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THE ETHNOBOTANY OF EAST TIMOR

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ABSTRACT

The ethnobotany of East Timor was examined for the first time with emphasis being placed on documenting traditional knowledge of medicinal plants. The medicinal plant traditions of 3 distinct East Timorese cultures were studied and compared using both modern quantitative ethnobotanical methods but also with classical descriptive ethnobotanical techniques. A total of 116 medicinal plant species were identified. The medicinal plant traditions of the Laklei and Idate cultures of East Timor were compared using Trotter and Logan's (1986) quantitative 'informant consensus factor'. On average, informant consensus was greater in Laklei suggesting a medicinal plant tradition that is more well defined than in Idate, where informants are more likely to use the same medicinal plants when treating similar illnesses. Furthermore, only 11 of 86 medicinal plant species documented with these two cultures were used by both cultures of which only 6 had similar uses. The medicinal plant tradition of a third indigenous culture, the Fataluku people, was documented using classical descriptive ethnobotanical techniques. Over 70% of the Fataluku medicinal plants were different from those used by the Laklei or the Idate people. In general, findings from studying the medicinal plant traditions of the Idate, Laklei and Fataluku people suggest that several distinct medicinal plant traditions exist on the island. In addition to documenting traditional knowledge of medicinal plants, indigenous culture and its relationship with biodiversity resources was documented and a lab study of natural insecticides selected through an ethnobotanical approach was conducted. Crude extracts of three natural insecticides were very active but as a group the traditionally used insecticides did not have significantly greater activity than other medicinal plants. Recommendations were made concerning the development potential of traditionally used plants of East Timor. Priority

plants were identified with particular promise as phytomedicines, natural insecticides and natural health products.

RÉSUMÉ

L'ethnobotanique du Timor Oriental a été étudiée en mettant pour la première fois l'emphase sur la documentation de la connaissance traditionnelle des plantes médicinales. Les plantes médicinales de trois cultures Est-Timoraises ont été répertoriées et comparées en utilisant non seulement des méthodes modernes d'ethnobotanique quantitative, mais aussi des techniques classiques d'ethnobotanique descriptive. Un total de 116 plantes médicinales traditionnelles utilisées par les cultures Laklei et Idate ont été comparées quantitativement en calculant les 'facteurs de consensus des informants', méthode dévelopée par Trotter et Logan en 1986. En moyenne, le consensus des informants était plus élevé chez les Lakleis, ce qui suggère une utilisation des plantes médicinales traditionnelles mieux définie que chez les Idates. Chez ces derniers, les informants ont tendance à utiliser les mêmes plantes médicinales lorsqu'ils traitent des maladies similaires. De plus, seules 11 des 86 espèces de plantes médicinales documentées pour ces deux cultures ont une utilisation commune, dont 6 pour des usages similaires. Les plantes médicinales traditionnelles d'une troisième population indigène, les Fatalukus, ont été documentées en utilisant des techniques classiques d'ethnobotanique descriptive. Plus de 70% des plantes médicinales Fatalukus sont différentes de celles utilisées par les Lakleis ou les Idates. En générale, les découvertes découlant de l'étude des plantes médicinales traditionnelles des Idates, Lakleis et Fatalukus suggèrent l'existance de plusieurs traditions médicinales sur l'île. Pour documenter d'avantage les connaissances traditionnelles des plantes médicinales, l'étude des relations entre les cultures et la biodiversité environnante, ainsi qu'une analyse en laboratoire d'insecticides naturels sélectionnés par l'approche ethnobotanique ont été entreprises. Les extraits bruts de trois insecticides naturels ont été très actifs, mais dans l'ensemble, les insecticides utilisés traditionnellement n'ont pas montré d'activités significativement plus élevées que d'autres plantes médicinales. Des recommendations ont été faites concernant le potentiel de développement des plantes médicinales traditionnelles du Timor Oriental. Les plantes prioritaires ont été identifiées en se basant principalement sur leur potentiel à fournir des phytomédicaments, des insecticides naturels ou des produits de santé naturelle.

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CHAPTER 1

GENERAL INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction

The ethnobotanical literature for the Malay archipelago is large (Elliott and Brimacombe 1987, Grosvenor *et al.* 1995, Holdsworth and Wamoi 1982). However, research documenting traditional botanical knowledge in East Timor is virtually non-existent. While many articles have been written concerning the ethnobotany of peoples in the Malay archipelago, they are mostly descriptive accounts that fail to use quantitative methods. One notable exception is the work of Leaman *et al.* (1995) where they correlated anti-malarial activity to informant consensus. The lack of scientific research in East Timor in general is due to its remoteness but more importantly, the political instability during much of the 20th century.

At the time of writing this thesis, East Timor, emerging from hundreds of years of conflict with occupying forces, is at a critical point in its development. Many highly skilled East Timorese fled during the violence of the summer of 1999 including business men, teachers and civil servants (Hill 2001). At least 50% of urban East Timorese are unemployed (Hill 2001). As a result of the 'scorched earth policy' implemented by the Indonesian army and East Timorese militias just before independence, physical infrastructure and health services are minimal (Zwi and Silove 2002). East Timor is in desperate need of development assistance to aid in stabilizing the society and helping it to develop economically.

USC (formerly known as the Unitarian Services Committee) is a Canadian based non-governmental organization that addresses development issues in Asia and Africa. Their main focus is improving agricultural methods through the introduction of better crop varieties, irrigation and farming techniques and preserving seed diversity and minimizing post harvest loss through their award winning 'seeds of survival' program. In collaboration with USC, this research was undertaken with two main objectives; 1) to document the traditional use of plants in East Timor with a focus on medicinal and insecticidal uses and 2) to propose realistic development objectives that arise from the documentation of this body of traditional knowledge.

1.2 The Modern Field of Ethnobotany

"Ethnobotany is the study of the direct interrelations between humans and plants" (Ford 1978). Throughout the 21^{st} century, the field of ethnobotany has struggled to receive recognition from the scientific community as a true scientific endeavor that contributes to scientific knowledge. One criticism of the field ethnobotany is simply a descriptive process that fails to quantify data and test hypotheses. While this may be true of some early research, modern ethnobotanists now utilize quantitative methodologies which enable the testing of hypotheses.

The documentation of traditional botanical knowledge can make significant contributions to not only the scientific literature but also to the sustainable development of less developed nations. Contributions include rigorous documentation of ancient knowledge systems that are being eroded through exposure to foreign cultures and identification of useful non-timber forest products with market potential. Literature pertaining to the progression of ethnobotany to a true science through the development of quantitative methodologies and the increased understanding of the importance of non-timber forest products will be reviewed.

1.2.1 Quantitative Ethnobotany

Early ethnobotanies were typically botanical lists that summarized information such as Latin name, local name, habitat of the plant, use of the plant and mode of preparation. However, there has been a recent shift in ethnobotanical literature towards methodologies incorporating quantitative techniques. Phillips (1996) sorted ethnobotanical methods into three categories; 1) uses totaled, 2) subjective allocation and 3) informant consensus.

The 'uses totaled' approach, used by Carneiro (1978), was the first attempt at developing a method to quantify the use of plants by people. This approach includes percentage use of plant species, and rank ordered lists. Boom (1987) is given credit as the first person to quantify ethnobotanical data. Unlike Carneiro, he collected voucher specimens. In Boom's study of the Chacobo Indians in Amazonian Bolivia, he calculated percentage use of trees (Boom 1987). His findings were that the Chacoba use 85% of tree species and 95% of individual trees in the hectare plots he examined (Boom 1987). This method of calculating percentage use of plants by indigenous people prevailed for some time and is still included in recent ethnobotanical studies (Anderson and Posey 1989, Boom 1990, Grosvenor *et al.* 1995).

The use of 'rank-ordered lists' is a method that is an approximation of importance of plants and how widely used a plant is. Lykke (2000) used rank-ordered lists when examining vegetation change in the Sine Saloum Region of Senegal. Species are recorded in order of the number of times they were cited as being used by the local people. Lykke (2000) used rank-ordered lists for four use categories which were construction wood, agriculture, medicine and livestock fodder. Using Spearman's rank tests, Lykke (2000) demonstrated that important construction, agricultural and all of the 20 most highly preferred species overall were thought by informants to be declining in abundance.

Frei *et al.* (1998) also used rank-ordered lists to identify medicinally important plant species to the Zapotecs of Mexico. Frei *et al.* (1998) divided medicinal use in terms of usage categories (i.e. dermatological, gastrointestinal, respiratory, etc…) and considered 'culture bound syndromes' to be a category. After establishing rank-ordered lists for the categories, the most frequently used species for treatment of each category of disease were researched in the literature. Phytochemical and pharmacological relevance for 'important' species were confirmed for many of the species by the literature reviews (Frei *et al.* 1998).

Unlike 'uses totaled', the approach of 'subjective allocation' seeks to quantify ethnobotanical information by taking relative use into consideration. Early studies using percentage use, weighted all plants equally in the calculation without regard for how heavily used the plant was. Prance *et al.* (1987) wanted to develop a method that gave more weight to heavily used (and therefore important) plants. Based on local perceptions, they assigned relative use to plants as being either a major use, which counted as 1.0, or a minor use which counted as 0.5. Separate use values were calculated for each use category that a plant was included in. Therefore, if plant A had a minor food use, a major remedy use and a minor commerce use, its combined use value was 2.0. Using this technique, it is possible to calculate family use values by summing use values for all species in a family and dividing by the total number of species in the family. This same methodology was used by Pinedo-Vasquez *et al.* (1990) who concluded that; 1) secondary forests are heavily used, 2) species with higher use values were important because there was a market for them and 3) species with exceptionally high use values were usually scarce from over extraction.

Another approach to subjective allocation was taken by Turner (1988), who assessed the importance of plants to the Lillooet Interior Salish and the Thompson people of British

Columbia. Turner developed an 'index of cultural significance' (ICS) which is calculated using the following equation:

$$\text{ICS} = \sum_{i=1}^{n} (q \times i \times e)_{\text{ui}} \qquad (1)$$

where

ICS = Index of Cultural Significance
q = quality of use
i = intensity of use
e = exclusivity of use
ui = specifies the specific use (no numerical designation)

Quality describes the cultural role of a plant. Those plants which contribute more to survival are more heavily weighted. Plants used daily received higher intensity ratings and highly preferred plants received higher exclusivity ratings. The scales of value for quality, intensity and exclusivity were constructed from Turner's judgment which renders this approach subjective and therefore it is unlikely that results are repeatable. Turner determined that the plants used by the Thompson group had a higher ICS than the plants used by the Lillooet group. Possible explanations for this as suggested by Turner include; 1) the ethnobotanical literature reviewed used to compile the ICS values were more comprehensive for the plants used by the Thompson group and 2) the Thompson people may attribute a greater importance to plants.

The 'informant consensus' approach is currently the most widely used quantitative method and with continued refinements will define ethnobotanical research in the future. Phillips (1993a) developed an objective method of assigning a use value to a plant that enabled the testing of hypotheses. The index determines the use value of a plant for a particular informant and an index to determine the overall use value of a plant species totaled across informants (Phillips 1993a). The calculation for the use value of a plant for one informant (UV_{is}) is given below where U_{is} is the number of uses of the plant in each event by informant i and n_{is} is the total number of events for species i with informant s.

$$UV_{is} = \frac{\sum U_{is}}{n_{is}} \qquad (2)$$

The calculation for the overall use value of a plant (UV_s) is given below where n_s is the number of informants (Phillips 1993a).

$$UV_s = \frac{\sum_i UVis}{n_s} \qquad (3)$$

For the purpose of these indices, an event was defined as "the process of asking one informant on one day about the uses they know for one species" (Phillips 1993a).

Phillips and Gentry consider this is an effective method because uses that are seldom mentioned are rendered negligible through the calculation and the continuous variable can be analysed with several different statistical techniques making the testing of falsifiable hypotheses possible (Phillips 1993a).

Phillips addressed two questions, 1) "are species equally useful?"and 2) "are families equally useful?" (1993a). For the first question, the non-parametric Kruskal-Wallis test was used with the result that certain species (especially palms) were of higher importance. For the second question, a method was adapted from Moerman (1979, 1991, 1996) which uses regression analysis. Using this method, they determined that Arecaceae, Annonaceae and Lauraceae were the most useful families. Phillips and Gentry continued to use their 'informant consensus' to test a series of hypotheses including whether or not 1) physical traits of plants can determine their usefulness, 2) informant knowledge varies with age, and 3) different forest types are equally useful (Phillips and Gentry 1993b, Phillips *et al.* 1994).

Begossi (1996) was the first to introduce ecological diversity indices to the field of ethnobotany. In his paper he used the Shannon-Weiner index, evenness and the rarefaction method to analyze differences in diversity between areas. The Shannon-Weiner index is a widely used ecological index that can be calculated readily (Begossi 1996). The calculation for the Shannon-Weiner index is given below.

$$H' = -\sum p_i \log p_i \qquad (4)$$

where pi = number of citations or informants per species

By calculating diversity with respect to species cited by informants, one is able to evaluate the intensity of plant use by different groups; men as opposed to women, and old as opposed to young (Begossi 1996, Begossi *et al.* 2002). Also, by calculating evenness, researchers can assess if the knowledge is spread evenly throughout the population, or held by a limited number of individuals (Begossi 1996). Begossi's studies in Peru, Mexico, Brazil and Thailand indicate high diversities of plant use. Furthermore, the theory of island biogeography with respect to plant use where "islands (especially distant ones) have a less diverse use of plants", holds true for the data analyzed by Begossi (1996). Other studies which use ecological methods include Lamont *et al.*'s (1999) research on diversity of Amazonian home gardens, Rossato *et al.*'s (1999) comparisons of plant use on mainland and island communities and Byg and Balslev's (2001) study of the use of palms in Madagascar.

'Informant consensus' was used by Heinrich *et al.* (1998) to compare plant usage across four Mexican indigenous groups; Maya, Nahua, Zapotec and Mixe. They used the method developed by Trotter and Logan (1986) and applied the informant consensus factor formula below:

$$F_{ic} = \frac{n_{ur} - n_t}{n_{ur} - 1} \qquad (5)$$

where

F_{ic} = informant consensus factor
n_{ur} = number of use-reports in each category
n_t = number of taxa used

This equation compares the number of use-reports in a category and the total number of taxa used in the category concerned (Heinrich *et al.* 1998). Values for the factor range from 0 to 1. A value of 1 indicates few taxa are used by healers, thus inferring a high degree of consensus and a well defined medicinal plant tradition (Heinrich *et al.* 1998). For Heinrich *et al.*'s (1998) purpose, a category corresponded to different medical problems and the taxa concerned was species. Heinrich *et al.* (1998) concluded that consensus was high amongst the cultural groups for gastrointestinal illnesses and culture bound syndromes.

In 1979, Moerman began a series of research projects to explore the issue of whether or not the selection of plants used for medicinal purposes by Native Americans was random. The work focused on whether certain groups of plant types had an unusually high or low number of species used for medicinal purposes. In his research, Moerman compared a census of all plant species found in North America to a database of North American species with known medicinal applications (1979, 1991, 1996). Using linear regression, he was able to determine whether the number of medicinal species was a function of the number of species in the grouping system in question (i.e. family for example) or that certain plant types were more intensely used in traditional medicine.

In Moerman's third paper, he determined whether the number of medicinal species in a family is a function of the number of species in the family (1996). Moerman first regressed the number of medicinal species in a family against the total number of species in the family. By doing so, he calculated the equation of the regression line in the form

Medicinal Species = (y intercept) + (slope)(Number of Species in the Family) (6)

Using this equation he determined residuals which are a measure of how different the actual number of medicinal species in a family are compared to the predicted number of medicinal species by the regression line. He was able to demonstrate that plant families with particularly high or low residuals exhibit exceptionally high or low selectivity respectively, by Native North Americans for medicinal uses. Using this technique, Moerman identified high use families such as Asteraceae and Apiaceae with residuals of 90.4 and 39.4 respectively, and low use families such as Cyperaceae and Poaceae with residuals of –79.9 and –109.8 respectively. Moerman's methodology was repeated by Phillips and Gentry (1993b) and Kapur *et al.* (1992) in the Kashmir State of India.

Teshome *et al.* (1999) tested the knowledge of Ethiopian farmers at predicting the storability of sorghum land races. Farmers were asked to categorize the sorghum they were growing as either a stored landrace or a non-stored landrace. Stored landraces were defined as those used at least one season from the time of harvesting and non-stored landraces were harvested and used immediately. The farmers were then asked how long their stored landraces lasted when exposed to *Sitophilus oryze* (a species of weevil that is a significant pest of stored sorghum). Storability was ranked as short, medium or long (Teshome *et al.* 1999). A farmer's index was used to calculate a value of the landrace's storability. The farmer's index can been seen below.

$$FI = \frac{4\,(L) + 2\,(M) + 1\,(S)}{L + M + S} \qquad (7)$$

FI = Farmer's Index for a stored-sorghum landrace

L = number of farmers who responded that the stored landrace had a long duration of storability (i.e. greater than two growing seasons)

M = number of farmers who responded that the stored landrace had a medium duration of storability (i.e. less than two growing seasons)

S = number of farmers who responded that the stored landrace had a short duration of storability (i.e. less than one growing season)

L + M + S = total number of farmer respondents who ranked the duration of storability of the stored landrace as long, medium or short

Stored sorghum landraces were then exposed to *S. oryze* and 5 variables were measured 1) F1 emergence, 2) development period 3) sorghum weight loss, 4) eggs/replicate, and 5) Dobie Index. The Dobie Index is a measure of the number of progeny divided by their median development time (Teshome *et al.* 1999). Development period was the only variable to demonstrate a low correlation (20%) while all other variables had correlations greater than 75% with the farmer's index (Teshome *et al.* 1999).

Leaman *et al.* (1995) tested the correlation of a local importance value index for traditional malaria remedies with their ability to inhibit *Plasmodium falciparum.* For their study, Leaman *et al.* (1995) developed a straightforward index to categorize the importance of a given malaria remedy. The index assigned a value to each remedy based on how many times it was cited; 1 for remedies cited once during the study, 2 for remedies cited twice in a community, 3 for remedies cited at least three times in a community and 4 for remedies cited in more than one community (Leaman *et al.* 1995). Crude extracts of the remedies were screened for antiplasmodial activity at concentrations of 10 and 20 ug ml^{-1} against *P. falciparum* using human red blood cells (Leaman *et al.* 1995). Both remedies, which had an importance value of 4, demonstrated significantly greater antiplasmodial activity on *P. falciparum* at both concentrations than remedies with lower importance values.

