, 1990.

_____ *Istoria della generazione dell' uomo, e degli animali se sia da' vermicelli spermatici o dalle uova.* Venice: Gabriel Hertz, 1721.

Veratti, Giuseppe. " Experimenta magnetica ", *Commentarii,* Vo. Vi, (1783), pp. 31-44.

_____ *Osservazioni fatte in Bologna l' anno MDCCLII dei fenomeni elettrici nuovamente scoperti in America e confermati a Parigi.* Bologna: Lellio della Volpe, 1752.

_____ *Osservazioni fisico-mediche intorno alla elettricità.* Bologna: Lellio della Volpe, 1748.

Verri, Pietro. " *Manoscritto" per Teresa,* Gennaro Barbarisi ed. Milan: Serer e Riva, 1983 (1777).

Vico, Giambattista. *Autobiografia. Il carteggio e le poesie varie,* B. Croce e F. Nicolini eds. Bari: Laterza, 1929.

_____ *The Autobiography of Giambattista Vico Translated from the Italian byMax H. Fisch and Thomas G. Bergin.* Ithaca: Cornell University Press, 1944.

" De vi corporum viva ", *Commentarii,* Vol. II, pt. 1a. (1745), pp. 377-413.

Vitrioli, Diego. *Elogio di Angela Ardinghelli Napoletana latinamente scritto da Diego Vitrioli e da lui volgarizato.* Naples: Gaetano Nobile, 1874.

Viviani della Robbia, Enrica. *La figlia di Galileo.* Florence: Sansoni, 1942.

Volta, Alessandro. *Epistolario di Alessandro Volta.* Massardi, Francesco ed. Bologna: Zanichelli, 1949-1955.

Voltaire. " Exposition du livre des institutions phyiques dans laquelle on examine les idées de Leibnitz " in *Oeuvres completes de Voltaire, nouvelle edition, Melanges II.* Paris: Garnier frères, 1879 (Kraus Reprints 1967)

Watts, Isacco. *Elementi di Geografia ed Astronomia del Signore Isacco Watts tradotti dalla settima ed ultima edizione inglese nell' idioma italiano da Maria Vigilante con alcune piccole osservazioni, e aggiunzioni della medesima, tanto in rapporto alle differenti posizioni di Napoli, e Londra, che per comutazione de' dominj di varie parti della Terra.* Naples: Raimondi, 1789.

Watts, Isaac. *The Works of the Reverend and Learned Isaac Watts D.D. Containing, Besides His Sermons and Essays on Miscellaneous Subjects, Several Additional Pieces. Selected from His Manuscripts by the Rev. Dr. Jennings and Rev. Dr. Doddridge in 1753*, Vol. V. London: J. Barfield, 1810, 407-95.

Zanotti, Francesco Maria. *Della forza de' corpi che chiamano viva. Libri tre del signor Francesco Maria Zanotti al signor Giambattista Morgagni.* Bologna: C. Pisarri, Primodi, 1752.

_____ *Opere scelte.* Milan: Società tipografica dei classici italiani, 1818.

_____ " De separandis indeterminatis ", *Commentarii*, Vol. III (1755), pp. 261-79.

Zanotti, Giampietro Cavazzoni. *Vita di Eustachio Manfredi.* Bologna: Cremona, 1745.

Secondary Sources:

Abbri, Fernando. *Le terre, l' acqua, le arie. La rivoluzione chimica del settecento.* Bologna: Il Mulino, 1984.

Abir-Am, Pnina and Outram, Dorinda. *Uneasy Careers and Intimate Lives: Women in Science, 1789-1979.* New Brunswick: Rutgers University Press, 1987.

Ackerknecht, Erwin H. *A Short History of Medicine.* Baltimore: The Johns Hopkins University Press, 1982.

Ajello, Raffaele ed. *Pietro Giannone e il suo tempo.* Naples: Jovene, 1980.

Alic, Margaret. *Hypatia's Heritage. A History of Women in Science from Antiquity through the Nineteenth Century.* Boston: Beacon Press, 1986.

Alma Mater Studiorum: la presenza femminile dal XVIII al XX secolo. Ricerche sul rapporto Donna/Cultura Universitaria nell' Ateneo Bolognese. Bologna: CLUEB, 1988.

Ambrosoli, Mario. *The Wild and the Sown. Botany and Agriculture in Western Europe 1350-1850.* Cambridge: Cambridge University Press, 1997.

Amodeo, Federico. *Vita matematica napoletana.* Naples: F. Giannini e Figli, 1905.

Andrè, Jacques. *Être médecin à Rome.* Paris: Belles Lettres, 1987.

Anfossi, D., Sandroni, S., Viarengo S. " Le misure di ozono troposferico nel secolo scorso e il contributo di Francesco Deza ", *Giornale di fisica*, XXXIII, no. 2 (aprile-giugno 1992), pp. 145-57.

Anzoletti, Luisa. *Maria Gaetana Agnesi.* Milan: L.F. Cogliati, 1900.

Arduini, Carlo ed. *La primogenita di Galileo Galilei rivelato dalle sue lettere.* Florence: Le Monnier, 1864.

Ascari, T. " Calcagnini, Celio ', *D.B.I.*, Vol. 16, pp. 492-98.

Bainton, Roland H. *Women of the Reformation in Germany and Italy.* Minneapolis: Ausburg Publishing House, 1971.

Baldini, Ugo. " Della Torre, Giovanni Maria ", *D.B.I.*, Vol. 37, pp. 573-77.

Baldini, Ugo, Napolitani Pier Daniele. " Per una biografia di Luca Valerio ", *Bollettino di storia delle scienze matematiche*, Anno XI, no. 1 (giugno 1991), pp. 3-157.

Bandi Buti, Maria ed. *Poetesse e scritrici.* Rome: Istituto editoriale italiano, 1942.

Baron, Margaret E. *The Origins of the Infinitesimal Calculus.* New York: Dover Publications, 1969.

" Bassi Veratti, Laura ", *D.B.I.*, Vol. 7, p. 146.

Belanger, Claude et al. *Histoire Générale de la presse française.* T. I: *Des origines à 1814.* Paris: Presses Universitaires de France, 1969.

" Benedetto XIV e la Scienza fisica: nella Bologna del settecento nasce un papa galileiano-newtoniano ", *Bologna incontri*, (17 giugno 1986), pp. 26-32.

Benjamin, Marina ed. *Science and Sensibility: Gender and Scientific Inquiry, 1780-1945.* Oxford: Basil Blackwell, 1991.