From my review of quantitative ethnobotanical literature, a few trends were noted. 1) Despite the apparent simplicity of uses totaled methods, this type of data is incorporated in almost all ethnobotanical studies, however it is seldom the focus or major finding of the study. 2) Subjective allocation was a first attempt at quantifying relative use of plants and was an essential stepping stone in ethnobotany. However, only a few studies using this technique are available and I believe this approach will not be used frequently in the future despite its popularity in the late 1980's. 3) Studies employing an informant consensus approach will continue to dominate ethnobotany because they can be analyzed rigorously using statistics and the findings are highly replicable.

Despite the fact that quantitative ethnobotany has experienced a rapid evolution, the value of recording indigenous knowledge in a traditional ethnobotanical approach has not been replaced. Phillips (1996) puts it succinctly; "Although quantitative techniques allow us to analyze patterns of plant use knowledge, in a full ethnological study they cannot replace the need for careful qualitative description of indigenous knowledge".

1.2.2 Non-timber Forest Products

NTFP (non-timber forest products), also known as NWFP (non-wood forest products) or minor forest products, describe a broad category of items harvested from the forest which include medicinal plants, fruit, resins, bush meat, latex and fibers. NTFP play a significant role in rural economies in tropical countries as they are available to the local/indigenous community at no cost since the land is, in most cases, publicly held. In tropical societies, NTFP provide vital building, nutritional and medicinal resources when affordable alternatives don't exist. Research concerning the use of NTFP has intensified on a global scale because NTFP may offer unique conservation opportunities through the use of extractive reserves, yield commercially valuable items such as pharmaceuticals or new varieties of crops and contribute to small scale rural economies where potential economic activities are rare or absent (Hall and Bawa 1993, Mendelsohn and Balick 1995).

The most often cited study regarding the yield in economic terms from NTFP extraction was made by Peters *et al.* (1989). They compared the net present value (NPV) of all NTFP from a one hectare plot in the Amazonian rainforest to the NPV of two destructive forest practices; timber extraction and cattle ranching. By Peters *et al.'s* (1989) calculation, the NPV for NTFP extraction from the 1 hectare plot was nearly twice the NPV for both timber extraction and cattle ranching. Peters *et al.* (1989) concluded that NTFP extraction has financial benefits that exceed those derived from forest conversion and made the bold statement that "Without question, the sustainable exploitation of non-wood forest resources represents the most immediate and profitable method for integrating the use and conservation of Amazonian forests". Peters *et al.*'s (1989) findings fostered the perception that high financial yields from NTFP extraction would encourage conservation of tropical rainforests by out competing destructive forest practices.

Other research, which put a value to NTFP extraction from tropical forest plots soon followed in support of Peters *et al.*'s (1989) conclusions (Balick and Mendelsohn 1992, Grimes *et al.* 1994). During the '90s, there was widespread optimism that high economic return from NTFP extraction from tropical rain forests would be able to justify their conservation. Not only were high economic returns forecast based on appraisals with respect to NTFP but also with respect to tourism, development of new pharmaceuticals, their value as carbon sinks and their importance in the hydrological cycle (Adger *et al.* 1995, Mendelsohn and Balick 1995, Tobias and Mendelsohn 1991).

While the argument that tropical rain forests should be protected because of their economic value to local people seems valid, the scientific method used to arrive at this conclusion has been questioned. Southgate and Clark (1993) strongly criticize Peters *et al.*'s (1989) methodology, stating that one of its' greatest shortcomings was that post-harvest loss was not accounted for. Ninety percent of the NTFP market value considered by the Peters *et al.* (1989) study was fruit which is highly susceptible to post harvest loss chiefly as a result of poor packaging and damage during transportation to markets (Salafsky *et al.* 1993).

Other explanations for the high valuation of NTFP in Peters *et al.*'s (1989) study are 1) a close proximity to an unusually strong market in the study site due to its isolation and therefore reduced competition from foreign goods, 2) customers of Indian and rubber tapper descent who are familiar with and like purchasing NTFP and 3) failure to take into consideration the effects of increased extraction of NTFP and the impact that this would have on the supply (Browder 1992, Southgate and Clark 1993).

Other critical reviews of whether the extraction of NTFP should be considered a viable rationale for tropical forest conservation focused on ecological and social factors. One of the most important constraints on the economic value of NTFP in tropical forests is the abundance of the NTFP themselves, a point that was made even in initial studies such as that by Peters *et al.* (1989). In tropical forest systems although the overall species diversity is very high, the frequency of individual species is low. This fact has important consequences with respect to harvesting species economically (Browder 1992, Crook and Clapp 1998, Salafsky *et al.* 1993, Shanley *et al.* 2002). NTFP with low species abundance require more intensive search techniques, more travel and longer collecting time to harvest which all significantly reduce the profitability of harvest (Salafsky *et al.* 1993).

Other important ecological factors for determining the viability of NTFP extraction are the temporal availability of different NTFP products and the long term sustainability of the resource (Boot and Gullison 1995, Salafsky *et al.* 1993). In Kalimantan, Indonesia, fruiting cycles are extremely long and some species only fruit once every 7 years (Salafsky *et al.* 1993). Markets for these fruits are therefore difficult to establish as the availability of the product is unreliable. The situation is made less viable by the availability of preferred domesticated varieties which out compete wild fruit (Salafsky *et al.* 1993).

The degree to which NTFP are harvested sustainably both in terms of the species itself and the overall health of the ecosystem is important in determining whether NTFP extraction has long term potential. When only part of the plant is harvested, for example seeds or nuts, this could often be highly sustainable to the individual but may have harmful effects to regeneration of the species and also on wildlife that rely on the plant species as a food source (Boot and Gullison 1995, Salafsky *et al.* 1993). Often NTFP extraction can be very destructive to the individual plant and general population when the roots or entire plant is harvested.

The challenges of sustainability of NTFP extraction are made greater by extreme boom and bust cycles. In some situations, increased demand for an NTFP may encourage extractors to harvest at levels that are well over sustainable levels. This could lead to the extinction locally of some NTFP (Crook and Clapp 1998). Other factors which affect the viability of NTFP extraction are 1) land tenure issues, 2) NTFP demand, 3) infrastructure and 4) political decision making (Salsafky *et al.* 1993, Shanley *et al.* 2002). NTFP harvesting often occurs on lands for which no clear land tenure has been established and are therefore open to the public with potential for extreme over extraction (Salafsky *et al.* 1993). This system offers no incentive to harvesters to conserve the resource for the future which results in further reducing the sustainability of the resource (Browder 1992, Salafsky *et al.* 1993).

Shanley *et al.* (2002) concluded that low demand for medicinal plants in NTFP markets in Brazil was a serious obstacle to NTFP extraction becoming economically feasible. Medicinal plant harvesters spend considerable time searching for medicinal plant species that occur at low densities which is not compensated for by the low price (USD 0.70 – 1.15 per 200 g package of medicinal bark) customers are willing to pay (Shanley *et al.* 2002).

Markets are often difficult and costly for extractors to reach, a problem that is made worse by poor transportation infrastructure. At times harvesting periods coincide with the rainy season which make road conditions hazardous (Shanley *et al.* 2002). Furthermore, government policy and decision making often favour the more destructive forest practices such as timber extraction. These industries are often controlled by well connected, politically powerful people, while NTFP extractors are typically the poor marginalized members of society (Salafsky *et al.* 1993).

The harvesting of sandalwood from West Timor and *Prunus africana* from Cameroon provide good examples of unsustainable harvesting of NTFP. Sandalwood, *Santalum album*, is found in the Timor region. It has several traditional uses but is most well known for demand in North America, Asia and Europe for the oil which is processed into perfumes and cosmetics (Rohadi *et al.* 2004). Since the end of colonial times when the trade of sandalwood in West Timor fell under Dutch jurisdiction, the Indonesian government has assumed complete control of the industry. The government has outlined explicitly that they own all naturally regenerated sandalwood and that citizens choosing to plant sandalwood will receive only 15% of the total value. Furthermore, Rohadi *et al.* (2004) indicate that "the local government has monopolized all matters regarding exploitation, and marketing of sandalwood". Sandalwood is becoming increasingly scarce in the area because 1) international demand for sandalwood oil remains high while the supply is decreasing as sandalwood has yet to be grown successfully in plantation in the Timor region, 2) illegal logging is common despite a government moratorium on sandalwood harvest and 3) the rights of local people concerning ownership over sandalwood have not been recognized by the government. Because the benefits from sandalwood extraction have been felt solely by the government no incentives for local people to help the regeneration or aid in preservation of wild stocks exist. For example, some locals have actually killed sandalwood seedlings as a means of avoiding the responsibility for its maintenance (Rohadi *et al.* 2004).

Prunus africana, also known as African cherry or pygeum, is a widely used traditional medicine in Cameroon where it is reported to be used in the treatment of malaria, "men's problems", gastrointestinal ailments and as an aphrodisiac (Stewart 2003). The wood is highly sought after as a building material, for tent pole construction and in the construction of handles for hoes (Stewart 2003). Bark from *P. africana* is exported to large manufacturers of herbal products, primarily in Europe, who then process the material into a wide array of herbal preparations used to treat benign prostatic hypertrophy (Cunningham *et al.* 2002).

In 1972, Plantecam Medicam, a subsidiary of Laboratoire Debat of France, established a large extraction factory in Cameroon where bark collected in nearby afromontane forest was delivered by local employees of the company (Cunningham and Mbenkum 1993). Employees were instructed on how to harvest the bark in a sustainable manner where only opposing quarters of the tree bark were stripped. The harvesting of bark appeared sustainable until 1985 when the government of Cameroon issued 50 additional harvest licenses to Cameroonian entrepreneurs (Cunningham and Mbenkum 1993). Extreme overexploitation of *P. africana* resulted due to too many licensed harvesters, a severely devalued Cameroonian currency through the '90s compensated for by increased harvesting by Plantecam Medicam employees and the erosion of traditional forestry management systems (Cunningham and Mbenkum 1993, Schröder 2001, Stewart 2003). Plantecam Medicam was forced to close in 2000 as a result of "economic, political and biological factors" (Stewart 2003).

Both the examples of sandalwood and African cherry demonstrate the potential hazards when trying to manage an NTFP with considerable international demand and therefore considerable economic development opportunities. In both cases, poor policy decisions were made by governments which factored heavily into the overexploitation of a resource. These examples indicate the importance of social factors in predicting the success of NTFP extraction. A lack of success in establishing large scale cultivation in plantation forests or as part of small scale farming projects contributed significantly to the overexploitation of wild stocks for both species (Cunningham *et al.* 2002, Rohadi *et al.* 2004). The importance of cultivation as a means of preserving NTFP resources has been mentioned by several authors (Cunningham *et al.* 2002, Mahapatara and Mitchell 1997, Rohadi *et al.* 2004, Shinwari and Gilani 2003). Sustainable international development through marketing NTFP will be very difficult to achieve without domestication and either plantation or cultivation in small scale farming systems.

Successful international development may yet be attainable through the use of NTFP. Madagascar has a unique flora where 85% of plants are endemic (Rosoanaivo 2003a). Approximately 3500 plant species are reported as being traditional medicines of which several are exported to Europe and the United States of America to be processed into natural health products and for use by the pharmaceutical industry (Rosoanaivo 2005b). During the early 1970s, export of medicinal plants, including Madagascar periwinkle (*Catharanthus roseus*), *Centella asiatica* and African cherry (*Prunus africana*), from Madagascar was at its highest level and significant volumes of medicinal plants are still exported today (Rosoanaivo 2005a). While small scale farmers do benefit financially from the medicinal plant industry in Madagascar as they are the primary collectors, Rosoanaivo (2005a) states that income earned from medicinal plant collection is less than the amount needed for subsistence and that farmer's are apprehensive about the industry as demand for the plants is highly variable.

Realizing the importance of medicinal plants not only for their export benefits but also for their role as phytomedicines and as a source of primary health care, the government of Madagascar has written a national policy on traditional medicine which seeks to "improve access for the population, especially the most vulnerable populations, to quality care and service" (Rosoanaivo 2005b). To name a few objectives, the policy seeks to regulate the use of traditional medicine for safety and efficacy, encourage dialogue between practitioners of traditional medicine with modern research and medical facilities and establish guidelines for the protection of intellectual property rights. Specific initiatives currently underway include the 'Malagasy Pharmacoepia' and phytomedicine production. The objective of the 'Malagasy Pharmacoepia' project is to identify the top 100 most important traditionally used medicines and detail botanical, geographical and phytochemical information as well as perform further assays to determine other activities (Rosoanaivo 2005b). Findings of the 'Malagasy Pharmacoepia' will be used in selecting traditional medicines with particular promise for the production of phytomedicines to be used by locals to combat prevalent conditions such as diarrhea, malaria, diabetes and AIDS (Rosoanaivo 2005b).

1.3 East Timor Background

1.3.1 History

For over 400 years East Timor has been either under colonial rule or occupied by foreign countries (Rawski 2002). Beginning in the 16th century, the Portuguese began to settle East Timor motivated primarily by the lucrative international trade in sandalwood, *Santalum album* (McWilliam 2003). Portuguese colonizers made little contribution to either the social or physical infrastructure of East Timor; however, their destructive presence was felt by decimating the sandalwood resource (Rawski 2002). In the early 1940s, the Japanese invasion and subsequent occupation of East Timor resulted in tens of thousands of East Timorese being killed while fighting the Japanese and from widespread famine (Rawski 2002).

At the end of World War II, Portugal resumed control of East Timor until Lisbon offered independence to the East Timorese in 1974 (Rawski 2002). Independence was short lived as Indonesian forces invaded in 1975 and by 1978 assumed control of the majority of the territory. Throughout the next 24 years, Indonesian forces carried out an illegal occupation where aggressive military operations were carried out against the population in direct violation of international law (Cotton 2001). During the occupation, it is estimated that approximately 100 000 to 200 000 East Timorese died at the hands of the Indonesian army (Cotton 2001). Acts of extreme violence, including torture and mass killings, were not uncommon (Modvig *et al.* 2000, Rawski 2002). In 1997 during the Asian economic crisis, the Indonesian government appealed to the International Monetary Fund for assistance thereby giving political leverage to the UN to establish East Timor as an independent state (Cotton 2001).

In August 1999, a UN sponsored 'popular consultation' was held, where 78.5% of East Timorese voted in favour of an independent state rather than autonomy within Indonesia (Chopra 2000). Following the vote, Indonesian forces and East Timorese militias implemented a 'scorched earth policy' and destroyed 70% of the physical infrastructure of the country. It is estimated that thousands of East Timorese were then murdered (Chopra 2000). The extreme violence forced the UN to deploy INTERFET (the Australian led International Force in East Timor) in September 1999 and later UNTAET (United Nations

Transitional Authority in East Timor) in November 1999 (Chopra 2000). While INTERFET is often criticized as arriving too late, the UN presence was instrumental in establishing East Timor as the newest independent nation on May 20, 2002.

1.3.2 Site Description

The total land area of East Timor, which includes the island of Jaco at the eastern tip of the country and Atauro Island north of Dili, is approximately 14 000 km^2 (Monk *et al.* 1997). During the Indonesian occupation, East Timor was part of the Nusa Tengarra province of Indonesia, with Dili, the present capital of East Timor, as the provincial capital. East Timor is composed of 13 districts, each with their own district capital, including the Oecussi enclave in West Timor. The country is approximately 300 km long by 100 km at its widest point (McWilliam 2003).

East Timor is a very mountainous country with several peaks greater than 2000 m. The landscape is dominated by the Ramelau range which runs along the long axis of the island. Hills on the north coast plunge directly into the sea, however, an extensive coastal plain on the south side of the island coupled with higher annual rainfall provides better conditions for agriculture. Accurate records indicate that 41% of East Timor is forested with only 29% of that being 'closed' forest, as described in McWilliam (2003). Forest types as defined by the Ministry of Agriculture, Forestry and Fisheries of East Timor are dry lowland forest, moist forest, montane forest and swamp. According to Whitmore (1975) however, the vegetation is classified as monsoon forests and savanna due to the marked wet and dry season with low annual precipitation. Furthermore, East Timor has several typical monsoon forest species including *Aegle marmelos*, *Cassia fistula*, *Eucalyptus alba*, *Tamarindus indica* and *Melia azedarach* (Whitmore 1975). While the majority of the country is very dry, small pockets of rain forests are present along the south coast due to rain from the on-shore winds

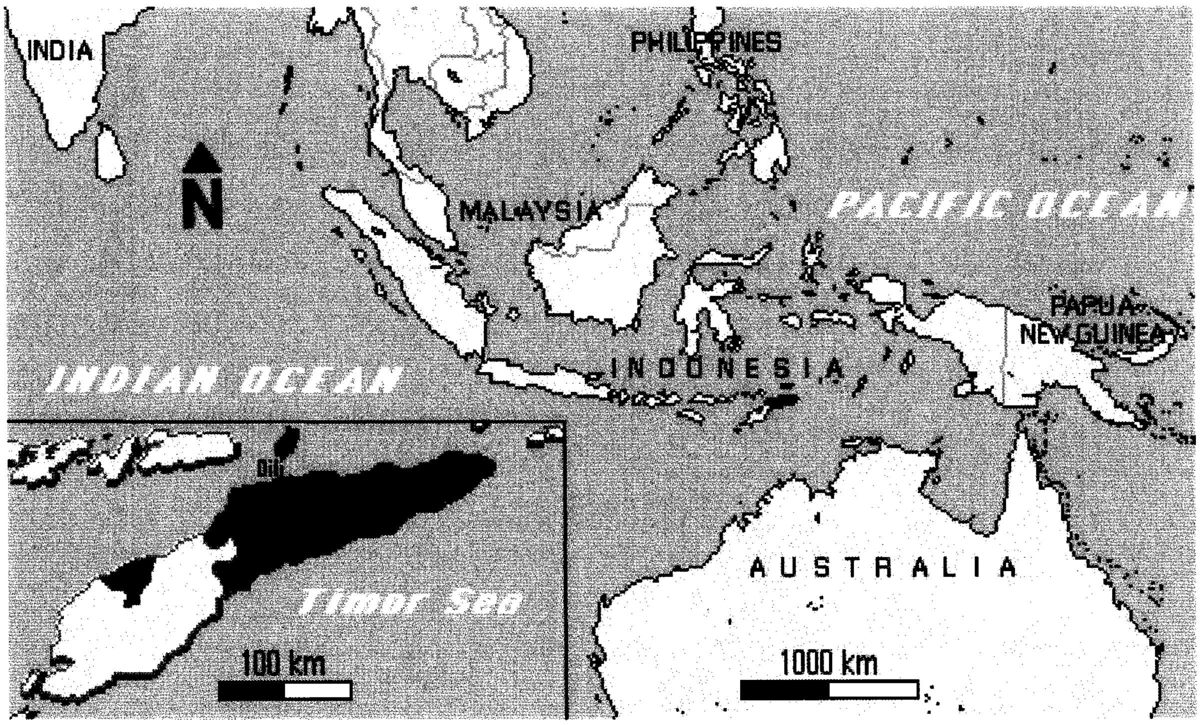

Figure 1.1 Map showing East Timor's location within the Malay archipelago

(Whitmore 1975). In the period from 1989-1999 forest cover was significantly reduced in all districts as a result of illegal logging, forest fires, grazing of livestock and conversion to agricultural uses (Bouma and Kobryn 2002). Most of the East Timorese landscape has been degraded to varying degrees with only small pockets of primary forest remaining around traditionally important sacred areas.

1.4 Hypotheses and Objectives

The overall objective of this research was to document the traditional use of plants in East Timor, as little research pertaining to this field has yet been undertaken in the country. Particular emphasis was placed upon recording traditional medicinal knowledge and how this body of knowledge varies between East Timorese cultural groups. Additionally, natural insecticides used in East Timor were analyzed for their efficacy under laboratory conditions.

Chapter 2 was written as an assessment of indigenous culture and how it is linked to biodiversity resources in East Timor. This chapter also provides the ethnobotanical context of the research. The specific objective of this chapter was to provide an introduction to the indigenous way of life in remote mountain communities in East Timor with an emphasis on spirituality, modes of food production, hunting and traditionally made fabric and alcohol. These cultural aspects were discussed qualitatively.

The selection of medicinal plants is an intellectual endeavour in indigenous societies and is a result of experimentation with the local flora over many generations. Medicinal plant traditions of 3 distinct indigenous East Timorese cultures, the Laklei, Idate (Chapter 3) and Fatlauku people (Chapter 4) were studied. Chapter 3 is a quantitative comparison of medicinal plant knowledge between the Laklei and Idate cultures. The hypothesis of Chapter 3 is that distinct cultures have unique medicinal plant traditions where patterns of consensus will vary and characteristics of medicinal plant use such as plant part used, habit, habitat and remedy preparation and administration will vary. These hypotheses were evaluated with the following objectives.

1) To calculate informant consensus in two East Timorese cultures using Trotter and Logan's (1986) quantitative method and to test if average consensus is significantly greater in one culture.
2) To count number of plant habit and habitat, plant part used, remedy preparation method and route of administration mentions in both cultures and determine if they are dependent on the cultural group.

In Chapter 4, the medicinal plant use of a third distinct East Timorese culture, the Fataluku people was qualitatively described. This chapter is descriptive in that it does not use modern quantitative ethnobotanical methods to test hypotheses. By carefully documenting the medicinal plant traditions of a Fataluku medicinal specialist who aided East Timorese resistance fighters during the Indonesian occupation, comparisons are drawn to the ethnobotanical literature and results described in Chapter 3. The objectives include;

1) To document the use of traditional medicine by a key Fataluku informant living in close proximity to the former stronghold of the East Timorese resistance force.
2) To draw comparisons to Chapter 3 in order to identify unique characteristics of this medicinal tradition.

In Chapter 5, activity of natural insecticides collected with East Timorese non-governmental organizations was determined. The hypothesis was that natural insecticides collected using an ethnobotanically guided approach will have significantly greater insecticidal activity than a control group of traditional East Timorese medicinal plants. The specific objective was;

1) To conduct acute toxicity bioassays on both the ethnobotanically selected insecticides and the control group and then test for significant differences in activity.

CHAPTER 2

INDIGENOUS CULTURE AND USE OF BIODIVERSITY IN REMOTE VILLAGES OF EAST TIMOR

2.1 Introduction

Although the majority of East Timorese live in rural areas, little effort has been made to document East Timorese spiritual or material culture in these locales. This lack of documentation is most evident for the remote mountainous regions of East Timor that are accessible only by foot or pack horse. Research is difficult to undertake as it requires extended periods of time in remote locations. While several documents that describe general living conditions in East Timor exist, they focus primarily upon issues affecting roadside communities and the major city centres of Dili and Baucau.

As suggested by McNeely (2005) culture and biodiversity should not be viewed as two separate entities as they typically have been in the past. Instead, traditional culture should be considered inextricably linked to and shaped by biodiversity. Information on some cultural aspects was recorded through extended stays in remote mountain villages and in the East Timorese bush. The intention of this chapter was not to present a full ethnographic study of the East Timorese people but to provide an introduction to traditional culture of people in remote regions and its relation to their use of biodiversity resources. Aspects of culture that were examined include spirituality and religion, day-to-day lifestyle, traditional fabric, food production, livestock, the importance of bush meat, and traditionally made palm alcohol. English common names are written in plain text while bracketed words are used to indicate Tetum, the lingua franca of East Timor. Table 2.1 provides a complete list of plants mentioned and a brief description of their use at the end of the chapter.

2.2 Spirituality and Religion

During Portuguese colonial times, many East Timorese were converted to Roman

Catholicism but the extent to which East Timorese people practise this faith varies greatly. In Dili, on Sundays and during Christian holidays, congregations are so large that they fill the churches and many must participate from outside. However, in remote villages no mention or participation in any ceremonies or rituals of a Roman Catholic nature, besides saying "Grace" at a formal dinner, was encountered.

The spiritual identity of East Timor's indigenous population is difficult to describe as it is an animist tradition with a foreign religion imposed upon it. Three of the most important aspects of East Timorese animist spirituality are the sacred house, traditional law and spiritual leaders.

2.2.1 The Sacred House

"Uma lulik", which translates to sacred houses, play a central role in the spirituality of East Timorese people. Before the violence and destruction of 1999, sacred houses were numerous. However, as a result of the 'scorched earth policy' of the retreating Indonesian forces, many sacred houses were destroyed and it has not been possible to rebuild them until recently (personal communication, Xisto Martins, June 2004).

All indigenous East Timorese people inherit membership in a sacred house paternally. Sacred houses each have a distinct name such as "Ten Brother's" for the ten brothers who built the house and who were the initial members. Membership in a sacred house has the important role of preventing inbreeding. Marriage to another member goes against traditional law, therefore, the first step during courtship is to learn your suitor's sacred house membership to determine if the relationship is possible.

The construction of a sacred house is a lengthy process that takes place in several stages over the course of a year. At each stage during the construction, all members of the sacred house and their families gather in the home village. The number of members can be very large with individuals dispersed throughout East Timor. Therefore, each ceremony is a family reunion as members return to the home village.

Each construction ceremony is a multi-day affair that includes a formal Portuguese style dance on the first evening followed by an early start to the traditional festivities the following day. During the ceremonies, male elders of the community adorn themselves with traditional articles such as headdresses, bracelets, traditionally made cloth, feathers and large silver disk necklaces. The headdress consists of a large, ornamental, silver crescent moon attached to the forehead with cord and decorated with chicken feathers. Male elders sing, chant and recite prayers for hours in standing groups or seated in circles around intricately carved upright eucalyptus logs where one end has been sunk in the ground. The carved logs are adorned with offerings of silver disks to the ancestors similar to the adornments of the male elders as well as ornamental plants and betel nut ("bua", *Areca catechu*).

The male elders decide where the holes for the four main support posts of the sacred house will be dug. During animated discussions, which verge on arguments, the male elders move about energetically testing out certain areas until a consensus is reached. The initial digging is carried out by members of the male elder community, but this quickly gives way to younger men who are better able to carry out the task of excavating holes that are approximately 8 feet deep.

Early the second morning, the community is awoken by male elders blowing buffalo horns. Money is donated by the members of the sacred house and then betel nut is divided up according to the size of the donations. The betel nut is to be saved and used only when a member of the family is sick, at which time it is to be chewed with powdered limestone and fresh "malus" (*Piper betle*) leaves and then spat on the sick person as a general tonic treatment.

The four 30 foot eucalyptus ("ai-bubur", *Eucalyptus alba*) support posts have been intricately carved with designs and are ready to be erected. Eucalyptus is the only type of wood used in the construction of sacred houses due to its strength. With the aid of a rope fixed to the top of the beam and long bamboo supports, adolescent and adult men lift and maneuver the massive beams into the holes excavated the previous day. This is a hazardous step in the construction as each beam weighs several hundred pounds and could easily crush someone if it fell. Over the following year, in separate ceremonies, the walls, also made of eucalyptus, will be secured and the roof made from palm fronds ("tua-metan", *Arenga pinnata*) or cogon grass ("du'ut manulain", *Imperata cylindrica*) will be constructed.

Construction ceremonies are accompanied by elaborate feast during which livestock are slaughtered such as pigs, goats, buffalo or cows. Elders read the animals' organs to determine the luck of the community and agricultural success for the next harvest. Once construction of the sacred house is finalized, a large festival is held to formally inaugurate the structure. A male elder from the community is chosen to live in and watch over the sacred house. If the selected elder does not want to or is unable to fulfill this role, he is able to appoint someone else. The elder must always sleep in the sacred house, however, meals are eaten with the family. The elder must guard sacred objects stored in the house such as gold, swords, traditional clothes and sometimes sacred animals.

The sacred house becomes an area where rituals and ceremonies of a spiritual nature are held. Elders and spiritual leaders come together in the sacred house to recite prayers and chants with the goal of solving problems such as; lack of rain, the inability of couples to bear children, or the violation of traditional law by members of the community. Prayer sessions may last for 7 consecutive days.

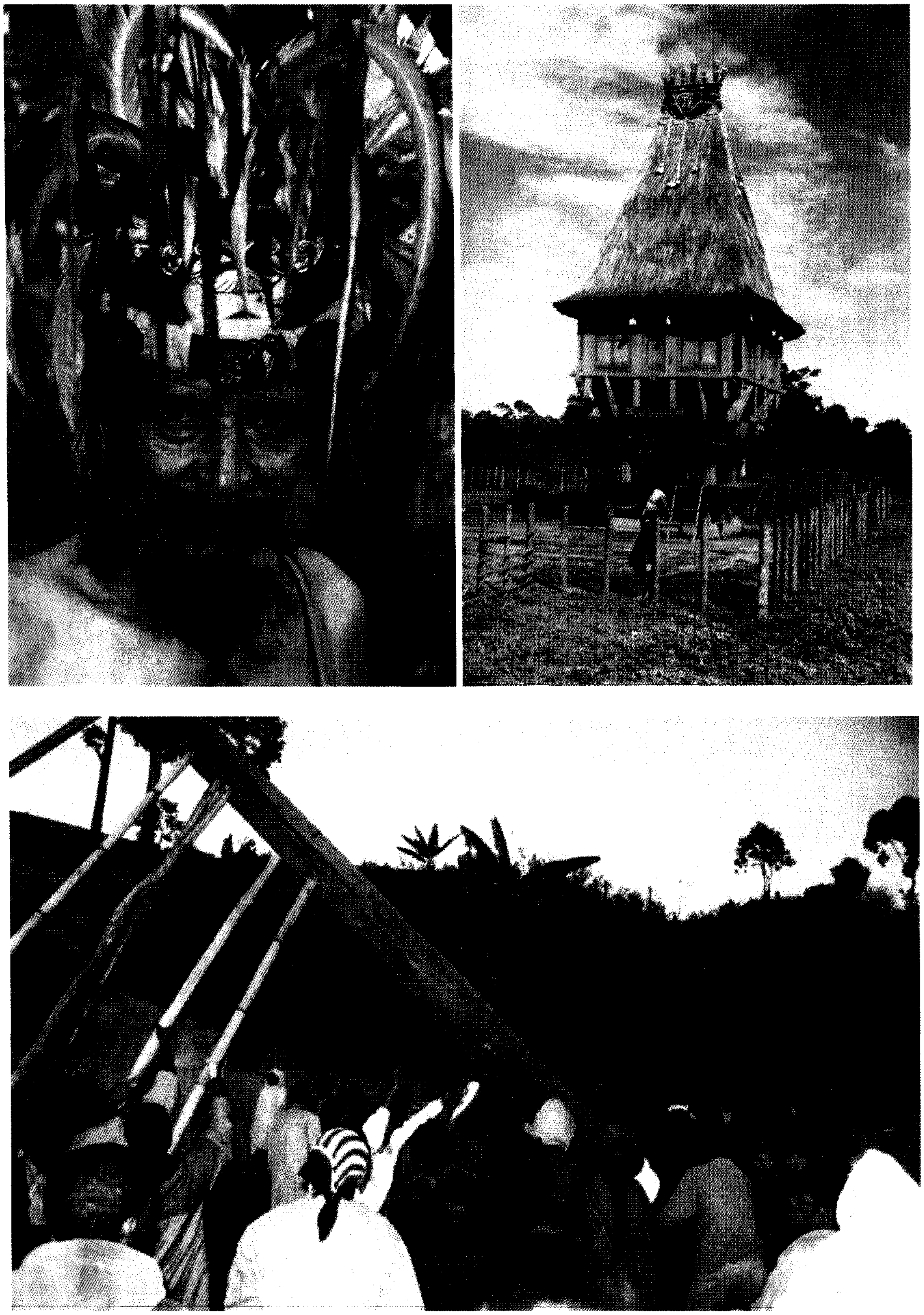

Figure 2. 1East Timorese elder in traditional headdress (top left). Sacred house from Lautem district (top right) and a sacred house raising (bottom).

2.2.2 Traditional Law

Traditional law describes the cultural code of conduct for East Timorese people with animist beliefs. Rules of traditional law include respecting elders, respecting sacred areas and forests and not marrying within one's sacred house. Generally speaking, violating traditional law equates to angering the ancestors. If the traditional laws are broken by an individual there may be serious consequences such as illness, extremely bad luck, poor crops and infertility. Often the only perceived solution to problems arising from the breaking of these laws is to seek advice from elders or the spiritual leader and to go through particular ceremonies at the sacred house.

Although the majority of the East Timorese landscape has been heavily degraded through destructive forest practices, small pockets of sacred forests have been preserved as part of traditional law. Traditional land management in these sacred areas include several rules; no logging, no clearing of land for agriculture and no hunting. One East Timorese person recounted a story of a man who hunted and killed monkeys in a sacred forest. As the man aged, he developed severe curving of the spine and arthritis. Because he did not consult a spiritual leader or undertake ceremonies at his sacred house, these afflictions became debilitating to the point that he had to beg to feed himself. Strong adherence to traditional law has resulted in the preservation of small but biologically important areas which would have otherwise been developed. Traditional forestry management in East Timor needs to be recognized for its effectiveness and incorporated in all future conservation strategies.

2.2.3 Spiritual Leaders

Spiritual leaders, also known as shamans in many Central and South American societies, are referred to as "matan do'ok" in Tetum which literally means far eye or far seeing eye. The name "matan do'ok" implies that these spiritual leaders can see into the domain of the spirit world and communicate with the ancestors. The ability to converse with the ancestors has serious implications as most indigenous East Timorese believe that the ancestors are all powerful and are able to dictate one's health, luck and success in life. On behalf of an individual, the "matan do'ok" is able to communicate with the ancestors and determine what actions are necessary to please them. Typically, the individual must perform sacrifices of livestock or make offerings in the form of money or other valuable items.

All "matan do'ok" are chosen ones so to speak as there is no way of becoming one unless selected by the elders or in rare instances, given special abilities by Christian Saints. "Matan do'ok" are born intuitively with the knowledge and ability to travel to the realm of the spiritual without any training. Strictly speaking, "matan do'ok" do not use plants to heal people, however, in some cases they are not only spiritual leaders but also well respected and well known traditional healers. Some "matan do'ok" are known throughout East Timor for their healing abilities using plants and the power of touch and are consequently traveled to from great distances to be consulted.

Today, spiritual healers are less common and in some cases are not as highly respected as they once were. East Timor is developing rapidly with increased exposure to Western concepts of health and healing and as a result more traditional belief systems have eroded. Furthermore, the perception of the "matan do'ok" has been tarnished as many are considered frauds because they predict one's fortune for a fee. Whereas in the past each village had a spiritual healer, "matan do'ok" are now present in only some villages where traditional beliefs are particularly strong.

2.3 Day-to-day Life

A typical day in a remote village of East Timor begins early in the morning as the sun begins to rise. Food left over from the day before is mixed with water and poured into bamboo troughs for the domesticated pigs. Breakfast, which may be as simple as a cup of coffee or more elaborate with rice, vegetables and in some cases meat, is made by the women of the community. Breakfast is eaten quickly and the men and some women depart for work in the fields.

Eating arrangements among villages vary. In smaller villages, the people may choose to eat as a group in a centralized eating structure, while in larger villages they may choose to eat in smaller more closely related family groups. While the women are preparing breakfast, the men will often fetch water, sharpen their machetes and knives or socialize.

Agricultural lands may be adjacent to the village or may require walking or riding horses long distances to access. The swidden fields, created by slash and burn techniques, and rice paddies are tended and owned by individual family groups that usually consist of a man, woman and their children. Due to the extensive genocide that took place during the Indonesian occupation, the members of a family group can be variable. Individuals that no longer have their own nuclear family group may be incorporated into other family groups.

At the swidden field and the rice paddy there are small shelters used for cooking and occasionally sleeping. The shelters also provide protection from the midday heat and rainstorms. Lunch, consisting of food from the swidden, is eaten in the shelter. In the evening, the workers return to the village where dinner has been prepared by the women. While cooking is generally the responsibility of women, the slaughtering, preparation and cooking of livestock and wild meat is often done by the men.

Elders unable to work, children and infants, and some women stay in the village during the day. Women who stay behind in the village are responsible for varied tasks; drying crops such as rice ("fo'os", *Oryza spp.)* corn ("batar", *Zea mays*) and tobacco

("tobacco", *Nicotiana tabacum*); preparing food; milling rice and corn; making handicrafts such as baskets and mats; and doing household chores such as cleaning.

Children, whose family can afford to send them, attend classes at the village school. In some cases, a village tax is collected from all households, whether they have children or not, to fund the school and pay the teacher's salary. Children from villages too small to have their own school must travel daily to nearby villages to attend classes. This may involve walking several hours. The school, benches and tables are constructed from bamboo ("au"). School supplies are minimal but the teachers generally have chalk and a low quality blackboard while students have notebooks and pencils. Occasionally, children from the villages are sent to larger centres to receive a high school education. This is rare, however, as it is too expensive for most people living in rural areas.

Outside of school, young children have few responsibilities and by and large are allowed to play. As they age they are expected to take on responsibilities such as looking after younger siblings, tending to livestock, collecting firewood, cooking, fetching water and serving older members of the community. Serving older members of the community entails such tasks as acting as waiter at formal dinners, serving coffee to guests, lighting cigarettes, running errands and delivering messages.

Villages consist of several huts used as living quarters, a central communal hut, and sometimes separate cooking huts and a school. The living quarters are usually square and are elevated above the ground on bamboo poles. This makes the dwellings level, discourages pests such as mice and rats from entering and provides shelter for livestock. Walls and floors are made with flattened bamboo and the main supports are either made from bamboo or eucalyptus. The roof can be made from a variety of materials, including palm fronds ("tua metan", *Arenga pinnata*, "ai-nu", *Cocos nucifera*,), bamboo or cogon grass ("du'ut manulain", *Imperata cylindrica*). The living space is communal as dividing walls are seldom used.