Benton, John F. " Trotula, Women's Problems and the Professionalization of Medicine in the Middle Ages ", *Bulletin of the History of Medicine*, Vol. 59, no. 1 (Spring 1985), pp. 30-53.

Beretta, Marco. *The Enlightenment of Matter. The Definition of Chemistry from Agricola to Lavoisier.* U.S.A.: Science History Publications, 1993.

_____ " Gli scienziati italiani e la rivoluzione chimica ", *Nuncius*, anno IV (1989), fasc. 2, pp. 119-45.

Bergia S. and Fantazzani P. " Dalla regolazione delle acque alle leggi dell' urto centrale elastico; una rivalutazione del ruolo di Giovanni Poleni nelle dispute delle forze vive ", *Giornale di fisica*, XXI, (1980), pp. 44-60.

Bernarde, A. *Asbestos the Hazardous Fiber.* Boca Raton: CRC Press, 1990.

Bernardi, Walter. *I fluidi della vita. Alle origini della controversia sull' elettricità animale.* Florence: Olschki, 1992.

Berti Logan, Gabriella. " The Desire to Contribute: An Eighteenth-Century Italian Woman of Science ", *The American Historical Review*, Vol. 99, no. 3, (June 1994), pp. 785-812.

Biagioli, Mario. *Galileo Courtier. The Practice of Science in the Culture of Absolutism.* Chicago: The University of Chicago Press, 1993.

_____ " Knowledge, Freedom and Brotherly Love: Homosociality and the Accademia dei Lincei ", *Configurations*, 2 (1995), pp. 139-66.

_____ " The Social Status of Italian Mathematicians ", *History of Science*, Vol. 27, part 1, no. 75 (March 1989), pp. 41-95.

Boas Hall, Marie. *The Scientific Renaissance 1450-1630.* New York: Dover Publications, 1994 (1962).

Boehm, L., Raimondi, E. eds. *Università, accademie e società scientifiche in Italia e in Germania dal cinquecento al settecento.* Bologna: Il Mulino, 1981.

Bonafede, Carolina. *Donne bolognesi insigni.* Bologna: Atesa editrice, 1971, reprint from 1845.

Bonazzi, Gabriele. *Bologna nella storia.* Bologna: Zanichelli, 1989.

Bortolotti, E. " L' Accademia delle Scienze dell' Istituto di Bologna ", *Atti e Memorie. Deputazione di storia patria per le provincie di Romagna*, XXV (1935), serie IV, pp. 113-65.

Bottazzini U., Freguglia, D., Rigatelli, L.T. *Fonti per la storia della matematica, aritmetica, geometria, algebra, analisi infinitesimali, calcolo delle probabilità, logica.* Florence: Sansoni, 1992.

Boyer, Carl B. " The First Calculus Textbooks ", *The Mathematics Teacher*, no. 39, (1946), pp.159-167.

_____ *History of Analytic Geometry.* New York; Scripta Mathematica, 1956.

_____ *A History of Mathematics, Reviewed by Uta C. Merzbach.* New York: John Wiley & Sons, 1968.

Braccesi, A. and Baiada E. " Proseguendo sulla specola di Bologna: dagli studi del Manfredi sull' aberrazione, al catalogo di stelle dello Zanotti ", *Giornale d' Astronomia*, Vol. 6, no. 1 (marzo 1980), pp. 5-29.

Braudel, Fernand. *Civilization and Capitalism 15th-18th century.* Vol II: *The Wheels of Commerce.* Frome: Fontana Press, 1982.

Bridenthal, R., Koonz, C., Stuard, S. eds. *Becoming Visible. Women in European History.* Boston: Houghton Mifflin Company, 1987.

Brigaglia, Aldo and Nastasi, Pietro. " Bologna e il Regno delle Due Sicilie. Aspetti di un dialogo scientifico (1730-1760) ", *Giornale critico della filosofia italiana*, 6ª serie, Vol. IV, anno LXIII, (1984), pp. 145-78.

Brizzi, G.P. " Davia, Giovanni Antonio ", *D.B.I.*, Vol. 33, pp. 127-30.

Brizzi, G.P., Marini, Lino, Pambeni Paolo eds. *L' Università di Bologna. Maestri, studenti e luoghi del XVI al XX secolo.* Bologna: Silvan, 1989.

Bucciarelli, Louis L., Dworsky, Nancy. *Sophie Germain. An Essay in the History of the Theory of Elasticity.* Dordrecht; D. Reidel Publishing Company, 1980.

Buffon 88: Actes du colloque international pour le bicentenaire de la mort de Buffon (Paris, Montbard, Dijon, 14-22 juin 1988). Paris: Vrin, 1992.

Butterfield, H. *The Origins of Modern Science 1300-1800.* London: G. Bell and Sons, 1957 (1945).

Buzzoni, G., Pegrasi, M. eds. *Cultura, religione e politica nell' età di Angelo Maria Querini.* Brescia, 1982.

Ca., E. " Mauri Ernesto ", *Enciclopedia italiana*, Vol. 22, p. 612.

Cagni, Giuseppe. " Il Pontificio Collegio Montalto in Bologna (1585-1797) ", *Barnabiti studi*, 5 (1988), pp. 7-194.

Carpaneto, Dino, Ricuperati, Giuseppe. *Italy in the Age of Reason 1685-1785*. London: Longman, 1987.

Casati, Stefano. " Giuseppe Toaldo: la luna, il saros e le meteore ", *Nuncius*, V, fasc. 1 (1990), pp. 2-42.

Casini, Paolo. " Les débuts du newtonianisme en Italie, 1700-1740 ", *Dix-huitième siècle*, Vol. 10, (1978), pp. 85-100.

Castelli Patrizia ed. *La rinascita del sapere: libri e maestri dello studio ferrarese*. Venice: Marsilio, 1991.

Castronovo, Valerio, Ricuperati, G., Cagna, Carlo eds. *La stampa italiana dal Cinquecento al Settecento*. Bari: Laterza, 1976.

Cavazza, Marta. " Accademie scientifiche a Bologna. Dal " coro anatomico " agli Inquieti (1650-1714) ", *Quaderni storici*, no. 48, III (1981), pp. 884-921.

_____ " Illuminismo e devozione: il caso Haller ", *Intersezioni*, A. XIII, no. 2 (agosto 1993), pp. 389-94.

_____ " Laura Bassi e il suo gabinetto di fisica sperimentale: realtà e mito ", *Nuncius*, anno X (1995), fasc. 2, pp. 715-53.