At the centre of the hut is the cooking area which consists of a fire pit on a bed of earth to keep the floor from being burned, an apparatus for suspending pots and a drying rack. There is no designated sleeping space per se, but inhabitants position themselves around the fire and sleep on bamboo or palm mats. To protect them from crop pests, rice and corn are stored in the rafters as are tools and items that are not often used. Each family group sleeps in their own structure and there is no division between male and female sleeping quarters.

The central communal hut provides an area for elders to discuss important issues with the chief and as accommodation for visitors. Structurally, the communal hut is similar to the family group hut with some key differences. It is not elevated off the ground, has no cooking area and is partitioned into two small rooms and a large gathering room. The two small rooms are usually furnished with bamboo beds. The large gathering room has chairs and a table which is made either from local materials (i.e. bamboo and palm) or plastic furniture that has been purchased at an urban market.

Leisure time begins in the late afternoon and can extend well into the evening. Groups of children, women and men carrying soap, towel and rinsing bucket make their way to the local water source to bathe and wash clothing. Empty detergent packets are usually strewn haphazardly about the most popular bathing and clothes washing spots. In some cases, the same water source is used for bathing, cooking, drinking, disposing of human waste and watering livestock such as buffalo and horses thus making its' potability questionable. Fortunate villages have a separate water source, and in some cases natural springs, for their drinking water.

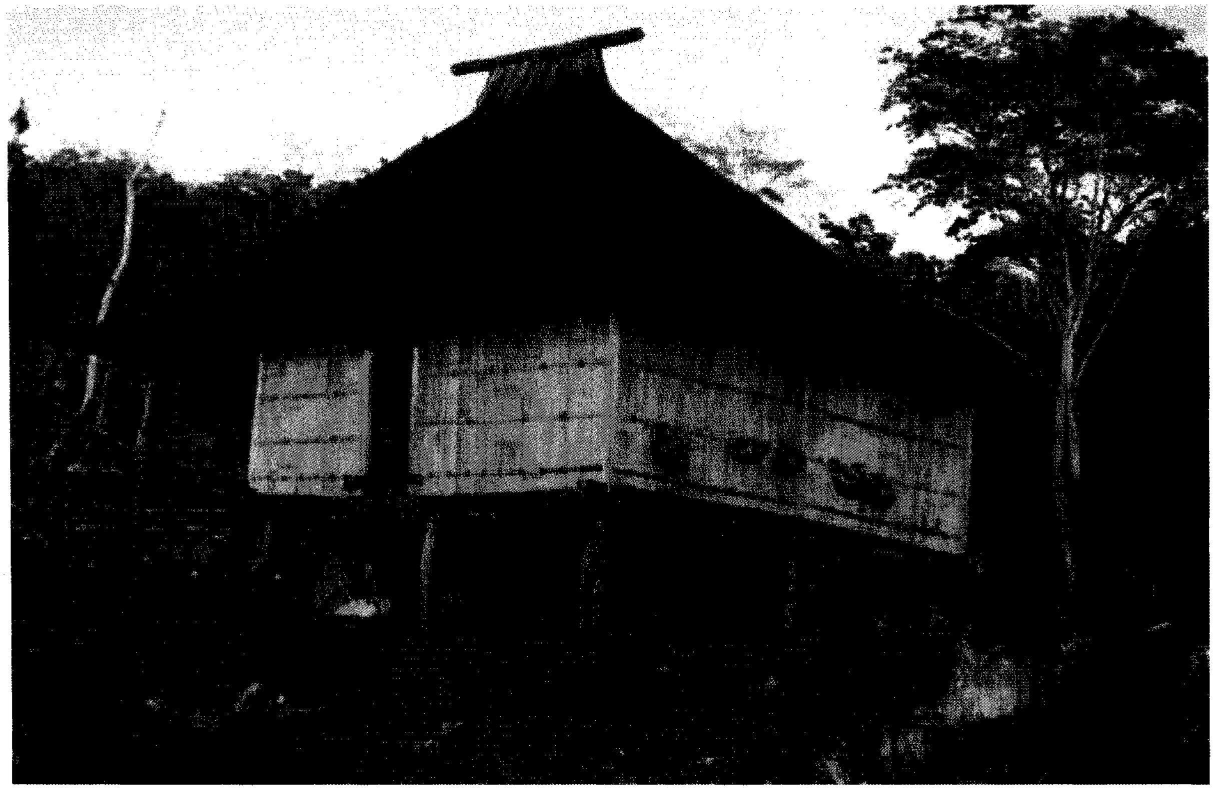

Figure 2. 2 Typical East Timorese huts made from bamboo and cogon grass. Note the chicken coups alongside the houses (top).

Young men from the village gather for soccer matches among themselves or with men from nearby villages that have made the trip specifically for a game. Some villages have relatively flat clearings that during the day are pastures for livestock but become soccer fields in the afternoon. Dry rice paddies also make suitable soccer fields in communities where other large open spaces are lacking. Goal posts are made from bamboo but the soccer ball has usually been purchased in the city. While volleyball is very popular in the city centres and roadside villages, it was not encountered in remote villages.

Men and women gather in separate groups and socialize with one another while smoking local tobacco, chewing betel nut and drinking coffee or tea sweetened with great quantities of sugar. Nearly every man has his own pouch of local tobacco which he always carries. Extremely large cigarettes nearly three times as thick but as long as a store bought cigarette are rolled using either store bought rolling paper but more often dried corn leaves collected from the swidden. For hour upon hour, these social groups sit together discussing village issues and telling stories until it is time to retire for the night.

Occasionally, there will be formal village meetings for which people assemble in the vicinity of the central communal hut. The Chief formally welcomes everyone to the meeting and makes special note of visitors. He then makes an introductory speech describing the reason for the meeting followed by his opinions and recommendations. Examples of possible meeting topics include negotiating boundaries with neighbouring villages and resolving conflicts between village members. Elders and important members of the community are then allowed to offer their opinions and voice their concerns. A speaker's right to voice their concern is highly respected and they are allowed to talk as long as they feel they need to, without being interrupted. In this way everyone is heard which means meetings can last well into the night. Typically, it is the men of the community that speak with some input from outspoken women and revered female elders.

2.4 Traditional Fabric

"Tais" or "ropa" in Tetum literally means clothing. While the word "tais" can describe clothing in general it also specifically means the traditional woven fabric of East Timor. Making this fabric is a labour intensive process which begins with growing cotton, spinning cotton thread, dyeing the thread using traditional dyes and then weaving the thread using traditional looms. Fabric made this way is generally referred to as being "asli" or original. Today, this fabric is made with varying degrees of originality, however, the traditional loom is used to weave all locally made fabric. "Tais" play a significant role in cultural gatherings and the selling of it makes an important contribution to household earnings.

If the entire "tais" making process is considered, the planting and tending of local cotton is the first step. Local cotton known as "kabas" (*Gossypium species*), grows wild. In households where the production of traditional fabric is the norm, "kabas" is usually found growing close to the family property in the homegarden. "Kabas" is a tall shrub with large yellow or pink flowers. As the flowers age and dry, white cotton is produced, and is then harvested. The dry cotton is placed in a small basket and is gradually formed into a thread by working a small amount of it in a twisting motion between the index finger and thumb. As the cotton is spun, a small amount of limestone powder is applied to the fingers and worked in. Since a "tais" requires many metres of thread, this stage of the process keeps the "tais" maker occupied for much of their time.

One of the most striking characteristics of a traditional "tais" is its colour, which it gets from the use of natural dyes. A variety of plants and soil types are infused with water to make traditional dyes. The resulting colours are subtle and earthy and include black, dark blue, red, brown and yellow. Fabric made from thread that has come from Indonesia or abroad is usually much brighter. Since there is a tremendous amount of work involved in producing a single original "tais", less authentic variations are more common. When making a modern "tais", the most time consuming steps in the process are eliminated; growing the cotton, spinning and dyeing the thread. The weaving step is still performed on a traditional loom.

Sale of traditional fabric contributes significantly to the East Timorese family income. An authentic original "tais" can be very valuable depending on the quality and age and can be sold or traded for equally valued items. Some original fabrics come with the added distinction of being "antigu", which means antique. These "tais" usually are not for sale due to their cultural significance, however, when fabric of this calibre is sold it may obtain a price of several hundred dollars (all money figures are in US dollars). Fabric made from a combination of Indonesian and original thread is more common but still rare. The most common type is made from Indonesian thread only. The usual price for this style of "tais" is 20 dollars but they can fetch 30 dollars or more. Traditional fabric can be purchased in markets, tourist shops, and from street vendors however, higher quality traditional pieces can only be purchased directly from artisans.

The 'Tais Market' in Dili provides a convenient venue for merchants to sell locally made crafts such as silver headdresses and jewelry alongside "tais". The market is centrally located and therefore is convenient for international visitors to access and purchase souvenirs that would otherwise require looking in local markets or dealing directly with East Timorese artisans. Unfortunately, fabric purchased in the "Tais Market" is usually of low quality, made from Indonesian thread and has over inflated international prices.

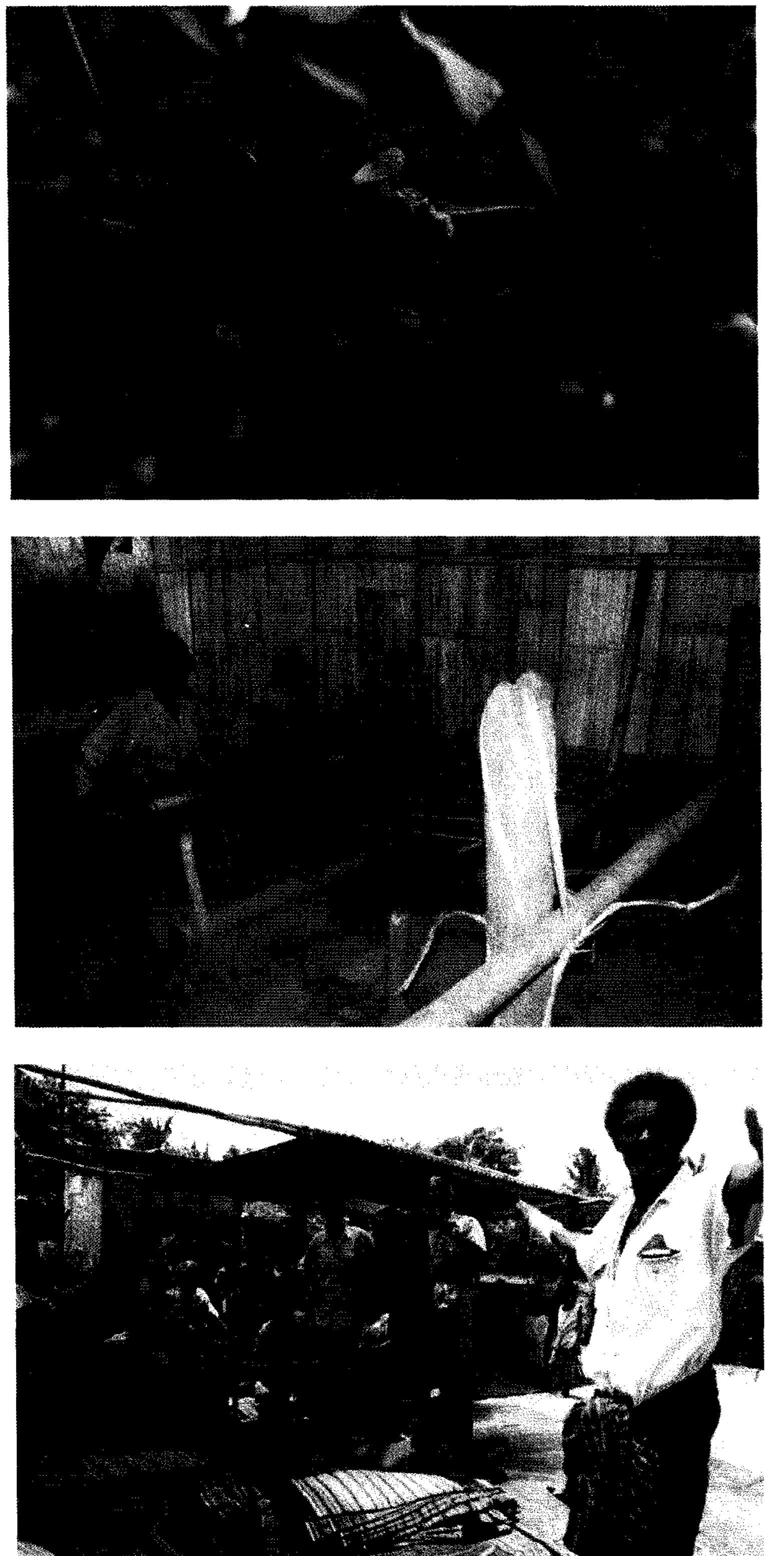

Figure 2. 3 "Kabas" (*Gossypium sp.*) flower used to make traditional fabric (top). Elder women weaving traditional thread using a loom (middle). East Timorese groom accepting "tais" from the bride's family at a traditional East Timorese wedding (bottom).

There is a distinction between "tais" for each sex. The sides of the female "tais" are sewn together thereby making a tube that is folded and tucked in at the waste to secure it. The male variation is not sewn together and is wrapped around the waist and either secured with a belt or folded and tucked in, in a similar fashion as the women's. "Tais" are not worn now on a daily basis but have been replaced by western clothing such as pants and shorts or by sheets of foreign made cotton cloth that is wrapped around the waist and secured in a similar fashion to the traditional "tais".

The place of the "tais" in East Timorese culture has shifted to predominantly ceremonial use. Now, they are worn during important ceremonies such as the construction of sacred houses, weddings, funerals and traditional dances and given as gifts to couples on their wedding day. Also, in Dili during important government ceremonies, foreign dignitaries are often entertained by traditional ceremonies involving the wearing of "tais" and are usually presented with a small one of their own to be worn around the neck.

2.5 Food Production in East Timor

Food production in East Timor can be separated into three general categories; 1) the home garden ("kintal"), 2) the swidden ("to'os") and 3) the rice paddy ("natar"). Each category represents a distinct mode of food production that requires different farming techniques and yields different types of food.

2.5.1 Home garden

The East Timorese home garden allows for the growing of a variety of fruits, vegetables, spices, building materials and textile related plants like cotton. As the name implies, the garden is adjacent to the home and is sometimes fenced off to discourage domestic animals, mainly goats and pigs, from browsing. Plants that produce edible fruit are the most abundant type in the home garden. The majority of the fruit, such as pineapple ("nenas", *Ananas comosus*), grapefruit ("jambua", *Citrus paradisi*), cucumber ("pipinu", *Cucurbita sativa*), orange ("sabraka", *Citrus sinensis*), tangerine ("sabraka", *Citrus reticulata*), coconut ("nu"), papaya ("ai-dila", *Carica papaya*), Indian bael ("ai-dila fatuk", *Aegle marmelos*), banana ("hudi", *Musa spp.*), avocado ("avocat", *Persea gratissima*), mango ("haas", *Mangifera indica*), *Annona species* ("ai-ata bo'ot"), sugar apple ("ai-ata ki'ik", *Annona squamosa*), jackfruit ("ai-kulu naka", *Artocarpus heterophylla*) and guava ("goevas", *Psidium guajava*) can be eaten raw without any preparation. Often several varieties of these fruit producing plants are grown. For example, in the case of bananas, there are at least four common types, which vary in size, taste and colour. Unripe starchy bananas are often boiled in water or deep-fried in batter and eaten for breakfast. Other varieties of fruit that are boiled while unripe include breadfruit ("ai-kulu kami", *Artocarpus incisa)* and papaya. These plants grown for their fruit have other uses as well. For example, papaya when ripe, are boiled with locally distilled alcohol to give the alcohol a distinct fruity flavour.

Foods that always require preparation include chilis ("ai-manas", *Capsicum spp.*), mung beans ("fore munguu", *Vigna radiata*), cashews ("ai-kaizu", *Anacardium occidentale*), egg plant ("brinjella", *Solanum melongena*), tomatoes ("tomati", *Solanum lycopersicum*), squash varieties and bitter melon ("baria", *Momordica charantia*). Several varieties of chili are grown and milled into a paste using traditional mills. The paste is combined with lemon juice or sliced tomatoes and served at every meal. Mung beans are boiled and are often eaten with breakfast. The fleshy portion of the cashew fruit is eaten raw, however, the nut is baked before eating. Egg plant, squash varieties, tomatoes and bitter melon are fried or boiled and then are eaten on their own or added to soups and stews.

Cassava ("ai-farina", *Manihot sp.*), "fia" (*Xanthosoma sp.*), potatoes ("fehuk europa", *Ipomoea batatas*), sweet potatoes ("fehuk midar", *Ipomoea batatas*) and sugar cane ("tohu", *Saccharum officinarum*) are all plants that are grown for their vegetable tissue. Cassava, of which there are several varieties in East Timor, is one of the most prevalent foods in the East Timorese diet and is planted in a large percentage of the area of the typical home garden. Both the leaves and tuber of cassava are prepared in a variety of ways. Fresh leaves are picked and are either boiled or fried in oil until they are tender. Boiling the tuber in water, sometimes with lemon grass ("du'ut morin", *Cymbopogon citrates*), which greatly enhances the flavour, is the most common method of preparation. For breakfast, the tubers are often sliced into thin chips and deep-fried. Potatoes and sweet potatoes also account for a large percentage of the area in home gardens and are prepared in a fashion similar to that of cassava. Sugar cane is not a common home garden plant but in some areas is grown as a treat for children.

Mustard ("mustarda"), an unidentified Convolvulaceae species ("canco") and horseradish tree ("ai-marunigi", *Moringa oleifera*) are leafy green vegetables planted in the home garden. Mustard is usually boiled or fried. "Canco" is a small leafy green plant that grows in standing water on the margins of rice paddies and in flooded areas. In Dili, "canco" grows very well in flooded ditches and on regularly tended "canco" farms, which are areas that have been flooded specifically for growing the green. Horseradish tree is a large tree with long seed pods and is occasionally found in the home garden. Its leaves are boiled and eaten. Mustard and "canco" are very heavily relied upon while horseradish tree is seldom used.

Various plants used to flavour food are also planted including gingers ("ai-lia"), basil ("silasi", *Ocimum tenuifolium*) and lemon grass. Ginger is used primarily to add flavour while frying vegetables or cooking stews. Red ginger ("lain kuas", *Alpinia species*), is used specifically to flavour dog meat, giving it an appealing taste. Basil and lemon grass are used in a similar fashion to ginger, mainly to add flavour while boiling or frying vegetables and during the preparation of meat for special occasions.

In addition to supplying food, the home garden is also an important source of construction materials. Palm species such as sugar palm ("tua-metan", *Arenga pinnata)* and "tali" (an unidentified palm species), coconut, bamboo, and candlenut ("ai-kami", *Aleurites moluccana*) are relied on heavily. "Tali" is extensively used for its fronds, which make a resilient thatch roof, extremely strong cordage, clothing such as traditional rain coats and tough woven baskets and mats. The palm stock, which can grow as long as 5 or 6 feet, can be nested and held in place with pegs. The nested palm stocks are sold in segments approximately a foot wide for the construction of hut walls. Fronds of sugar palm are used for thatching roofs. Coconut tree wood is used in construction; the fronds also make a convenient broom and the dried exterior of the fruit ignites well producing a long lasting flame for cooking.

Several varieties of bamboo are among the most useful plants for construction purposes. Bamboo is an indispensable building material in remote communities where the use of corrugated aluminum or cement is not an option due to the difficulty of transporting it and cost. It is not possible to list all of the construction uses of bamboo but examples include; main support beams for elevated huts, hunting bows, arrows and quivers, troughs for livestock, fencing, cups, chairs and other furniture including beds and troughs used to transport rain water. Bamboo can be split and flattened making it very convenient for constructing flat surfaces such as walls, table tops and mats.

In addition to "kabas", candlenut is an important textile. Candlenut fruit can be processed and made into candles. After harvesting, the fruit is crushed in a traditional mill.

Traditionally made thread is cut into foot long sections and is then covered with the milled candlenut fruit which is allowed to solidify. Candles made in this traditional manner are not as common as in the past but in areas that are particularly poor and remote they can still be found.

Plants grown in the home garden for recreational use include tobacco, *Piper betle* ("malus") and betel nut. Several varieties of tobacco are present in East Timor where the vast majority of men smoke. Tobacco is harvested, chopped into small shavings and then dried in the sun on mats woven from palm fronds. Local tobacco is always for sale in markets and is very popular because it is more affordable than store bought varieties. In the remote villages, tobacco is planted for local consumption and the excess is sold in market. Betel nut and "malus" are also used recreationally for their reported benefits in strengthening teeth and from the mild euphoria experienced by chewers. Chewing betel nut and "malus" is much more common in rural parts of East Timor. In Dili, chewing has a negative stigma as it stains the teeth a dark red and is sometimes regarded as something only people from rural areas partake in.

The degree to which East Timorese utilize the home garden is variable. Home gardens tend to be more developed in communities along roadways where incomes are higher and access to markets is greater than in remote communities. People in roadside communities build stands and sell fruits such as papaya, bananas and pineapple, hot sauce made from chilis, locally made alcohol, tobacco and breadfruit. This local economy creates a monetary incentive to expand the home garden and plant more economically desirable species. In Dili, home gardens tend to be less developed due to the lack of space in the city and a reliable and affordable supply of products from nearby rural areas. Dili's gardens tend to have less of an emphasis on edible and useful plants and more on ornamental flowers.

Home gardens are least developed in remote mountain villages if present at all. In communities where home gardens are not present, villagers rely solely on food staples provided by the cultivated field and rice paddy.

2.5.2 Cultivated Field

The cultivated field is where the most important staples are grown. Cultivated fields are formed through the process of swidden agriculture, more commonly known as slash and burn. The preparation of swiddens is timed according to the rains. During the months leading up to the rainy season (September and October), patches of forest (1-2 hectares) are cleared by adult and elder men using machetes. Once the land has been cleared, the remaining bush and unwanted debris is burned (November). When the rain starts (November and December) the fields are planted. The first harvest occurs approximately 4 months after planting. In the dry areas of the north there is only one cycle of planting and harvest. However, in the southern regions of East Timor in the expansive plains along the south coast, more rain falls and a second planting is possible in May after the land has been weeded in April. The second crop is harvested in August and September. The swidden is productive for one to two years. After that time it is abandoned and other land is cleared. Fields are allowed to fallow for approximately 15 years (Figure 2.4). When one farmer was asked whether or not important medicinal trees are spared during the clearing stage he replied 'No, there are many more left in other parts of the forest'.

The main crops grown in the swidden are corn and dry land rice. These are usually intercropped with cassava and squash. The majority of corn varieties grown are foreign, brought to East Timor during the Indonesian occupation or by non-governmental organizations. The foreign varieties give higher yields and grow faster than local varieties thus making them very attractive to peasant farmers. However, as foreign varieties become

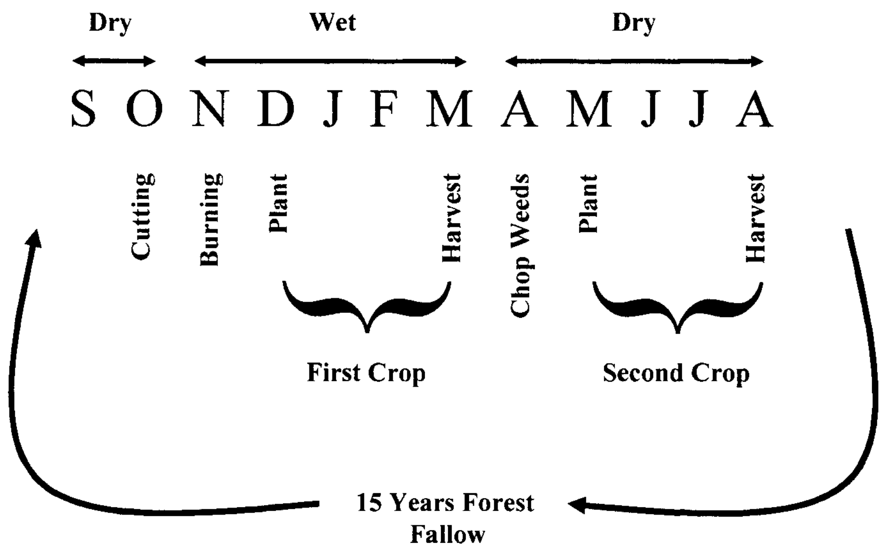

Figure 2. 4 Swidden agriculture cropping cycle in East Timor.

more popular, local varieties become displaced as they are no longer being planted. Currently, initiatives are being undertaken by non-governmental organizations operating in East Timor to secure enough stock of local corn varieties for seed replication programs.

Each year, as corn matures and ripens, it becomes the mainstay of the diet. The corn is boiled or baked over a fire. What is not used immediately, is dried unhusked and stored for later use. Once dried, the corn is either bundled and suspended over branches in trees high off the ground, stored in lofts over cooking fires or put in tightly sealed drums. While not common, modern silos are also being used in roadside villages where non-governmental organizations and the United Nations have development initiatives.

Some East Timorese rank the quality of corn based on the degree to which the corn is suited to making pop corn ("batar funan"). For example, corn whose dried kernels pop 100 per cent of the time have a higher value than corn whose dried kernels pop only 50 per cent of the time. The dried corn is eaten popped or is milled in traditional mills and then stewed on its own or sometimes along with domestic or wild beans. In villages where rice is not planted, corn is eaten for every meal. While corn is a critically important food source for many East Timorese it is generally regarded as inferior to rice.

Dry rice is an important crop in areas where wet rice cannot be grown and was encountered in several villages. In one village, three varieties of dry rice and one of wet rice were planted. The different varieties are distinguishable by colour, shape, size and flavour. Dry rice is highly preferred due to its superior flavour.

2.5.3 Rice Paddy

Rice paddies ("natar"), are common in lowland areas near the ocean and on flat plateaus such as in the Meliana region. Even in relatively flat areas, extensive terracing is needed to level out the ground. As a major portion of East Timor is very mountainous, the lack of knowledge and expertise in terracing has limited the extent to which wet rice is grown. Consequently, rice paddies are less common in the remote mountain villages.

Buffalos are used to prepare rice paddies before planting. The first step is to use machetes and controlled burning to clear the rice paddy of debris and weeds that grow during the off season. The terrace segments are then flooded one by one and damaged portions of the terrace walls are reinforced and repaired using mud. As many buffalo as are available are then herded back and forth over the paddy to churn up the soil. This method is still used in remote regions of East Timor. However, in accessible areas where international assistance can be delivered, it is becoming common for villagers to use donated hand tractors. The use of hand tractors can be more practical as it requires less time, less manpower and is the only possible method in areas where there are no buffalo. The rice paddy is ploughed three times after it has been flooded. Once the rice field has been ploughed, rice seeds are spread or seedlings planted. The seedlings are about three weeks old and have been grown in small paddies specifically used as nurseries.

In areas with a long rainy season there are at least two harvests and in particularly wet years three harvests may be possible. However, due to limited rain in northern regions of East Timor only one rice harvest is possible, as is the case with corn. Rice is stored in the same way as corn, in tightly sealed drums, near or above fires or in modern silos. Excess unmilled rice can be sold at rural markets for approximately \$5.50 for a 50 kg bag. When asked about the difference between rice varieties in terms of their storability and susceptibility to post harvest loss, farmers consistently replied that there was no difference between varieties as their storage techniques were adequate for the harvest to be eaten before pests could infest them.

2.5.4 East Timorese Diet and Relative Importance of Food Types

Despite the variety of food plants grown, the diet of the East Timorese is in general poor. In areas where rice is available, it is eaten for at least two of three meals. Furthermore, it is not only eaten regularly it also constitutes the majority of the meal, which may or may not be accompanied by other food. It is difficult, however, to determine the most important food in East Timor as it is location specific.

The main food source was different between the two remote villages where information was gathered. In one village, lunch, dinner and sometimes breakfast were mainly rice, as three varieties of dry and one variety of wet rice were cultivated. Breakfast usually consisted of popcorn, cassava or sweet potato. Lunch and dinner consisted of large portions of rice accompanied by cooked cassava leaves. Meat such as dog, pork and local wild meat such as wild pig were occasionally eaten and some freshwater shrimp and eel. Home gardens were present in the village, however, they were not heavily relied upon. The only items eaten from the home garden were cassava, potatoes and sweet potatoes. Fresh fruit was rarely if ever eaten in this village.

For reasons most likely relating to poverty, the second village had no wet or dry rice under cultivation. Instead this village relied heavily upon swidden agriculture to produce corn, which was the mainstay of the diet. Corn was eaten for breakfast, lunch and dinner and was only accompanied by generous portions of local alcohol and sometimes wild beans and chicken or goat meat. Unfortunately, this village had no home gardens and wild fruit trees such as mango and breadfruit while present were rare. No fresh fruit was eaten in this village.

Food variety increases in roadside villages and in large urban centres such as Baucau and Dili. More fruits and vegetables were eaten in these areas, however, wet rice and corn

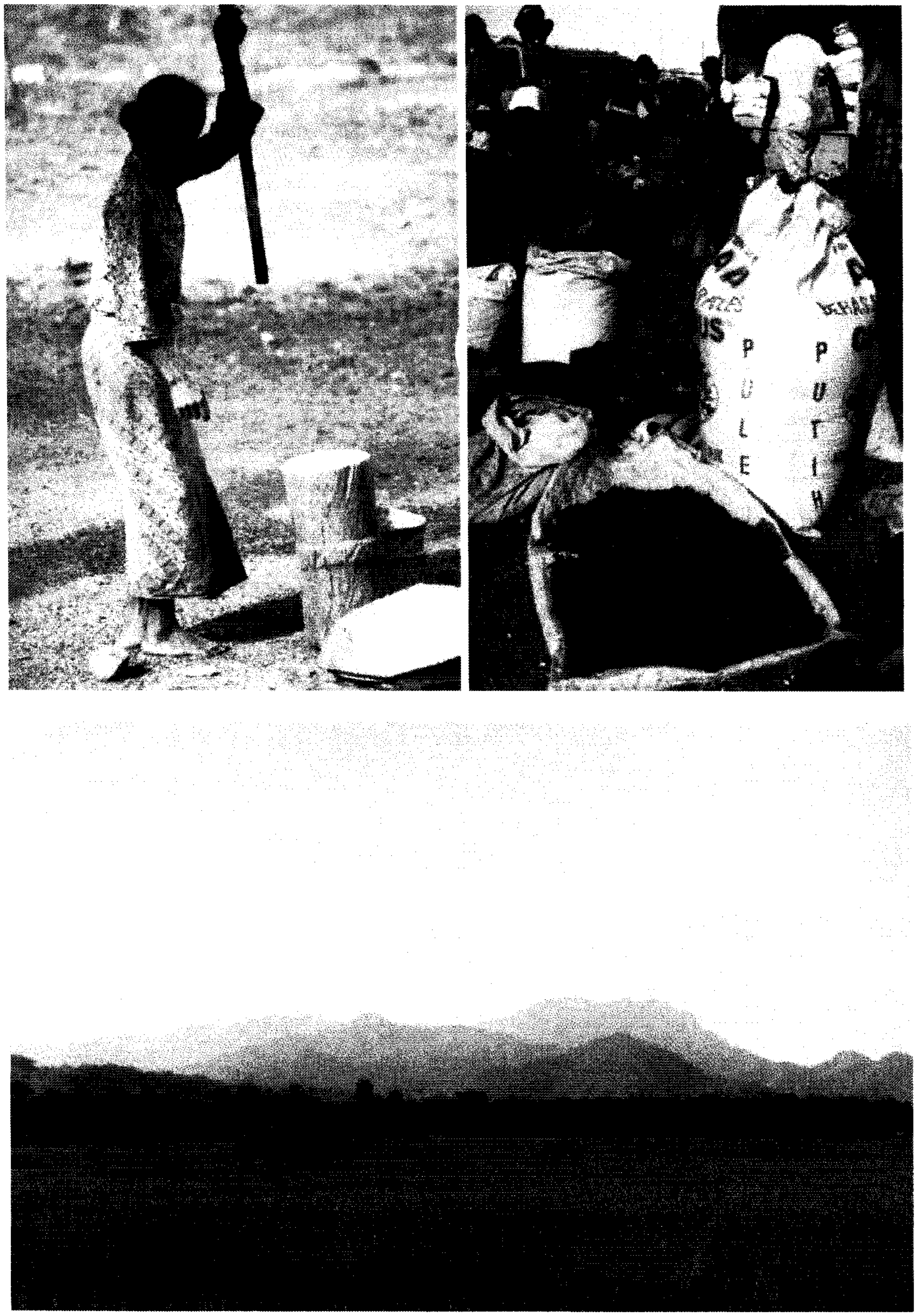

Figure 2. 5 Elder woman using a traditional mill (top left). Chillis for sale in a roadside market (top right). Rice paddies of the extensive south coast plains region (bottom).

were still the most important foods. When considering the home garden as a food source, cassava, potatoes, sweet potatoes and breadfruit are the only foods eaten regularly. The other fruits and vegetables discussed did not contribute significantly to the East Timorese diet.

2.6 Livestock

The most commonly raised animals for human consumption are chickens, dogs, pigs, goats, cattle and water buffalo. To a much lesser extent ducks and pigeons are raised but this was only encountered in Dili. While "manu malay" or foreign chickens are quite common, they are perceived as being inferior to the local chickens which are typically smaller but have a distinct flavour. In the remote villages, chickens are 'put to bed' so to speak by throwing them onto roofs of grass huts or placing them in palm baskets that are attached to the sides of huts. Chicken eggs are eaten fried for breakfast and are also used in Indonesian influenced meals such as fried rice and fried noodles. Butchering of chickens in East Timor seems to be a haphazard affair with no regard for cuts of meat as is customary in western culture. If a market is to emerge for the sale of locally raised chickens to East Timorese restaurants catering to foreigners, training in proper butchering techniques must be a priority.

Cock fighting is a popular activity throughout East Timor, especially in Dili and urban centres of the districts. Blades are attached to the legs of two male birds and then they are forced to fight until one of the birds has been killed. In relative terms to the economy of East Timor, large amounts of money are bet on the cock fights and the events can attract large crowds. Bets from an individual can be as high as $100 with total pots being worth $1,000. Typically, a chicken can be purchased for $2 to$4 in Dili, while a cock in peak fighting form will sell for $15 to $25 or higher.

Dogs are very important animals in East Timorese culture as they have many uses. They provide a cheap and reliable security system, are commonly used as a food source and are vital in their role as hunters. Their meat is usually boiled or fried and is flavoured with local ginger. Unfortunately, hunting dogs that do not perform are not fed adequately and are routinely beaten and are susceptible to disease. While a skinny dog with limited hunting skills is almost worthless, a muscular dog with proven hunting ability can sell for approximately $50 or more.

Goats and pigs are very numerous both in Dili and in the remote villages of East Timor and serve a central function in the social and ritualistic lives of the East Timorese. The slaughtering of goats and pigs is used to mark important social gatherings or the arrival or departure of a respected guest or member of the community. The number of slaughtered animals is directly proportional to the importance of the guest or social gathering. For example, during the raising of a sacred house it is customary to slaughter several animals, which are supplied by the families erecting the house. The pigs feet are bound and the pigs are laid on the earth to wait for a member of the community with a long dagger to walk down the line of pigs quickly and precisely puncturing the pigs' hearts. Once a pig is dead and it has been bled thoroughly, another incision is made so that its liver and gall bladder can be removed and read by a skilled elder of the community. During the reading of the pigs' organs, a small crowd will form around the reader listening intently for information.

Goats and pigs are also used as sacrifices when traditional law is broken. For example, in one of the villages a young girl was left unattended and fell to the ground from a house with particularly long stilts, a distance of approximately 10 feet. This was a major event in the village and there was considerable animosity between the father of the girl and the woman responsible for the child at the time. It was believed by the Chief and villagers that the combined events of the child falling and the resulting arguments had angered the village ancestors and that the ancestors would have to be appeased. As a result, a large goat was slaughtered and eaten by the village. Goats are highly valued for their meat and their milk, which can be used to make cheese. A full grown goat can be sold in market for $60 and a large pig can be sold for as much as $200 or more.

Water buffalo play a critical role in East Timorese culture and its agricultural system. The importance of a man or family is often dictated by how many buffalos they own. Members of a community with the most buffalos are the most outspoken at community gatherings and their opinions are held in higher esteem. As with pigs and goats, buffalo play an important role in cultural gatherings but bear more importance due to their higher value. Because of their large size, buffalos are slaughtered for grander occasions and are not practical for smaller gatherings where a pig or goat would suffice. Slaughtering of buffalo is common especially at weddings, deaths and other large gatherings, which can number in the thousands. Again, the number of buffalos slaughtered is directly proportional to the importance of the event and it is not unheard of for over five buffalos to be slaughtered for the funeral of an important elder. Buffalo meat is readily available in Dili but can be difficult to find in the districts as the owner wants to ensure that all the meat can be sold promptly before rotting. Buffalo can be milked daily and the milk collected in a cut section of bamboo. The end of the section is sealed with a mass of leaves until the milk is brought back to the kitchen. The milk is then boiled to kill harmful bacteria and is then drunk on its own or added to coffee. Traditionally, buffalos were used to plough the rice paddy in preparation for planting. During the Indonesian pullout of 1999, buffalos were slaughtered by Indonesian soldiers and militias thereby halting this traditional method in many areas of the country. Almost five years later, many rice paddies remain untilled as there is no alternative method of plowing the rice paddy.