_____ *Settecento inquieto. Alle origini dell' Istituto delle Scienze di Bologna*. Bologna: Il Mulino, 1990.

Cavazzana, Cesira. " Cassandra Fedele, erudita veneziana del rinascimento ", *Ateneo veneto*, 29, 2 (1906), pp.73-91, 249-75, 361-97.

Cechelli, Marco ed. *Benedetto XIV (Prospero Lambertini). Convegno Internazionale di Studi Storici*. Cento: Centro Studi Girolamo Baruffaldi, 1979.

Ceranski, Beate. " Il carteggio tra Giovanni Bianchi e Laura Bassi, 1733-1745 ", *Nuncius*, anno IX (1994), fasc. 1, pp. 207-31.

Le cere anatomiche bolognesi del settecento. Università degli Studi di Bologna, Accademia delle Scienze settembre-novembre 1981. Bologna: CLUEB, 1981.

Cerreta, Florindo. *Alessandro Piccolomini letterato e filosofo senese del cinquecento*. Siena: Accademia senese degli Intronati, 1960.

Cessi, Ugo. *Una dottoressa rodigina del secolo XVIII*. Venice: Visentini, 1901.

Chandrasekar, S. *Newton's "Principia" for the Common Reader.* Oxford: Clarendon Press, 1995.

Checchi, Mario. " Maria Gaetana Agnesi, Guido Grandi e la 'versiera' ", *Atti e memorie della Accademia Petrarca di lettere, arti e scienze*, nuova serie, Vol. XLV (1982), pp. 305-320.

Ciancio, Luca. *Autopsie della terra. Illuminismo e geologia in Alberto Fortis (1741-1803).* Florence: Olschki, 1995.

Clough, Cecil H. ed. *Cultural Aspects of the Italian Renaissance. Essays in Honour of Paul Oskar Kristeller.* Manchester: Manchester University Press, 1976.

Cohen, B. *Franklin and Newton. An Inquiry into Speculative Newtonian Experimental Science.* Philadelphia: American Philosophical Society, 1956.

Collina, Beatrice. " Moderata Fonte e il *Merito delle donne* ", *Annali d' italianistica*, Vol. 7 (1989), pp.143.

Collina, Maria D. *Il carteggio letterario di uno scienziato (Janus Plancus).* Florence: Olschki, 1957.

Comelli, G.B. *Laura Bassi e il suo primo trionfo.* Bologna , 1912.

Conti, Lino ed. *La matematizzazione dell' universo. Momenti della cultura matematica tra 500 e 600.* Perugia: Perziuncola, 1992.

Conti Odorisio, Ginevra. *Donne e società nel seicento.* Rome: Bulzoni, 1979.

Coolidge, Julia. " Six Female Mathematicians ", *Scripta Mathematica*, 17 (1951), pp. 21-31.

Cooper, L.N. *An Introduction to the Structure and Meaning of Physics.*, New York, 1968.

Costabel, Pierre ed. *L' enseignement classique au XVIIIe siècle. Collèges et universités.* Paris: Hermann, 1986.

Cottingham, John. *Cartesio.* Bologna: Il Mulino, 1991.

Cremante, Renzo and Tega Walter eds. *Scienza e letteratura nella cultura italiana del settecento.* Bologna: Il Mulino, 1984.

Crossland, Maurice ed. *The Emergence of Science in Western Europe.* New York: Science History Publication, 1976.

Cunningham, Andrew, French Roger eds. *The Medical Enlightenment of the Eighteenth Century*. Cambridge: Cambridge University Press, 1990.

Cusani, Francesco. *Storia di Milano dall' origine a' nostri giorni*. Milan: Pirotta, 1864.

Dal Pane, Luigi. *Economia e società a Bologna nell' età del risorgimento*. Bologna: Zanichelli, 1969.

Daumas, Maurice. *Les instruments scientifiques au XVIIe et XVIIIe siècles*. Paris: Presses Universitaires de France, 1953.

Debus, Allen G. " The Paracelsian Aerial Niter ", *Isis*, 55 (1964), pp. 43-61.

Degelius, Gunnar. *The Lichen Genus Collema in Europe: Morphology, Taxonomy, Ecology*. Upsala : Lundequistska, 1954.

Delambre M. *Histoire de l' Astronomie du Moyen Age*. Paris: Coucier, 1891.

Del Fonte, Alessandro. " Amore, famiglia e matrimonio nell' *Institutione* di Alessandro Piccolomini ", *Nuova Rivista Storica*, anno LXVIII (settembre-dicembre 1984), fasc. V-VI, pp. 511-26.

Dollo, Corrado ed. *Archimede: mito, tradizione, scienza*. Siracusa-Catania, 9-12 ottobre 1989. Florence: Olschki, 1989.

Dooley, Brandon. " Social Control and the Italian University from Renaissance to Illuminismo ", *Journal of Modern History*, 61 (June 1989), pp. 205-39.

Drake, Stillman. *Galileo at Work. His Scientific Biography*. New York: Dover Publications, 1995.

_____ *Galileo: Pioneer Scientist*. Toronto: The University of Toronto Press, 1990.

Dugas, René. *A History of Mechanics*. New York: Dover Publications, 1988.

Dulong, Claude. *Marie Mancini la première passion de Louis XIV*. Paris, 1993.

Eamon, William. *Science and the Secrets of Nature. Books of Secrets in Medieval and Early Modern Culture*. Princeton: Princeton University Press, 1994.

Ehrman, Esther. *Mme. Du Châtelet Scientist, Philosopher and Feminist of the Enlightenment*. Lemington Spa: Berg, 1986.

Esistere come donna. Milan: Mazzotta, 1983.

Fabi, A. " Bianchi, Giovanni ", *D.B.I.*, Vol. 10, pp. 105-10.

Fantini, Bernardino. " Iatrofisica e iatrochimica: la fisica, la chimica ed i modelli dell' organizzazione del vivente ", *Medicina nei secoli, arte e scienza*, Vol. 9, no. 1 (1997), pp. 59-95.

Fantuzzi, G. *Memorie della vita di Ulisse Aldrovandi, medico e filosofo*. Bologna: Lellio dalla Volpe, 1774.

Fara, Patricia. " An Attractive Therapy: Animal Magnetism in Eighteenth Century England ", *History of Science*, Vol. 33, Part 2 (June 1995), pp. 127-77.