Horses provide a critical method of transportation both for people and goods. For

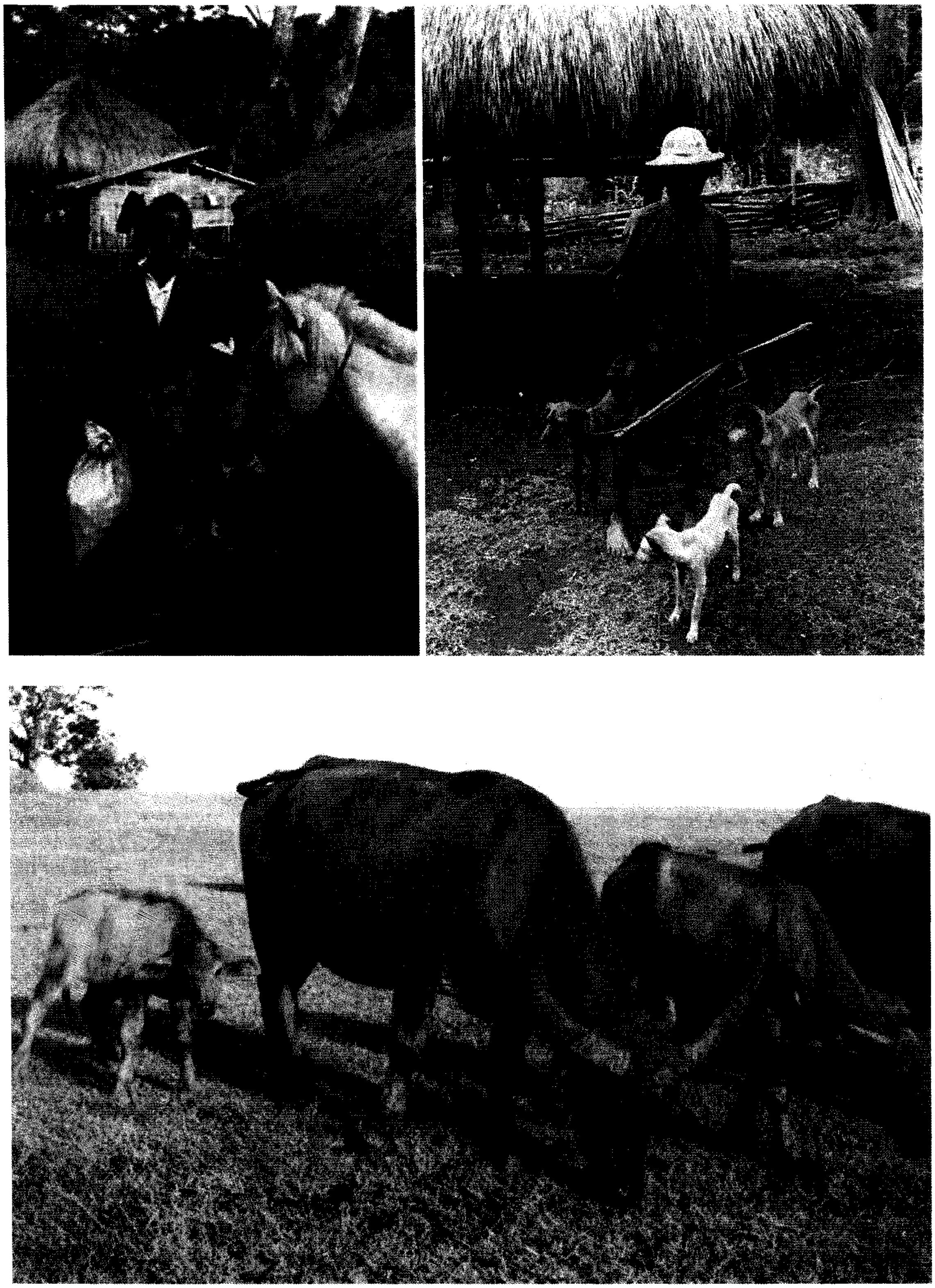

Figure 2. 6 Important livestock animals of East Timor; horses (top left), hunting dogs (top right) and water buffalo (bottom).

many remote villages with only dirt trails connecting them to major markets, horses provide the means to transport enough goods to make trips economical. As the population of East Timor rises, land availability decreases and individual farmer's cultivated fields become further and further away from their homes. Horses enable farmers with remote fields to access them and to be able to return home in the same day.

2.7 The Importance of Bush Meat

Bush meat is an important source of protein in the diet of East Timorese people living in remote areas. Animals that provide the most bush meat include wild deer, wild pigs, saltwater and freshwater fish, freshwater shrimp and cuscus. Deer and wild pig hunting is still regularly practiced in rural areas and makes a substantial contribution to the East Timorese diet and village economy. East Timorese men armed with either a spear made from welded metal or bamboo, or a traditionally made bamboo bow and arrow use between one and five dogs to locate, chase and then hold the prey. The hunts have very low success rates but because the East Timorese men rarely travel without their weapons or dogs, deer and pigs are occasionally killed. The meat is then butchered and is either consumed by the village or transported to market. A large male deer can be sold for $70-$100 while small deer can be sold for $20-$30.

The majority of hunting is done advantageously while en route to cultivated fields. However, in certain circumstances planned hunts are carried out during calculated burning of fields as farmers prepare to plant the swidden. Grass is burnt systematically to funnel prey into collecting areas such as dry river beds where the hunters wait with their dogs. An alternate, more passive method is lassoing. Lassoing or snaring is an effective method for capturing deer and pigs, however, it is essential that the traps are checked regularly as a dead animal will rot quickly rendering the valuable meat useless in only a few short days. The rotting of a trapped animal is an extremely frustrating and unfortunate event as the meat could have been sold at market for significant sums of money. For example, one hind quarter of a medium sized wild pig is worth approximately $5.

Hunting of large wild animals of East Timor is not without risk. Wild pigs for example have large sharp tusks that protrude from the mouth and provide it with an effective defence. The tusks can easily gore valuable hunting dogs attempting to corner or hold down a pig. One hunter had actually been gored himself by a wild pig during a hunt and suffered a serious cut to his inner thigh. He lost a considerable amount of blood and at the time of the interview still walked with a noticeable limp. On top of the possibility of being injured by goring or kicking from the powerful hind legs of deer, dogs are commonly injured during the chase by falling for example.

East Timor's seas are a valuable natural resource as the waters have not been heavily fished. As a result, it is easy for people living in remote communities to catch a considerable amount of fish from the ocean. The most common traditional fishing techniques are with nets and the aid of a dug out canoe, spear guns, attracting fish with fire or a powerful light source or using traditional fish poisons. All along the north coast the use of nets and spear guns is very popular. Enough fish are caught to supply a sizeable fish market in the heart of Dili. In the market, several species of fish including tuna, mackerel, barracuda and squid can be purchased fresh for reasonable prices. Traveling east of Dili to Los Palos, smaller fishing operations are evident from the several roadside stands selling fresh and already cooked fish. Typically, a cooked foot-long fish will cost $1.50.

One of the most traditional methods of capturing saltwater fish is through the use of fire as an attractant. Palm leaves are baked in the sun until they are completely dry. Single dried palm leaves are then tightly bundled together using cordage made from fresh palm.

The resulting bundled palm leaf is made into a large wick. Once it is night and the sea is at low tide, the fishermen carry the bundled palms to the ocean and build a small fire. Each fisherman grabs one of the bundles and lights the end. The palm burns in a controlled fashion and is very bright. The fishermen then make their way to the ocean and walk around in water that is one to two feet deep waving the ignited palms close to the water to attract fish. Usually, there is one fisherman whose job it is to carry extra bundled palms to be distributed to the others as their fire runs out. Once fish come within range, the fishermen use their machetes to kill them.

Freshwater streams also provide a valuable source of food, mainly shrimp and eels. During the dry season, creeks and rivers shrink and form pools of stagnant water where shrimp and eels congregate. Using just the hands, it is possible to feel around the base of rocks and catch enough to provide a meal. Alternately, at night, fishermen use flashlights to lure shrimp out into the open and then kill them with a machete.

Unidentified species of *Derris* ("ai-tuha") and *Euphorbia* ("ai-riti") and an unidentified Myristicaceae ("paunete") species were repeatedly mentioned as being effective fish poisons, but their use was never directly observed. Their leaves or bark of these fish poisons are milled in traditional bamboo mills, scraped with a machete or simply crushed with large rocks before being added to tidal pools or other small bodies of water. As the poisons diffuse into the water, shrimp and fish begin to float to the surface as they die. Typically, all fish will have risen to the surface in an hour, however, it is worthwhile to check again the following day as fish caught on rocks or other debris could have risen to the surface. Most fish poisons have limited toxicity and are not capable of killing large livestock such as dogs, pigs and buffalo. However, in the case of *Derris spp.*, great care must be taken not to poison water sources that may be used by livestock as this poison is capable of killing

Figure 2. 7 Commonly used fish poisons of East Timor; "Ai-riti" (*Euphoriba sp.*) (top), "Paunete" (bottom left) and "Ai-tuha" (*Derris sp.*) (bottom right).

them.

Cuscus (*Phalanger species*) are marsupials with a long prehensile tail and are approximately the size of a cat. They are relatively easy to catch during the day due to their nocturnal habit. Highly skilled members of the community will walk through the forest looking for dead standing trees. It is in the holes of these trees that cuscus make their nests and sleep the majority of the day. Once a dead standing tree has been spotted, the hunter will climb the tree to the hole. Climbing smaller trees is easier as the hunter can wrap his arms fully around the tree. Large trees require considerably more skill and technique to climb. The hunter will cut notches into large trees to use as steps and slowly maneuver up to the hole. Once at the hole, the hunter reaches in and tries to grab the cuscus by the tail. In some instances, the cuscus will have another hole to exit. Experienced hunters try to locate these escape holes in advance and block them with leaves. Once the cuscus has been securely grabbed by the tail the hunter pulls it out of the tree. Removing the cuscus from its hole is sometimes quite difficult as the cuscus has considerable strength for its size and long nails to grab onto the sides of its nest hole. Once the cuscus is out of its nest, the hunter drops it to the ground where another hunter is waiting with a machete to kill it. The meat is butchered in a relatively routine manner and is either boiled, deep fried or smoked to preserve it for eating later. If fetuses are present in the pouches of females they too are eaten.

The dangers of this sort of hunting are obvious. The heights of some of the cuscus nests can be as high as 60 feet. The hunter uses no ropes or safety equipment of any kind, making the climbing risky. Some of the hunters mentioned that it is not uncommon for people to fall out of trees which often results in serious injuries and sometimes death. This type of hunting is left to skilled tree climbers as it is too risky for amateurs. One young informant noted "Young people can not catch the cuscus anymore, only the old men."

Figure 2. 8 Cuscus (*Phalanger sp.*) and fish are two important bush meats in East Timor (top). Dried and bundled palms are ignited to attract fish before killing them with a machete (bottom).

2.8 Palm Alcohol

The abundance and variety of palm species growing in East Timor provide a convenient supply of sap that can be fermented into wine and then later distilled into hard liquor. The palm alcohol holds a key place in East Timorese social gatherings and also is economically important as it can be sold at market.

Palm varieties used by East Timorese people to make alcohol include "tali", coconut and sugar palm. As the different varieties of palm have unique growing conditions, the variety of palm alcohol varies with location. For example, because "tali" grows only at low elevations, "tali" alcohol is more common in sea level communities while sugar palm wine is more prevalent in the mountainous areas of the country. Although one of the three varieties of palm can usually be found in any given location, some communities do not make the alcohol themselves but purchase it from neighbouring villages or from the local market.

As stated previously, there are two forms of East Timorese alcohol; the fermented wine form known as "tua mutin" and the distilled hard alcohol known as "tua sabo". The first step is to select palm trees with fruit present. The fruit is removed from the tree leaving only the stalk to which the fruit was originally attached. The stalk is then bruised by striking it repeatedly with a stick or other blunt object. A small slice (approximately 2 cm) is removed from the tip of the stalk. This step is not done with a machete, instead a separate specialized knife is carried specifically for slicing the palm.

Once the section has been sliced off, the sap is allowed to drip out which soon ferments due to the heat. A 1 to 2 foot section of bamboo is attached to the palm tree to collect the sap which then ferments to make alcohol, at this point known as "tua mutin". A small section is removed from the tip regularly, sometimes once but usually twice a day, to speed up the draining process. Usually, the selected palms will be along commonly used trails that go to other villages, the market or most importantly to and from the field or rice paddy.

The amount of liquid present in the section of bamboo is checked regularly. If the bamboo section is full, it is emptied into a larger container, usually a four litre jug known as a “masa”. The jug or “masa” is then sealed with a handful of grass or leaves in preparation for transport. It is not uncommon for villagers to take a break from work in the fields near fermenting palms and to have some wine. During these unplanned alcohol breaks, cups are made by chopping bamboo into foot long sections.

While palm wine is a popular alcoholic beverage, many East Timorese prefer to distill the wine into hard alcohol known as “tua sabo”. A simple still is used consisting of a round bottomed cauldron, a metal joint fitting that connects the cauldron to a long (approximately 20 foot) piece of bamboo that has had the tissue separating the bamboo into segments removed. The piece of bamboo slopes to the ground to a container in which the hard liquor is collected. The cauldron is filled with wine and then fixed to the joint fitting. A large fire is built under the cauldron to boil the wine. The steam travels through the joint and into the sloping bamboo where the steam condenses and drips down the length of the bamboo into the collecting container at the end. The task of maintaining the fire at the correct temperature is usually the responsibility of a young villager.

During the distillation process, other plants may be used to give the hard alcohol a distinct flavour. The leaves of *Schleichera species* (“ai-daak”) for example are often formed into a ball and inserted into the bamboo. This forces the steam to pass through the mass of leaves. This treatment makes the “tua sabo” bitter as opposed to sweet. Another example is the use of the roots of an unidentified species of tree (“ialoloroto” the vernacular name in

Figure 2. 9 Tapped sugar palm (Arenga pinnata) with attached bamboo section to collect fermenting sap (top left). Bamboo segments are used as cups during palm alcohol rests (top right and bottom).

Fataluku). The roots are chopped into small pieces and tied into a bundle which is inserted into the bamboo section. Unlike "ai-daak", "ialoloroto" appears to have more of an effect on the potency. Locals mentioned that "tua sabo" made with "ialoloroto" will make the drinker feel 'very dizzy', 'as though they own very many buffalo even though they may own none', and 'as though they can touch the sky'. While this description may lead one to believe that the alcohol takes on hallucinogenic properties, locals say that it only increases the potency.

Stills are always located inside, usually in the main cooking shelter. The number of stills in a village varies. For example, in one village of 20 grass huts there were no stills, however, in another small village of four huts two were present. The number of stills is related to the number of palm trees in the village territory and the demand for alcohol.

"Tua sabo", and to a lesser extent "tua mutin", is a very important component of any East Timorese social gathering such as weddings, welcoming guests and in formal farewell parties. It is customary to give guests a glass of "tua sabo" as well as a small portion of cooked buffalo, goat or pig. In very formal situations, all guests wait with their portion of "tua sabo" until the most honoured guest has been given their portion. At this point, the honoured guest is expected to acknowledge to the group that he will now drink. This is usually accomplished by raising the glass and stating "disensa" or literally excuse me.

Not only does locally made alcohol play an important role in cultural gatherings but it can also contribute to the economy of a village. Both "tua mutin" and "tua sabo" can be sold in market. The price of alcohol is variable and depends on the location. In rural areas, where average daily earnings are low, a four litre jug of "tua mutin" can be purchased for approximately $1. Alternatively, in Dili, the same amount of alcohol would be sold for double that amount.

2.8 Conclusions

This chapter represents one of only a very few documents which describe cultural aspects of the East Timorese and how it relates to biodiversity resources. Through documenting plant use in the day-to-day life of rural East Timorese one major observation is worth reiterating. In the remote mountain communities, homegardens were either absent or small and undeveloped compared to roadside villages. As a result, the typical diet in the remote communities consists primarily of staples such as rice and corn supplemented with cassava. The diets of East Timorese living in these remote communities, while much better than during the Indonesian occupation where people were forced to live entirely off food collected from the forest, may lead to increased occurrence of malnutrition as important vitamins, such as vitamin A obtained from papaya, are lacking. Increased occurrence of disease as a result of malnutrition is a serious barrier to the development of East Timor and needs to be addressed through the implementation of programs which educate the public on the use of home gardens and their benefit to human health.

Table 2.1 Important construction, fishing, food, medicine, recreation, ritual and textile plants in remote areas of East Timor

Usage Category	English Common Name	Botanical Name Voucher Number	Tetum Name	Specific Use
Construction	Bamboo	several varieties of bamboo SC 40	au	Bamboo is a multipurpose construction material and is used to build a variety of items including walls, tables, water containers, irrigation systems and bows and arrows.
	Coconut	*Cocos nucifera* L. SC 269	ai-nu	The palm fronds are used to thatch rooves of living shelters and are also made into brooms. The wood is used in the construction of the main supports of living shelters. The dried husks from the fruit are a good fuel source that provides a long controlled burn.
	Cogon grass	*Imperata cylindrica* (L.) P.Beauv. SC 232	du'ut manulain	This grass is used as thatch for living shelters where palm species are in short supply.
	Eucalyptus	*Eucalyptus alba* Reinw. ex Blume SC 234	ai-bubur	The wood is used in the construction of the main support beams for sacred houses and living huts.
	Sugar palm	*Arenga pinnata* (Wurmb) Merrill SC 313	tua-metan	The palm fronds are a highly preferred thatch for sacred houses and living huts.

Table 2.1 Continued

Usage Category	English Common Name	Botanical Name Voucher Number	Tetum Name	Specific Use
Construction	unknown	unknown SC 202	tali	The palm fronds are used as thatch for living shelters, hut walls, traditional rain coats, mats, baskets and cordage.
Fishing	Coconut	*Cocos nucifera* L. SC 269	ai-nu	Dried palm fronds are bundled and ignited to attract fish.
	Derris	*Derris spp.* Lour. nom. cons. SC 222 SC 307	ai-tuha	Derris leaves and stem are milled and added to confined bodies of water to poison fish.
	unknown	*Euphorbia sp.* L. SC 177	ai-riti	The stem is milled and added to confined bodies of water to poison fish.
	unknown	unknown SC 287	paunete [1]	The roots and bark are milled and added to confined bodies of water to poison fish.
Food	Avocado	*Persea gratissima* Gaertn. fil. SC 20	avocat	The ripe fruit is eaten raw.
	Banana	*Musa spp.* L	hudi	The ripe fruit is eaten raw or unripe fruit is boiled and eaten.
	Basil	*Ocimum tenuifolium* L. SC 21	silasi	The leaves are used to spice vegetables and meat.
	Bitter melon	*Momordica charantia* L.	baria	The fruit is boiled or fried and eaten.
	Breadfruit	*Artocarpus incisa* L. SC 23	ai-kulu kami	The unripe fruit is boiled and eaten.