Favaro, " Amici e corrispondenti di Galileo Galilei: Margherita Sarrocchi ", *Atti del R. Istituto Veneto di Scienze, Lettere ed Arti*, (novembre 1893 all' ottobre 1894), pp. 575-76.

Fee, Elizabeth. " Science and the Woman Problem: Historical Perspectives " in *Sex Differences: Social and Biological Perspectives*, Michael Teitelbaum ed. New York: Anchor Books, 1976, pp. 175-223.

Ferrari, A. De. " Colombo, Giovanni Alberto ", *D.B.I.*, Vol. 27, pp. 207-08.

Ferrari, Giovanna. "Public Anatomy and the Carnival: The Anatomy Theater of Bologna", *Past and Present*, 117 (1987), pp. 50-106.

Ferri, Pietro. *Biblioteca femminile italiana*. Padua: Crescini, 1842.

Ferrone, Vincenzo. " Alcune riflessioni sulla cultura illuministica napoletana e l' eredità di Galilei ", *Giornale critico della filosofia italiana*, sesta serie, Vol. IV, (settembre-dicembre 1984), pp. 315-331.

_____ *Scienza, natura, religione. Mondo newtoniano e cultura italiana nel primo settecento*. Naples: Jovene, 1982.

Findlen, Paula. " Controlling the Experiment: Rhetoric, Court Patronage and the Experimental Method ", *History of Science*, 31 (1993), pp. 35-64.

_____ *Possessing Nature. Museums, Collecting, and Scientific Culture in Early Modern Italy*. Berkeley: The University of California Press, 1994.

_____ " Science as a Career in Enlightenment Italy: The Strategies of Laura Bassi ", *Isis*, Vol. 84, no. 3 (september 1993), pp. 441-69.

_____ " Translating the New Science: Women and the Circulation of Knowledge in Enlightenment Italy ", *Configurations*, 2 (1995), pp. 157-206.

Fisch, Max H. " The Academy of the Investigators " in *Science, Medicine and History: Essays on the Evolution of Scientific Thought and Medical Practice Written in Honour of Charles Singer*, E. Ashwater Underwood. ed. London: Oxford University Press, 1953.

Formica, Marina. " Tra cielo e terra. Gli almanachi romani del XVII e XVIII secolo ", *Studi settecenteschi*, Vol. 15 (1995), pp. 115-62.

Fox-Keller, Evelyn. *A Feeling for the Organism: The Life and Work of Barbara McClintock*. San Francisco: Witt Freeman & Co., 1983.

_____ *Reflections on Gender and Science*. New Haven: Yale University Press, 1985.

Franceschini, Pietro. " Della Torre, Giovanni Maria ", *D.S.B.*, Vol. IV, pp. 25-26.

Franchini, Dario A. et al. *La scienza a corte. Collezionismo eclettico, natura e invenzione a Mantova fra Rinascimento e Manierismo*. Rome: Bulzoni, 1979.

Fränsmyr, Tore ed. *Linnaeus: The Man and His Work*. Berkeley: University of California Press, 1983.

Frängsmyr, Tore, Heilbron J.L., and Rider, Robin E. *The Quantifying Spirit in the 18th Century*. Berkeley: University of California Press, 1990.

French, Roger, Wear, Andrew. *The Medical Revolution of the Seventeenth Century*. Cambridge: Cambridge University Press, 1989.

Fusco, Nicola. *Elena Lucrezia Cornaro Piscopia (1646-1684)*. Pittsburgh: The United States Committee for the Elena Lucrezia Cornaro Piscopia Tercentenary, 1975.

Gabrieli, Giuseppe. " Luca Valerio Linceo e un episodio memorabile della vecchia accademia ", *Rendiconti della Accademia dei Lincei: Classe di Scienze Morali*, serie 9 (1933), pp. 691-728.

Gaddum, P.W. *Silk How and Where It Is Produced*. Chesire: H.T. Gaddum & Company, 1968.

Galleria di giovanette illustri italiane che nel nostro secolo XIX fiorivano ogni genere di virtù. Foligno: Tomasini, 1841.

Galluzzi, P. ed. *Novità celesti e crisi del sapere. Atti del Convegno Internazionale di Studi Galileiani*. Florence: Giunti Barbera, 1984.

Gamba, Bartolomeo. *Donne italiane del secolo decimosesto.* Venice: Alvisolio, 1832.

Garbari, F. " De Notaris, Giuseppe ", *D.B.I.*, Vol. 38, pp. 773-78.

Gelfand, Toby. *Professionalizing Modern Medicine: Paris Surgeons and Medical Science and Institutions in the 18th Century.* Wesport, Connecticut: Greenwood Press, 1980.

Geneva, Ann. *Astrology and the Seventeenth Century Mind. William Lilly and the Language of the Stars.* Manchester: Manchester University Press, 1995.

Giacardi, Livia. " Guido Grandi e il calcolo leibniziano. Presentazione di un manoscritto inedito ", *Bollettino della storia delle scienze matematiche*, Vol. XIV (1994), fasc. 2, pp. 195-238.

Giacobbe, G.C. " Castracane degli Antelminelli, Francesco Saverio Giuseppe Baldassare ", *D.B.I*, Vol. 22, pp. 191-94.

Giacomini V. " Bertoloni, Antonio ", *D.B.I.*, Vol. 9, pp. 610-11.

_____ " Brocchi, Giovanni Battista ", *D.B.I.*, Vol. 14, pp. 396-99.

Giampalmo, Antonio. " Il gozzo endemico nelle raffigurazioni dell' arte ", *Medicina nei secoli, arte e scienza*, 8, no. 1 (1996), pp. 85-103.

Giulini, A. " Contributo alla biografia della Contessa Clelia Borromeo del Grilli ", *Archivio storico lombardo*, XLVI, (1919), pp. 582-592.

Gliozzi, M. and Orlandelli, G.F. " Agnesi Maria Gaetana ", *D.B.I.*, Vol. 1, pp. 441-43.

Gomez, Susana. " The Bologna Stone and the Nature of Light: The Science Academy of Bologna ", *Nuncius*, anno VI (1991), fasc.2, pp. 3-32.

Goodman, D. " Enlightenment Salons: The Convergence of Female and Philosophical Ambitions ", *Eighteenth Century Studies*, 22 (Summer 1989), pp. 329-50.

Gosztonyi Ainley, Marianne. *Despite the Odds: Essays on Canadian Women and Science.* Montreal: Véhicule Press, 1990.

Grant, Edward. *Planets, Stars and Orbs. The Medieval Cosmos, 1200-1687.* Cambridge: Cambridge University Press, 1994.

Greco, O. *Bibliobiografia femminile italiana del secolo XIX.* Venice, 1875.

Green, Monica. " Women's Medical Practice and Health Care in Medieval Europe ", *Signs*, Vol. 14, no. 2 (Winter 1989), pp. 434-473.

Greenberg, John L. *The Problem of the Earth's Shape from Newton to Clairaut. The Rise of Mathematical Science in Eighteenth Century Paris and the Fall of " Normal Science "*. Cambridge: Cambridge University Press, 1995.

Grendler, Paul F. *Schooling in Renaissance Italy, 1300-1600.* Baltimore: The Johns Hopkins University Press, 1989.

Griffiths, G., Honkius, J. Thompson, D. *The Humanism of Leonardo Bruni. Selected Works.* Binghamton N.Y.: Medieval & Renaissance Texts & Studies, 1987.

Grillo, E. " Barbapiccola, Giuseppa Eleonora ", *D.B.I.*, Vol. 6, p. 39.

Guerlac, Henri. " The Continental Reputation of Stephen Hales ", *Archives Internationales d' Histoire des Sciences*, Vol. 4, no. 15 (1951), pp. 394-404.

_____ " Hales, Stephen ", *D.S.B.*, Vol. VI, pp. 37-38.

Guerrini, Paolo. " Il maestro di Maria Gaetana Agnesi ", *Commentari dell' Ateneo di Brescia per l' anno 1918*, pp. 377-405.

Hale Jr., E. *The Biology of Lichens.* London: E. Arnold, 1967.

Hall, A.R. *From Galileo to Newton.* New York: Dover Publications, 1981 (1963).

Halliday, D. Resnick, R. *Physics.* New York: John Wiley & Sons, 1978.

Harman, P. M. and Shapiro, Alan E. eds. *The Investigation of Difficult Things: Essays on Newton and the History of Exact Sciences in Honour of D. T. Whiteside.* Cambridge: Cambridge University Press, 1992.

Harshberger, J.W. *Mycology and Plant Pathology.* Philadelphia: Blakiston, 1977.

Harth, Erica. *Cartesian Women: Versions and Subversions of Rational Discourse in the Old Regime.* Ithaca: Cornell University Press, 1992.

Hawkins, Frank H. *Adolphe Quetelet as Statistician.* New York: AMS Press, 1968.

Hearder, Harry. *Italy in the Age of the Risorgimento 1790-1870.* London: Longman, 1983.

Heilbron, J.L. *Electricity in the 17th and 18th Centuries. A Study of Early Modern Physics.* Berkely: The University of California Press, 1979.

Huffen, Charles M., Trinklein, F.E., Bunge M. *An Introduction to Astronomy.* New York: Holt, Rinehart & Winston, 1967.

Hurd Mead, Kate. *A History of Women in Medicine from the Earliest Times to the Beginning of the Nineteenth-Century.* Boston: Mitford House, 1973 (1938).

Iacobacci, Rora. " Women of Mathematics ", *The Arithmetics Teacher*, 17 (1970), pp. 316-24.

Iliffe, Rob. " 'Aplatisseur du monde et de Cassini' Maupertuis, Precision Measuremnet, and the Shape of the Earth in 1730s ", *History of Science*, Vol. 31, part 4, no. 94 (December 1993), pp. 335-75.

Iltis (Merchant), Carolyn. " The Leibnizian-Newtonian Debates in Natural Philosophy and Social Psychology ", *The British Journal for the History of Science*, Vol. 6, no. 24 (1973), pp. 343-77.

_____ " Madame du Châtelet's Metaphysics and Mechanics ", *Studies in the History of Philosophy and Science*, 8 (1977), no. 1, pp. 28-48.

Itard, Jean. " Clairaut, Alexis ", *D.S.B.*, Vol. III, p. 284.

Jardine, N., Secord, J.A., and Sparey E.C. eds. *Cultures of Natural History.* Cambridge: Cambridge University Press, 1996.

Kass-Simon, G. Farnes, Patricia eds. *Women of Science: Righting the Record.* Bloomington: Indiana University Press, 1990.

Kidwell, Peggy. " Women Astronomers in Britain, 1780-1930 ", *Isis*, Vol. 75 (1984), pp. 534-46.

King, Margaret. *Women of the Renaissance.* Chicago: University of Chicago Press, 1991.

Klens, Ulrike. *Mathematikerinnen im 18. Jahrhundert: Maria Gaetana Agnesi, Gabrielle Emilie Du Châtelet, Sophie Germain.* Pfeffenweiler: Centarus-Verlagsgesellscheft, 1994.

Kline, Moris. *Storia del pensiero matematico.* Vol. I: *Dell' antiquità al settecento.* Turin: Einaudi, 1996.

Knoefel, Peter K. *Felice Fontana. Life and Works.* Trento: Società di Studi trentini di Scienze Storiche, 1984.

Kolsky, Stephen D. " Walls of Knowledge: Moderata Fonte's *Il Merito delle Donne* ", *The Italianist*, no. 13 (1993), pp. 57-96.

Koyré, Alexander, " The Significance of the Newtonian Synthesis ", reprinted in Koyré, *Newtonian Studies*. London, 1965 , 3-24.

Kuhn, Thomas S. *The Essential Tension: Selected Studies in Scientific Tradition and Change*. Chicago, 1977.

_____ *The Structure of Scientific Revolutions*. Chicago, 1970 (1962).

Labalme, Patricia H. ed. *Beyond Their Sex: Learned Women of the European Past*. New York, 1980.

I laboratori storici e I musei dell' Università di Bologna; I luoghi del conoscere. Bologna, 1988.

Lagrange, E. " Les femmes astronomes ", *Ciel et terre*, Vol. 5, (1885), pp. 513-22.

Lankford, J. and Slavings R.L. " Gender and Science; Women in American Astronomy, 1859-1940 ", *Physics Today*, Vol. 43, no. 3 (March 1990), pp. 58-65.

Lattis, James M. *Between Copernicus and Galileo: Christopher Clavius and the Collapse of Ptolemaic Cosmology*. Chicago: Chicago University Press, 1994.

Laudan, Rachel. *From Minerology to Geology. The Foundation of a Science 1650-1830*. Chicago: University of Chicago Press, 1987.