[1] local name in the indigenous language of Fataluku

Table 2.1 Continued

Usage Category	English Common Name	Botanical Name Voucher Number	Tetum Name	Specific Use
Food	Cashews	*Anacardium occidentale* L. SC 10	ai-kaizu	The fleshy portion of the fruit is eaten raw while the nut is baked and eaten.
	Cassava	*Manihot sp.* Mill SC 9	ai-farina	The tuber is boiled or baked and eaten.
	Chilis	*Capsicum spp.* L.	ai-manas	The fruits are milled and eaten as a side dish.
	Coconut	*Cocos nucifera* L. SC 269	ai-nu	The coconuts are eaten and sap is made into palm alcohol.
	Corn	*Zea mays* L. SC 67 - 71	batar	Corn is boiled or roasted and eaten.
	Cucumber	*Cucurbita sativa*	pipinu	The ripe fruit is eaten raw.
	Egg plant	*Solanum melongena* L. SC 62	brinjella	The fruit is boiled or fried and eaten.
	Ginger	*Zingiber officinale* Roscoe SC 25	ai-lia	The root is used to spice vegetables and meat.
	Guava	*Psidium guajava* L. SC 145	goebas	The ripe fruit is eaten raw.
	Grapefruit	*Citrus paradisi* Macfad.	jambua	The ripe fruit is eaten raw.
	Horse radish tree	*Moringa oleifera* Lam. SC 63	ai-marungi	The leaves are boiled or fried and eaten.
	Indian bael	*Aegle marmelos* Correa SC 114	ai-dila fatuk	The ripe fruit is eaten raw.
	Jackfruit	*Artocarpus heterophylla* Lam. SC 16	ai-kulu naka	The ripe fruit is eaten raw or unripe fruit is boiled or fried and eaten.
	Lemon grass	*Cymbopogon citrates* (DC.) Stapf SC 86	du'ut morin	Lemon grass is used as a spice for cassava, potatoes and meat.

Table 2.1 Continued

Usage Category	English Common Name	Botanical Name Voucher Number	Tetum Name	Specific Use
	Mango	*Mangifera indica* L. SC 268	haas	The ripe fruit is eaten raw.
	Mung beans	*Vigna radiata* (L.) R.Wilczek SC 44	fore munguu	The beans are boiled and eaten.
	Mustard	unknown	mustarda	The leaves are boiled or fried and eaten.
	Orange	*Citrus sinensis* (L.) Osbeck	sabraka	The ripe fruit is eaten raw.
	Papaya	*Carica papaya* L. SC 311	ai-dila	The ripe fruit is eaten raw or unripe fruit is boiled or fried and eaten.
	Pineapple	*Ananas comosus* (L.) Merr.	nenas	The ripe fruit is eaten raw.
	Red Ginger	*Alpinia sp.* Roxb. SC 22	lain kuas	The root is used to spice meat.
	Squash	*Cucurbita sp.* L. SC 28	kamalenga	The fruit is boiled or fried and eaten.
	Sugar apple	*Annona squamosa* L. SC 62	ai-ata ki'ik	The ripe fruit is eaten raw.
	Sugar cane	*Saccharum officinarum* L.	tohu	The sugar cane is eaten raw.
	Sugar palm	*Arenga pinnata* (Wurmb) Merrill	tua-metan	Sap from the fruit is made into palm alcohol.
	Sweet potatoe	*Ipomoea batatas* (L.) Lam. SC 12	fehuk midar	The tuber is boiled or baked and eaten.
	Tangerine	*Citrus reticulata* Blanco	sabraka	The ripe fruit is eaten raw.
	Tomatoes	*Solanum lycopersicum* L.	tomati	The ripe fruit is eaten raw.

Table 2.1 Continued

Usage Category	English Common Name	Botanical Name Voucher Number	Tetum Name	Specific Use
Food	Turmeric	*Curcuma zedoaria* (Christm.) Roscoe SC 98	kontas mutin	The tuber is used to spice vegetables.
	unknown	*Annona species* SC 178	ai-ata bo'ot	The ripe fruit is eaten raw.
	unknown	unknown SC 202	tali	The sap is made into palm alcohol
	unknown	unknown SC 24	canco	The leaves are boiled or fried and eaten.
	unknown	unknown SC 290	ialoloroto [1]	The roots are used in the distillation of palm alcohol to give the alcohol a distinct flavour and increase potency.
	unknown	*Xanthosoma sp.* (L.) Schott SC 11	fia	The tuber is boiled or baked and eaten.
Medicinal	Betel nut	*Areca catechu* L.	bua	Betel nut is chewed with pepper leaves and powdered limestone and then spat on sick people as a general tonic cure.
	Pepper	*Piper betle* L.	malus	This pepper species is chewed with betel nut and powdered limestone and spat on sick people as a general tonic cure.

[1] local name in the indigenous language of Fataluku

Table 2.1 Continued

Usage Category	English Common Name	Botanical Name Voucher Number	Tetum Name	Specific Use
Recreational	Betel nut	*Areca catechu* L.	bua	Betel nut is chewed with pepper leaves and powdered limestone for recreational use.
	Pepper	*Piper betle* L.	malus	This pepper species is chewed with betel nut and powdered limestone for recreational purposes.
	Tobacco	*Nicotiana tabacum* L. SC 185	tobacco	Tabacco leaves are dried and smoked.
Ritual	Betel nut	*Areca catechu* L.	bua	Offerings of betel nut are made to please the ancestors during traditional ceremonies.
	Eucalyptus	*Eucalyptus alba* Reinw. ex Blume SC 234	ai-bubur	Eucalyptus poles are carved with ceremonial designs and are used as offerings to the ancestors and as part of the sacred house raising ceremony.
	Ornamental flowers	various	ai-funan	Various species of ornamental flowers are used during traditional ceremonies as offerings to the ancestors.
	Pepper	*Piper betle* L.	malus	Offerings of this pepper species are made to the ancestors during traditional ceremonies.

Table 2.1

Usage Category	English Common Name	Botanical Name Voucher Number	Tetum Name	Specific Use
Textiles	Candlenut	*Aleurites moluccana* (L.) Willd. SC 66	ai-kami	The fruits are milled and then molded around traditional thread to make candles.
	Cotton	*Gossypium sp.* L. SC 27	kabas	This cotton is spun into thread, dyed using traditional dyes and then woven using traditional looms into fabric known as "tais".

CHAPTER 3

QUANTITATIVE ETHNOBOTANY OF TWO EAST TIMORESE CULTURES

3.1 Introduction

The research objective of the majority of ethnobotanical literature is to document traditional botanical knowledge without making comparisons between cultural groups (Fernandez *et al.* 2003, Frei *et al.* 1998, Giday *et al.* 2003, Lykke 2000 and Pinedo-Vasquez *et al.* 1990). Preliminary attempts to compare traditional plant use between cultural groups include Prance *et al.*'s (1987) work in Brazil and Turner's (1988) research with the Thompson and interior Salish people of British Columbia. Both Prance *et al.*'s (1987) and Turner's (1988) research utilized consensus factors with subjectively allocated values which made the data unsuitable for statistical analysis.

Heinrich *et al.*'s (1998) research in Mexico, where the medicinal plant knowledge of four separate indigenous groups was compared, is one of the best examples of recent ethnobotanical research that compares plant knowledge between cultural groups. The collected data was analyzed using the 'informant consensus factor' first developed by Trotter and Logan (1986). Although data compiled in this manner is suitable for statistical tests, Heinrich *et al.*'s (1998) research did not include any statistical analysis.

The purpose of this chapter is to compare medicinal plant knowledge between two distinct cultural groups in East Timor using the same 'informant consensus factor' employed by Heinrich *et al.* (1998). Differences in informant consensus values between the two cultural groups are analyzed to determine whether or not one culture had higher average informant consensus. Comparisons concerning medicinal plant habit, habitat, plant family, route of administration and method of preparation are also made to determine differences and similarities between the two cultures. Lastly, possible explanations for the discrepancies between the two medicinal plant traditions are discussed.

3.2 Methods

3.2.1 Ethical Approval

This research was initiated by USC-Canada to examine traditional medicine in East Timor. USC-Canada, formerly the Unitarian Services Committee, is a Canadian non-governmental organization whose program focuses on developing agricultural methods, improving community water supply and conserving crop diversity in underdeveloped countries of Asia and Africa. USC-Canada facilitated a collaboration between the University of Ottawa, Canada and USC's East Timor branch (USC-CET) located in Dili, East Timor. Two USC-CET staff members, Mateus Soares Maia and Marcellino da Costa Perreira aided in translation, plant collection, voucher preparation and explanations of local customs and etiquette.

Prior to undertaking field activities, local government authorities were consulted and permission was requested to work in the area. Community meetings were held in the villages where research would be undertaken to explain the objectives of the research and to obtain consent from the village chief and elders. Ethical approval was granted by the University of Ottawa Ethics Committee with the understanding that the identity of each healer would be kept confidential. The Ministry of Agriculture, Forestry and Fisheries of East Timor was consulted prior to conducting research. Collecting permits were not issued as regulations have not yet been developed by the East Timorese government.

3.2.2 The Study Site

As the objective of this research was to document the differences in medicinal plant traditions between two cultures, villages whose traditional languages are different were selected. However, due to the prevalence of Tetum, the lingua franca of East Timor, and Bahassa Indonesian, most cultural groups with distinct traditional languages can still communicate. Villages were also selected on the basis that they were remote in terms of being only accessible either on foot or by horse as opposed to roadside communities. This criterion was implemented as we hypothesized that more remote communities would have a greater dependence on local plant resources and therefore a greater knowledge of medicinal plants. Exceptions were made when key informants originally belonging to the selected village, and therefore of the same cultural group, were interviewed in their current roadside communities.

The first village was in the Fatoberliu sub district of the Manufahe District. One full day, using pack horses, was required to access the village from the nearest road. The village was located in secondary forest at an approximate elevation of 400 m above sea level in hilly terrain. The village consisted of approximately 150 people in 20 family groups. Laklei is the traditional language of the community, therefore, this village will be referred to as Laklei.

The second village was in the Laclubar sub district of the Manatuto District. Half a day, using pack horses, was required to access the village from the nearest road. The village was located in a secondary forest at an approximate elevation of 800m above sea level, also in hilly terrain. This village was considerably smaller than Laklei, with a population of approximately 30 people in 5 family groups. Idate is the traditional language of this community, therefore, this village will be referred to as Idate. Both villages were in monsoon forest (Whitmore 1975).

3.2.3 Informants

All informants were subsistence farmers with no source of income other than that gained from the sale of surplus produce in roadside markets. In Laklei, both wet and dry varieties of rice were grown along with corn and other minor vegetable crops. In Idate, rice was not grown and the primary crop was corn supplemented mostly with wild beans. No informant had the designated title of 'village healer' per se in either village; however, the degree of medicinal plant knowledge varied considerably between informants.

3.2.4 Interviews

Following consultation with the village Chief, medicinal plant collection trips and interviews were arranged between the research team and community members who had medicinal plant knowledge. At the beginning of every interview, the research team explained that the informant could end the interview at any time and that they were in no way obligated to share information of a spiritual nature or any other information that they were uncomfortable sharing.

Plant collections and interviews were conducted on casual walks, during which the informants were asked to point out or describe any plants that they considered to be important medicinal or poisonous plants. In both villages, the interviews were conducted in Tetum and generally lasted 1-3 hours. During interviews, indications of the medicinal plant's use, part of the plant used, method of preparation, route of administration, habitat, habit and the plant's vernacular name were recorded. At the end of the interview the informant was compensated for their time with a nominal sum of money.

3.2.5 Voucher Specimens

Voucher specimens were collected when possible in triplicate. Sets of the voucher specimens are now stored at the National University of East Timor, Dili, East Timor; The Northern Territory Herbarium, Darwin, Australia; and the University of Ottawa, Ottawa, Canada. Identifications were made by Andrew Mitchell of Australian Quarantine and Dr. Dale Dixon of The Northern Territory Herbarium. The majority of the collection is identified to species, however, when this was not possible the genus and or family name were used.

3.2.6 Ethnobotanical Terminology

A mention for a plant was considered to be a 'single record of use' from the interviews with informants in the two villages (Treyvaud Amiguet *et al.* 2004). For example, if Plant A was used to treat cough, a single mention would be recorded; however, if Plant A treated both cough and malaria, two mentions would be recorded and so on with cough and malaria being the 'specific uses'. 'Specific uses' were then divided into 'usage categories' following the method developed by Cook (1995).

Disease 'usage categories' are groupings of medical conditions that affect a system of the body. The disease categories are; Circulatory System Disorders (CIR), Digestive System Disorders (DIG), Genitourinary System Disorders (GEN), Ill-Defined Symptoms (ILL), Infections/Infestations (INF), Inflammation (IFM), Injuries (INJ), Metabolic System Disorders (MET), Muscular-Skeletal System Disorders (MUS), Nervous System Disorders (NER), Poisoning Disorders (POD), Pregnancy/Birth/Puerperium Disorders/Effects (PRE), Respiratory System Disorders (RES), Sensory System Disorders (SEN) and Skin/Subcutaneous Cellular Tissue Disorders (SKI).

In addition to the disease 'usage categories' identified by Cook (1995), three additional 'usage categories' were used. These categories are Veterinary Medicine (VET), Poisons (POI) and Culture Bound Syndromes (CUL). Culture bound syndromes are conditions that are 'not recognized by biomedical practitioners as diseases' (Treyvaud Amiguet *et al.* 2004).

3.2.7 Consensus

Until recently, ethnobotanical literature documented medicinal plant traditions by compiling lists detailing preparation, administration and diseases treated by plants (Boom 1987, Holdsworth and Wamoi 1982, Singh 1986). However, as the field of ethnobotany has evolved, more sophisticated methods have been developed to enable the testing of falsifiable hypotheses. Such consensus indices include Phillips and Gentry's (1993a and 1993b) well known 'use value' and Trotter and Logan's (1986) 'informant consensus factor'.

Trotter and Logan's 'informant consensus factor' is a measure of the agreement between informants concerning what plants to use to treat illnesses. The consensus factor is calculated as

$$F_{ic} = \frac{n_{ur} - n_t}{n_{ur} - 1}$$

where

F_{ic} = informant consensus factor
n_{ur} = number of mentions in each usage category
n_t = number of taxa used

The 'informant consensus factor' is a comparison of the number of 'mentions' in a usage category and the total number of taxa used in the category concerned. Values for the factor range from 0 to 1. A value of 1 indicates few taxa are used by informants, thus inferring a high degree of consensus and a well defined medicinal plant tradition (Heinrich *et al.* 1998). For the purposes of this study, the taxon considered is species. The 'informant consensus factor' was calculated for each usage category in Laklei and in Idate.

It was assumed that unique medicinal plant traditions would have significantly different 'informant consensus factors' indicating differences in how well the medicinal plant traditions are defined. A one tailed paired t-test was used to determine if the average value of the 'informant consensus factor' was significantly greater in Laklei than in Idate.

3.2.8 Comparison of Medicinal Plant Selection

Using Chi-square analysis, number of habit, plant part used, habitat, route of administration and method of preparation mentions were compared between the two cultures to determine if these aspects of medicinal plant traditions are dependent upon culture.

3.3 Results and Discussion

In total, 86 medicinal plant species were collected. Of the 86 medicinal plant species, 44 were collected in Laklei and 53 were collected in Idate. Table 3.1 and Table 3.2 list the medicinal plant species collected in Laklei and Idate respectively, as well as family and botanical name, vernacular name in the local language, and the ailment or specific use of the plant. Specific uses of the plant species collected with the Idate culture were not included to respect their wishes to not have this information made public. Of the plants collected in Laklei, 28 of the plants were identified to species, 10 to genus and 6 to family. Of the plants collected in Idate, 25 of the plants were identified to species, 20 to genus, and 8 to family. All plants identified to the level of genus or family represent unique species.

A low overlap of medicinal plants identified to species was detected between our findings and other ethnobotanical literature for Indonesia and the islands of the south Pacific (Elliott and Brimacombe 1995, Hirschhorn 1983, Holdsworth and Rali 1989, Holdsworth and Wamoi 1982, Whistler 1985). For example, Leaman (1996) documented the use of 209 medicinal plants used in Kalimantan, Indonesia, of which only 7 were common to our findings. Although the flora of Kalimantan and East Timor are drastically different, this comparison demonstrates the unique assemblage of medicinal plants documented.

It was assumed that the usage categories which received the highest number of mentions are the most prevalent in the communities and also of the greatest importance to the people living in the villages. In Laklei, the most important usage category is

Table 3.1 Family name, botanical name, Laklei name and specific uses of 44 medicinal and poisonous plant species collected in Laklei.