L.B., H. " Watts, Isaac ", *The Dictionary of National Biography*, Vol. XX, pp. 978-81.

Leicester, Henry M. *The Historical Background of Chemistry*. New York: Dover Publications, 1971.

Lindberg, David C. ed. *Science in the Middle Ages*. Chicago: University of Chicago Press, 1970.

Lindberg, D.C. and Westman, R.S. *Reappraisals of the Scientific Revolution*. Cambridge: Cambridge University Press, 1990.

Loria, Gino. " Les femmes mathématiciennes ", *Revue scientifique*, no. 13, 4me. série, T. XX, (26 septembre 1903), pp. 388-91.

Maddalena, A. De, Rotelli E., Barbarisi G. eds. *Economia, istituzioni, cultura in Lombardia nell'età di Maria Teresa*, Vol. 2: *Cultura e società*. Bologna: Il Mulino, 1980.

Maffioli, C.S. " Guglielmini vs. Papin (1691-1697): Science in Bologna at the End of the Seventeenth Century through a Debate on Hydraulics ", *Janus*, Vol. 71, (1984), pp. 250-87.

Malamani, Vittorio. *Una giornalista veneziana del secolo XVIII.* Venice: Visentini, 1891.

Malavasi, Gloria. "L' Archivio privato Bentivoglio-Manzoli di Bologna (1327-1759)", *Inventario Università degli Studi di Bologna 1987-1988.* Facoltà di Lettere e Filosofia, Tesi: Archivistica. Corso di Laurea di Lettere Moderne.

Malpezzi Price, Paola. " A Woman's Discourse in the Italian Renaissance: Moderata Fonte's *Il Merito delle Donne* ", *Annali d' italianistica*, Vol. 7 (1989), pp. 165- 81.

Maragon, Tiziana P. " La Miscellania Astrologica del prototipografo padovano Bartolomeo Valdizoceo e la diffusione di testi astrologici e medici fra i lettori padovani del '400 ", *Quaderni per la storia dell' Università di Padova*, Vol. 11 (1978), pp. 87-106.

Maschietto, F.L. *Elena Cornaro Piscopia: la prima donna laureata del mondo.* Padua, 1978.

Masetti-Zannini, Gian Ludovico. " Laura Bassi (1711-1778): testimonianze e carteggi inediti ", *Strenna storica bolognese*, Anno XXIX, (1979), pp. 221-41.

_____ *Motivi storici della educazione femminile (1500-1650): scienza, lavoro, giuochi.* Naples: M.D' Auria, 1982.

Masi, Ernesto. " Laura Bassi e il Voltaire " in *Studi e ritratti.* Bologna: Zanichelli, 1881.

Masotti, A. " Maria Gaetana Agnesi ", *Rendiconti del seminario matematico e fisico di Milano*, Vol. XIV (1940-XVIII), pp. 89-127.

I materiali dell' Istituto delle Scienze. Bologna: CLUEB, 1979.

Maylender, Michele. *Storia delle Accademie d' Italia.* Bologna: A. Forni, 1926-1930.

Medici, Michele. " Elogio di Giovanni e di Anna Morandi coniugi Manzolini ", *Memorie della Accademia delle Scienze dell' Istituto di Bologna*, T. VIII (1857), pp. 3-26

Merchant, Carolyn. *The Death of Nature: Women, Ecology, and the Scientific Revolution.* San Francisco: Harper and Row, 1980.

_____ " Isis' Consciousness Raised ", *Isis*, Vol. 73, no. 268, (1982), pp. 398-409.

Michelis, C. De. " Caminer, Domenico ", " Caminer Elisabetta ", *D.B.I.*, Vol. 17, pp. 234-36, 236-41.

Montalenti, G. and Rossi, Paolo eds. *Lazzaro Spallanzani e la biologia del settecento.* Florence: L. Olschki, 1982.

Mozans, H.J. *Women in Science with an Introductory Chapter on Women's Long Struggle for Things of the Mind.* Cambridge, Mass.: M.I.T. Press, 1974 (1913).

Napoletani, Daniele. " Metodo e statica in Valerio con edizione di due opere giovanili ", *Bollettino di storia delle scienze matematiche*, Anno II, no. 1 (giugno 1982), pp. 3-173.

Nardi. E ed. *Atti dell' Accademia delle Scienze dell" Istituto di Bologna.* Bologna: Compositori, 1988.

Nash, Leonard K. " Plants and the Atmosphere " in *Harvard Case Histories in Experimental Science*, James Bryant Conant, L.K.Nash eds. Vol. 2. Cambridge: Harvard University Press, 1957.

Nastasi, P. " De Martino Nicola "and " De Martino Pietro ", *D.B.I.*, Vol. 38, pp. 600-07.

Nastasi, P. " I primi studi sull' elettricità a Napoli e in Sicilia ", *Physis*, Anno XXIV (1982), fasc. 2, pp. 237-64.

Nauert Jr., Charles G. " Humanists, Scientists, and Pliny: Changing Approaches to a Classical Author ", *American Historical Review*, Vol. 84, no. 1 (February 1979), pp. 72-85.

Nicolini Burgatti, Laura. *Maria Dalle Donne (1778-1842).* Loiano, 1971.

Noble, David F. *A World without Women: The Christian Clerical Culture of Western Science.* New York: A.A. Knopf, 1993.

Ogilvie, Marilyn. *Women in Science, Antiquity through the Nineteenth Century.* Cambridge, Mass.: M.I.T. Press, 1986.

Olmi, Giuseppe. *L' Inventario del mondo: catalogazione della natura e luoghi del sapere nella prima età moderna.* Bologna: Il Mulino, 1992.

Orofino, Giulia. " L' immagine della malattia del medievo: due testimonianze di età sveva ", *Medicina nei secoli, arte e scienza*, Vol. 8, no. 1 (1996), pp. 43-58.

Pace, Antonio. " Beccaria Giambattista ", *D.B.I.*, Vol. VII, pp. 469-71.

_____ *Benjamin Franklin and Italy.* Philadelphia: American Philosophical Society, 1958.

Palladino, Franco. " Origine e diffusione del calcolo differenziale in Italia. Con un appendice di lettere inedite ", *Giornale critico della filosofia italiana*, sesta serie, Vol. IV, Anno LXIII (settembre-dicembre 1984), pp. 384-90.

Palma, M. " Cereto, Laura ", *D.B.I.*, Vol. 23, pp. 729-30.

Paluzi, Giorgio ed. *Stefano Guazzo e la Civil conversazione*. Rome: Bulzoni, 1990.

Pannekoek, A. *A History of Astronomy*. New York: Dover Publications, 1989.

Pannella L. " Candi, Isabella ", *D.B.I.*, Vol. 17.

Park, David. *The Fire within the Eye. An Historical Essay on the Nature and Meaning of Light*. Princeton: Princeton University Press, 1997.

Pascoli, Lione. *Vite de' Pittori, Scultori e Architetti Perugini*. Rome: Antonio di Rossi, 1732.

Pasta, Renato. " L' Accademia dei Georgofili e la riforma dell' agricoltura ", *Rivista storica italiana*, anno CV, fasc. II (1993), pp. 440-50.

_____ " Fabbroni, Adamo ", *D.B.I.*, Vol. 32, pp. 669-73.

Pedrazzi, M. " Alesssandro Piccolomini e la sua assiomatica per la *Sfera del mondo* ", *Cultura e scuola*, anno XV, no. 63-64 (luglio-dicembre 1977), pp. 423-32.

Pepe, Luigi. " Il calcolo infinitesimale in Italia agli inizi del secolo XVIII ", *Bollettino di storia delle scienze matematiche*, Vol. I (dicembre 1981), pp. 56-89.

_____ " Note sulla diffusione della *Géométrie* di Descartes in Italia nel secolo XVII ", *Bollettino di storia delle scienze matematiche*, Anno II, no. 2 (dicembre 1982), pp. 249-88.

Perey, Lucien. *Une princesse romaine au XVIIe siècle: Marie Mancini Colonna après des documents inédits*. Paris: C. Lévy, 1896.

Peroni, Vincenzo. *Biblioteca bresciana*. Brescia, 1818-1823.

Piaia, Gregorio and Soppelsa, Maria Laura eds. *I Riccati e la cultura della Marca nel settecento europeo*. Florence: Olschki, 1992.

Pierattini, Giovanna. " Suor Fiammetta Frescobaldi: Cronista al Monastero Domenicano di Sant' Jacopo a Ripoli in Firenze (1523-1586) ", *Memorie Domenicane*, 56 (1939), pp. 101-16, 233-40, 57 (1940), pp. 106-11, 260-69, 58 (1941), pp. 28- 38, 74-84, 226-34, 258-68.

Pighetti, Clelia. *Influsso scientifico di Roberto Boyle nel tardo '600 italiano.* Milan: F. Angeli, 1988.

Pinet, Marie Josèphe. *Christine de Pisan, 1364-1430. Étude Biographique e Littéraire.* Paris: Honoré Champion, 1927.

Pirazzoli, Bruno. " La formazione filosofica del Card. Giulio Alberoni ", *Archivio storico per le provincie parmense,* quarta serie, 39 (1987), pp. 321-55.

Pomata, Gianna. *La Promessa di guarigione: malati e curatori in Antico Regime Bologna XVI-XVIII secolo.* Bari: Laterza, 1994.

Poppi, Antoni ed. *Scienza e filosofia all' Università di Padova nel quattrocento.* Padua: Lint, 1983.

Premuda, Loris. *Da Fracastoro al novecento: mezzo millenio di medicina tra Padova, Trieste e Vienna.* Padua: Lagarangola, 1996.

Pycior, Helena M., Slack, Nancy G., Abir-Am, Pnina. *Creative Couples in the Sciences.* New Brunswick, N.J.: Rutgers University Press, 1996.

Rappaport, Rhoda. " Italy and Europe: The Case of Antonio Vallisneri (1661-1730) ", *History of Science,* XXIX (1991), pp. 72-90.

Ravoux-Rollo, Elizabeth. *La femme à Venise au temps de Casanova.* Paris: Stock/Laurent Pernod, 1984.

Rebière, Alphonse. *Les femmes dans les sciences: notes recuilles.* Paris: Nony, 1897.

Richards, Evelleen. " A Political Anatomy of Monsters, Hopeful and Otherwise: Teratogeny, Transcendentalism, and Evolutionary Theory ", *Isis,* Vol. 85, no. 3 (September 1994), pp. 377-411.

Roberts, Gareth. *The Mirror of Alchemy. Alchemical Ideas and Images in Manuscripts and Books from Antiquity to the Seventeenth Century.* Toronto: University of Toronto Press, 1994.

Rosa, Mario. " Benedetto XIV ", *D.B.I.,* Vol. 8, pp. 398-408.

_____ *Riformatori e ribelli nel '700 religioso italiano.* Bari: Dedalo, 1969.

Rose, Paul Lawrence. *The Italian Renaissance of Mathematics. Studies on Humanists and Mathematicians from Petrarca to Galileo.* Geneva: Droz, 1975.

Rosen, Richard Leonard. " The Academy of Sciences of the Institute of Bologna, 1690-1804 ", Ph. D. Dissertation, Case Western Reserve University, 1971.

Rosenberg, Charles E. *The Cholera Years. The United States in 1832, 1849 and 1866.* Chicago: The University of Chicago Press, 1987.

Rossi, Paolo. *La nascita della scienza moderna in Europa.* Rome: Laterza, 1997.

Roversi, Giancarlo ed. *Donne celebri dell' Emilia Romagna e del Montefeltre dal Medioevo all' Ottocento.* Bologna: Graffis, 1993.

Sanlorenzo, Olimpia. *L' insegnamento di ostetricia nell' Università di Bologna.* Bologna: Alma Mater Studiorum Saecularia Nona, 1988.

Sarton, George. " Early Observations of Sunspots ", *Isis*, Vol. 37, Pts 1&2, nos. 107 &108 (May 1947), pp. 69-71.

Savaris, Paola. " Cristina Roccati: una rodigina del '700 tra scienza e poesia " *Tese di Laurea*, Università degli Studi di Ferrara, Facoltà di Magistero, anno Accademico 1990-1991.

Schiebinger, Londa. " Maria Winkelmann at the Berlin Academy: A Turning Point for Women in Science ", *Isis*, Vol. 78 (1987), pp. 174-200.

_____ *The Mind Has No Sex? Women in the Origins of Modern Science.* Cambridge, Massachussetts: Harvard University Press, 1989.

Schmidt Nielsen, Knut. *Animal Physiology.* Engle wood Cliffs, New Jersey: Prentice Hall, 1965.

Shanks, Merrill E. et al. *Pre-Calculus Mathematics.* Reading: Addison Wesley, 1965.

Shteir, Ann B. *Cultivating Women, Cultivating Science. Flora's Daughters and Botany in England 1760 to 1860.* Baltimore: The Johns Hopkins University Press, 1996.

Simeoni, Luigi. *Storia della Università di Bologna.* Vol. II: *L' età moderna (1500-1888).* Bologna: Zanichelli, 1947.

Siraisi, Nancy G. *Medieval & Early Renaissance Medicine. An Introduction to Knowledge and Practice.* Chicago: Chicago University Press, 1990.

_____ *Taddeo Alderotti and His Pupils: Two Generations of Medical Learning.* Princeton: Princeton University Press, 1981.

Smith, A.W., Cooper, J.M. *Elements of Physics.* New York, 1964.

Spenser, Samia I. ed. *French Women and the Age of Enlightenment.* Bloomington: Indiana University Press, 1984.

Spini, G. *Ricerca dei libertini: la teoria dell' imposture delle religioni nel seicento italiano*. Rome: " Universale di Roma ", 1950.

Stannard, Jerry. " Medieval Herbals and Their Development ", *Clio Medica*, Vol. 9, no. 1 (1974), pp. 23-33.

Stella, P. " Casati Michele ", *D.B.I.*, Vol. 21, pp. 262-65.

Stock-Morton, Phyllis. " Control and Limitation of Midwives in Modern France: The Example of Marseilles ", *Journal of Women's History*, Vol. 8, no. 1 (Spring 1996), pp. 60-94.

Storer, T.I. and Usinger R.L. *Elements of Zoology*. New York: McGraw-Hill, 1961.

Storia d' Italia. Annali 3: *Scienza e technica nella cultura e nella società dal Rinascimento a oggi*. Turin: Einaudi, 1980.

Struik, D. J. ed. *A Source Book in Mathematics 1200-1800*. Princeton: Princeton University Press, 1969.

Sutter, Rufus. " The Scientific Work of Alessandro Piccolomini ", *Isis*, 60 (1969), pp. 210-23.

Taton, René, Wilson, Curtis eds. *Planetary Astronomy from the Renaissance to the Rise of Astrophysics*. Vol. 2, Part B: *The Eighteenth and Nineteenth Centuries*. Cambridge: Cambridge University Press, 1995.

Tega, Walter ed. *Anatomie Accademiche*, Vol. II: *L' enciclopedia scientifica dell' Accademia delle Scienze di Bologna*. Bologna: Il Mulino, 1987.

Terrall, Mary. " Gendered Spaces, Gendered Audiences: Inside and Outside the Paris Academy of Sciences ", *Configurations*, 2 (1995), pp. 207-232.

Testoni, Alfredo. *Il Cardinale Lambertini. Commedia storica in cinque atti, con note. Introduzione di Luigi dal Pane*. Bologna: Capelli, 1975.

Tettoni, Emma. " Le scienziate italiane " in *La donna italiana descritta da scrittrici italiane*. Florence: Civelli. 1890.

Thorndike, Lynn. *A History of Magic and Experimental Science*. New York: Columbia University Press, 1934.

Tilche, G. *Maria Gaetana Agnesi*. Milan: Rizzoli, 1984.

Torrini, Maurizio. " L' Accademia degli Investiganti Napoli 1663-1670 ", *Quaderni storici*, no. 48 (1981), pp. 845-83.

Truesdell, C. " Maria Gaetana Agnesi ", *Archives for the History of Exact Sciences*, 40, no.2 (1989), 120-37.

Tugnoli Pattaro, Sandra. *Metodo e sistema delle scienze nel pensiero di Ulisse Aldrovandi.* Bologna: CLUEB, 1981.

_____ *La teoria del flogisto. Alle origini della rivoluzione chimica.* Bologna: CLUEB, 1983.

Turner, James G. ed. *Sexuality and Gender in Early Modern Europe: Institutions, Texts, Images.* Cambridge: Cambridge University Press, 1993.

Tutin, F.C. et al. *Flora europea.* Cambridge University Press, 1976.

Van Helden, Albert. *Measuring the Universe: Cosmic Dimensions from Aristarchus to Halley.* Chicago: University of Chicago Press, 1985.

Venturi, Franco. *Settecento riformatore.* Vol. I: *Da Muratori a Beccaria 1730-1764.* Turin: Einaudi, 1969.

_____ *Settecento riformatore.* V: *L' Italia dei Lumi.* Tomo secondo: *La Repubblica di Venezia (1741-1803).* Turin: Einaudi, 1990.

Vermiglioli, Gio: Battista. *Biografia degli scrittori Perugini e notizie delle opere loro.* Perugia: Baduel, 1829.

Vigilante, M. " Collina, Bonifacio ", *D.B.I.*, Vol. 27, pp. 58-60.

Villani, Carlo. *Stelle femminili.* 1915.

Villari, Rosario ed. *Baroque Personae.* Chicago: University of Chicago Press, 1995.

Visconti, D. " Acerbi Giuseppe ", *D.B.I.*, Vol. 1, pp. 134-36.

Voss, Stephen ed. *Essays on the Philosophy and Science of René Descartes.* New York: Oxford University Press, 1992.

Wear, A., French, R.K. and Lonie, I.M. eds. *The Medical Renaissance of the Sixteenth Century.* Cambridge: Cambridge University Press, 1985.

Westfall, Richard S. *The Construction of Modern Science: Mechanisms and Mechanics.* New York, 1971.

Wetzels, Walter D. " Newton for the Ladies: Algarotti's Popularisation of Newton's *Opticks* ", *Transactions of the Eight International Congress on the Enlightenment.* Oxford: The Voltaire Foundation, 1992, pp. 1152-55.

Wilson, Katherine M. ed. *An Encyclopedia of Continental Women Writers.* Vol. I: A-K. New York: Garland Publishing Inc., 1991.

Wilson, Lindsay. *Women and Medicine in the French Enlightenment. The Debate over Maladies des Femmes.* Baltimore: The Johns Hopkins University Press, 1993.

Zarri, Gabriella. *Le sante vive: profezie di corte e devozione femminile tra '400 e '500.* Turin: Rosenber & Sellier, 1990.

Zemon Davis, Natalie, Farge, Arlette. *Storia delle donne dal Rinascimento all' età moderna.* Bari: Laterza, 1991.

Zilsel, E. " The Sociological Roots of Modern Science ", *American Journal of Sociology*, 47, (1942), pp. 544-62.