Family	Botanical Name	Voucher	Laklei Name	Specific Uses
Acanthaceae	*Justicia gendarussa* L.	SC 97	Kahoris	UTI [1]
Acoraceae	*Acorus calamus* L.	SC 105	Kanuan	colds, dementia
Agavaceae	*Cordyline species A* Comm. ex R. Br.	SC 122	Bunak	inflammation, haemorrhagic fever
Anacardiaceae	*Mangifera indica* L.	SC 160	Ai-haas	veterinary medicine
Apocynaceae	*Alstonia scholaris* (L.) R. Br.	SC 39a	Karuti mutin	helminth worm infection, malaria, UTI
	Alstonia species A R. Br.	SC 143	Karuti metan	malaria
	Alstonia spectabilis R. Br.	SC 148	Karuti metan	malaria, migraine, UTI
	Ervatamia pubescens (R.Br.) Domin	SC 169	Ai-laliti	UTI
	Thevetia peruviana (Pers.) K. Schum.	SC 133	Ai-liis	diarrhea
	Wrightia pubescens R.Br.	SC 151	Ai-litik metan	UTI
Asclepiadaceae	*Calotropis gigantea* (L.) W. T. Aiton	SC 115	Ai-sucar	constipation, UTI
Bignoniaceae	unknown	SC 109	Ai-naan maran	cough, UTI
Cycadaceae	unknown	SC 138	Bet	leprosy
Dilleniaceae	*Dillenia indica* L.	SC 123	Ai-laboku	wound
Euphorbiaceae	*Antidesma ghesaembilla* Gaertn.	SC 134	Ai-formi	fractures, wounds
	Jatropha curcas L.	SC 166	Baruk malakan mutin	asthma, sore teeth
	Mallotus philippensis (Lam.) Mull. Arg.	SC 102	Ai-manu teen	fractures, haemorrhagic fever, prolonged menstruation, wounds
	Phyllanthus species L.	SC 157	Kelan	chest pain
	unknown	SC 175	Ai-hok	malaria
Leeaceae	*Leea indica* Merr.	SC 111	Ai-asu ulun	inflammation
Leguminosae	*Cassia fistula* L.	SC 117	Kadus	asthma, cough, fever, snake bite, worm infection, wounds
	Cassia species L.	SC 119	Ai-reras	malaria
	Erythrina variegata L.	SC 37	Ai-dik	sore teeth

[1] Urinary tract infection

Table 3.1 Continued

Family	Botanical Name	Voucher	Laklei Name	Specific Uses
Leguminosae	*Leucaena leucocephala* (Lam.) de Wit	SC 101	Samtuku fuik	hernia
	unknown	SC 120	Ai-hai	poor eye sight
Malvaceae	*Urena lobata* L.	SC 156	Kakuik	wound, severed limb
Meliaceae	*Melia azedarach* L.	SC 125	Ai-saria	hepatitis, malaria
Moraceae	*Ficus hispida* L. f.	SC 35	Ai-tafui	diarrhea, dysentery, poor milk quality
	Ficus racemosa L.	SC 140	Ai-gun	arthritis
	Ficus septica Burm. f.	SC 171	Ai-mahak	arthritis, itching
Myrtaceae	*Psidium guajava* L.	SC 145	Goivas	dysentery, UTI
Piperaceae	*Piper species A* L.	SC 113	Ai-manas rain	cough, itching
Poaceae	unknown	SC 40	Au	hepatitis
Polypodiaceae	*Drynaria quercifolia* (L.) J. Sm.	SC 108	Manu fuluk	asthma, cough
Rhamnaceae	*Ziziphus species* Mill.	SC 161	Ai-lok	UTI, veterinary medicine
Rubiaceae	*Nauclea orientalis* (L.) L.	SC 107	Ai-fukira	diarrhea, hepatitis, malaria
	Morinda citrifolia L.	SC 104	Ai-fauo	fatigue/malaise
	Timonius timon (Spreng.) Merr.	SC 165	Ai-katinun	migraine
Rutaceae	*Aegle marmelos* Correa	SC 36	Ai-dila-tukun	diarrhea, dysentery, veterinary medicine
Sapindaceae	*Schleichera species* Willd.	SC 168	Ai-daak	migraine
Verbenaceae	*Callicarpa species* L.	SC 155	Ai-caltomak	fractures
	unknown	SC 149	Bak moruk	malaria, UTI
	Vitex species L.	SC 130	Ai-ritas	fish poison
Zingiberaceae	*Curcuma zedoaria* (Christm.) Roscoe	SC 98	Bilik	bad body odour, foreign body extraction

Table 3.2 Family name, botanical name, Idate name and specific uses of 53 medicinal and poisonous plant species collected in Idate.

Family	Botanical Name	Voucher	Idate Name
Acanthaceae	*Barleria species* L.	SC 252	Ai-roma
	Thunbergia species Retz.	SC 211	Ai-asu amat
Agavaceae	*Cordyline species B* Comm. ex R. Br.	SC 65	Punas-mean
Apocynaceae	*Alstonia scholaris* (L.) R. Br.	SC 206	Ai-dotik
	Plumeria rubra L.	SC 57	Santo Antoni
Araceae	*Alocasia species* (Schott) G. Don	SC 220	Talas fuik
Araliaceae	*Schefflera species A* J.Forst. & G. Forst.	SC 248	Tali kerek
Asclepiadaceae	*Calotropis gigantea* (L.) W. T. Aiton	SC 58	Ai-tabuac
	unknown	SC 245	Leki Meak
Asteraceae	*Conyza species* Less.	SC 244	Antoni
Dioscoreaceae	unknown	SC 263	Menlala
Euphorbiaceae	*Aleurites moluccana* (L.) Willd.	SC 236	Ai-badu
	Jatropha curcas L.	SC 59	Ai-badut
	Jatropha gossypifolia L.	SC 212b	Ai-baduk malay
	Mallotus philippensis (Lam.) Mull. Arg.	SC 219	Lurli
	Ricinus communis L.	SC 60	Ai-kalula mean
Lamiaceae	*Hyptis capitata* Jacq.	SC 257	Laka ho
Leeaceae	*Leea species* L.	SC 233	Ai-tur-elas
Leguminosae	*Acacia species* Mill.	SC 259	Ata hok
	Albizia species Durazz.	SC 224	Hilalo
	Cassia fistula L.	SC 226	Ai-laras
	Derris species A Lour.	SC 222	Tuha
	Pterocarpus indicus Willd.	SC 209	Ai-naro
	unknown	SC 213	Ai-salo
Liliaceae	*Proiphys species*	SC 247	Liis fuik

[1] Urinary tract infection

Table 3.2 Continued

Family	Botanical Name	Voucher	Idate Name
Liliaceae	unknown	SC 212a	Tebe rai
Loganiaceae	*Strychnos lucida* R.Br.	SC 260	Ai-boikir
Loranthaceae	*Amymea species A*	SC 218	Bere ligu teen
	Amymea species B	SC 262	Ber liko teen
Malvaceae	*Gossypium species* L.	SC 204	Abut fuik
	Thespesia species Sol. ex Correa	SC 227	Abas fuik
	Sida acuta Burm.f.	SC 238	Arboy matan
	Sida retusa L.	SC 258	Arbau wain mata
Meliaceae	*Azadirachta indica* A. Juss	SC 235	Ai-lelo
Moraceae	*Ficus species A* L.	SC 253	Ai-hahiik
	Ficus species B L.	SC 255	Ai-sapu
Myrtaceae	*Eucalyptus alba* Reinw. ex Blume	SC 234	Ai-bubur
	Psidium guajava L.	SC 215	Goivas
Nyctaginaceae	*Boerhavia species* L.	SC 250	Kasalak
Poaceae	*Arundo donax* L.	SC 242	Ai-lia fuik
	unknown	SC 243	Au
	Imperata cylindrica (L.) P.Beauv.	SC 232	Duut manly
Polypodiaceae	*Drynaria quercifolia* (L.) J. Sm.	SC 217	Manu butik
Rhamnaceae	*Ziziphus species* Mill.	SC 239	Ai-bulai
Rubiaceae	*Nauclea orientalis* (L.) L.	SC 207	Ai-soso
	Timonius timon (Spreng.) Merr.	SC 229	Ai-katimuk
Rutaceae	*Aegle marmelos* Correa	SC 230	Ai-dila tukun
Sapindaceae	*Ganophyllum falcatum* Blume	SC 251	Ai-lelo
Sterculiaceae	*Sterculia foetida* L.	SC 61	Ai-nitas
Tiliaceae	*Grewia species* L.	SC 210	Ai-kalina

Table 3.2 Continued

Family	Botanical Name	Voucher	Idate Name
Urticaceae	unknown	SC 241	Ramek
Verbenaceae	unknown	SC 256	Tali buti
Zingiberaceae	unknown	SC 221	Lakoni

Infections/Infestations, which accounted for slightly more than 30% of all mentions. Genitourinary System Disorders (13%), Digestive System Disorders (12%) and Muscular-Skeletal System Disorders (9 %) and Injuries (9%) were also common (Figure 3.1). In Idate, Infections/Infestations was also the most important usage category and accounted for 16% of the total mentions. Genitourinary System Disorders (12 %). Digestive System Disorders (10%) and Injuries (10 %) were also common usage categories (Figure 3.1). Treyvaud Amiguet *et al.* (2004) used similar methodology while studying medicinal plant use by the Mayans in Belize and also found that Infections/Infestations was the most important usage category. Grosvenor *et al.* (1995) also found a very high incidence of Infections/Infestations and Digestive System Disorders in Sumatra where of the remedies, 50%, 33% and 31% were used to treat fever, diarrhea and "other gastrointestinal problems" respectively. While Infections/Infestations is the highest frequency usage category for both villages, the frequency in Laklei was nearly twice that of Idate.

In Laklei, the four ailments with the most mentions in decreasing order are malaria, urinary tract infections, diarrhea and wounds (Table 3.3). In Idate, the four ailments with the most mentions in decreasing order are urinary tract infections, wounds, cough and fractures (Table 3.4). The specific uses urinary tract infection describes illnesses with symptoms that include painful urination, urine that is cloudy, whitish or bloody and pain in the abdominal and back region. Furthermore, symptoms may include lesions on and discharge from the genitals. In some cases it was advised that patients were not to have sexual intercourse with their partner, indicating that some conditions classified under this specific use are sexually transmitted. Several of the plants used to treat urinary tract infection resemble symptoms of the ailment therefore indicating the importance of the Doctrine of Signatures in both healing traditions. The Doctrine of Signatures states that plant remedies resemble in some way,

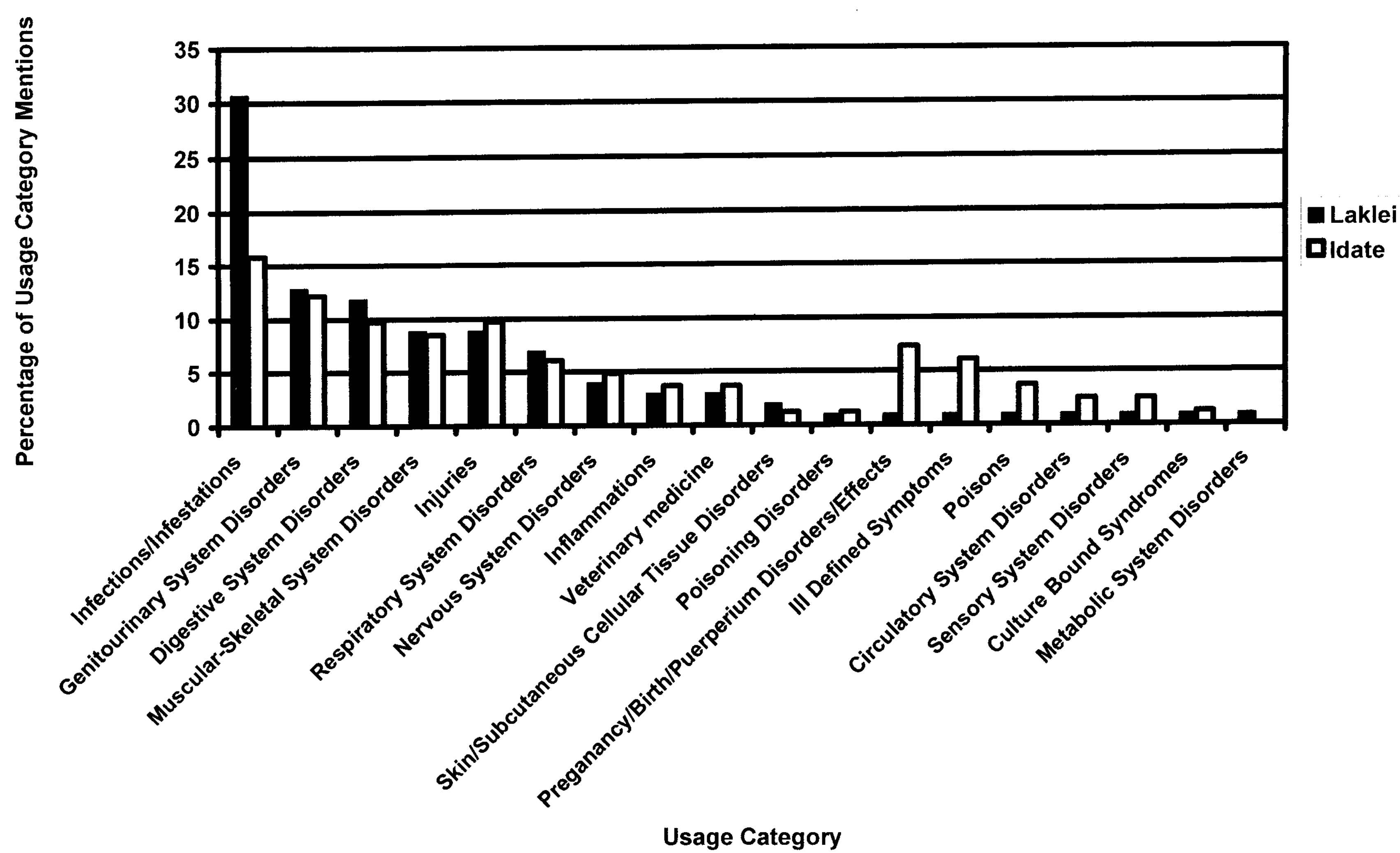

Figure 3.1 Frequency of usage category mentions for medicinal and poisonous plants collected in Laklei and Idate.

Table 3.3 Usage categories with number of mentions for specific uses in Laklei.

1) **Circulatory System Disorders**					
chest pain	1				
2) **Culture Bound Syndrome**					
poor quality breast milk	1				
3) **Digestive System Disorders**					
constipation	1	dysentery	3		
diarrhea	7	hernia	1		
4) **Genitourinary System Disorders**					
urinary tract infection	13				
5) **Ill Defined Symptoms**					
fatigue/malaise	1				
6) **Infections/Infestations**					
colds	1	helminth worm infection	3	leprosy	1
fever	2	hepatitis	4	malaria	16
haemorrhagic fever	4				
7) **Inflammations**					
inflammation	3				
8) **Injuries**					
foreign body extraction	1	wound	7	severed limb	1
8) **Metabolic System Disorders**					
body odour	1				
9) **Muscular-Skeletal System Disorders**					
arthritis	3	sore teeth	2		
fracture	4				
10) **Nervous System Disorders**					
dementia	1	migraine	3		
12) **Poisoning Disorders**					
snake bite	1				
13) **Poisons**					
fish poison	1				
14) **Preganancy/Birth/Puerperium Disorders/Effects**					
prolonged menstruation	1				
15) **Respiratory System Disorder**					
asthma	3	cough	4		
16) **Sensory System Disorders**					
poor eye sight	1				
17) **Skin/Subcutaneous Cellular Tissue Disorders**					
itching	2				
18) **Veterinary Medicine**					
Infection	3				

Table 3.4 Usage categories with number of mentions for specific uses in Idate

1) **Circulatory System Disorders**					
chest pain	2				
2) **Culture Bound Syndrome**					
shaking new born	1				
3) **Digestive System Disorders**					
hernia	1	dysentery	4		
diarrhea	2	nausea	1		
4) **Genitourinary System Disorders**					
infertility	1	urinary tract infection	9		
5) **Ill Defined Symptoms**					
fatigue/malaise	4	smelly nose	1		
6) **Infections/Infestations**					
fever	2	hepatitis	2	measles	1
food poisoning	1	infection	1	pink eye	1
helminth worm infection	1	malaria	4		
7) **Inflammations**					
inflammation	3				
8) **Injuries**					
foreign body extraction	1	wound	7		
9) **Muscular-Skeletal System Disorders**					
arthritis	1	fracture	5	sore teeth	1
10) **Nervous System Disorders**					
migraine	4				
12) **Poisoning Disorders**					
snake bite	1				
13)**Poisons**					
fish poison	1	insecticide	1	pest control	1
14) **Preganancy/Birth/Puerperium Disorders/Effects**					
labour induction	2	lactations stimulant	3	post partum bleeding	1
15) **Respiratory System Disorder**					
cough	5				
16) **Sensory System Disorders**					
poor eye sight	1	deafness	1		
17) **Skin/Subcutaneous Cellular Tissue Disorders**					
boils	1				
18) **Veterinary Medicine**					
cuts	1	tonic	2		

either colour or shape for example, the disease or condition that they treat (Dafni and Lev 2002). For example, in Idate a decoction of the roots of *Thunbergia sp.*, and the bark of *Grewia sp.* and *Pterocarpus indicus* is drank by patients with progressed urinary tract infections where the symptoms include very painful bloody urinations. *P. indicus* bark has a large amount of red sap which closely resembles blood, furthermore, the bark of *Grewia sp.* and the roots of *Thunbergia sp.* are also red. In Laklei, the roots of *Calotropis gigantea*, whose sap is milky white, are boiled and drank by patients experiencing painful urinations that are cloudy white.

The large number of medicinal plant species used to treat wounds and fractures is a reflection of the day-to-day lifestyle of the villagers and the prolonged conflict with the Indonesian army. Machete wounds are common as the machete is used on a daily basis to clear land and harvest food. Fractures are also common as trees are routinely climbed in order to harvest edible fruits and bush meat. In this process persons often fall. Also, the conflict with the Indonesian army made the development of remedies to treat machete wounds, broken bones and bullet wounds necessary. In Laklei, a poultice from the macerated root of *Curcuma zedoaria* is applied to bullet wounds. According to the informant, one day after applying the treatment the bullet will have moved to the surface of the skin, where it can easily be removed. Digestive system disorders such as diarrhea were common in Laklei. Typically, the source of the community's drinking water is also used for bathing, watering livestock and in some cases for sewage disposal. These practices give rise to poor water quality and may lead to increased incidence of gastrointestinal problems. Malaria was not among the most mentioned conditions in Idate however, it was very prevalent in Laklei. Morris (2001) states, the main "public health threat" in East Timor are infectious diseases; particularly malaria. After the pullout of the Indonesian government in

1999, crowded living conditions of the displaced East Timorese population coupled with the rainy season led to a tripling of diagnosed malaria cases from 1998 to 2000 (Morris 2001).

The medicinal plant species were analyzed with respect to frequency of plant family, habitat, habit, part used, preparation type and route of administration. In Laklei the highest percentage of plant species were Apocynaceae (14%), Euphorbiaceae (11%) and Leguminosae (11%), but in Idate plants which occurred with the highest frequency were Leguminosae (11%), Euphorbiaceae (9%) and Malvaceae (8%) (Figure 3.2). Statistical analysis using contingency tables was attempted to determine differences or similarities in family selection, however almost all families had expected cell counts lower than 5 thereby substantially reducing the accuracy of computed p values from Chi-square analysis. However, upon visual inspection a trend towards differing family selection is apparent as 18 of the 37 plant families were used in only one of the two villages (Figure 3.2) and only 11 of a total 86 plant species were used in both cultures (Table 3.5).

Of the 11 species used by Laklei and Idate only 6 have common specific uses in both cultures. Leonti *et al.* (2003) found that of 600 and 215 medicinal plants collected respectively with the Zoque-Popoluca and the Lowland Mixe, two ethnic Mayan groups, 123 were used by both cultures. Therefore, 57% of the medicinal plant species used by the Lowland Mixe, where fewer medicinal species were collected, are common to the Zoque-Popoluca. In Laklei, where fewer medicinal species were collected, only 25% of the medicinal species are common to Idate. Furthermore, Leporatti and Ivancheva (2003) found that of 250 medicinal plant species used in both Bulgaria and Italy, 80% had common applications in both cultures whereas of 11 medicinal plant species collected in Laklei and Idate only 55% have common uses in our study. Therefore, Laklei and Idate have relatively

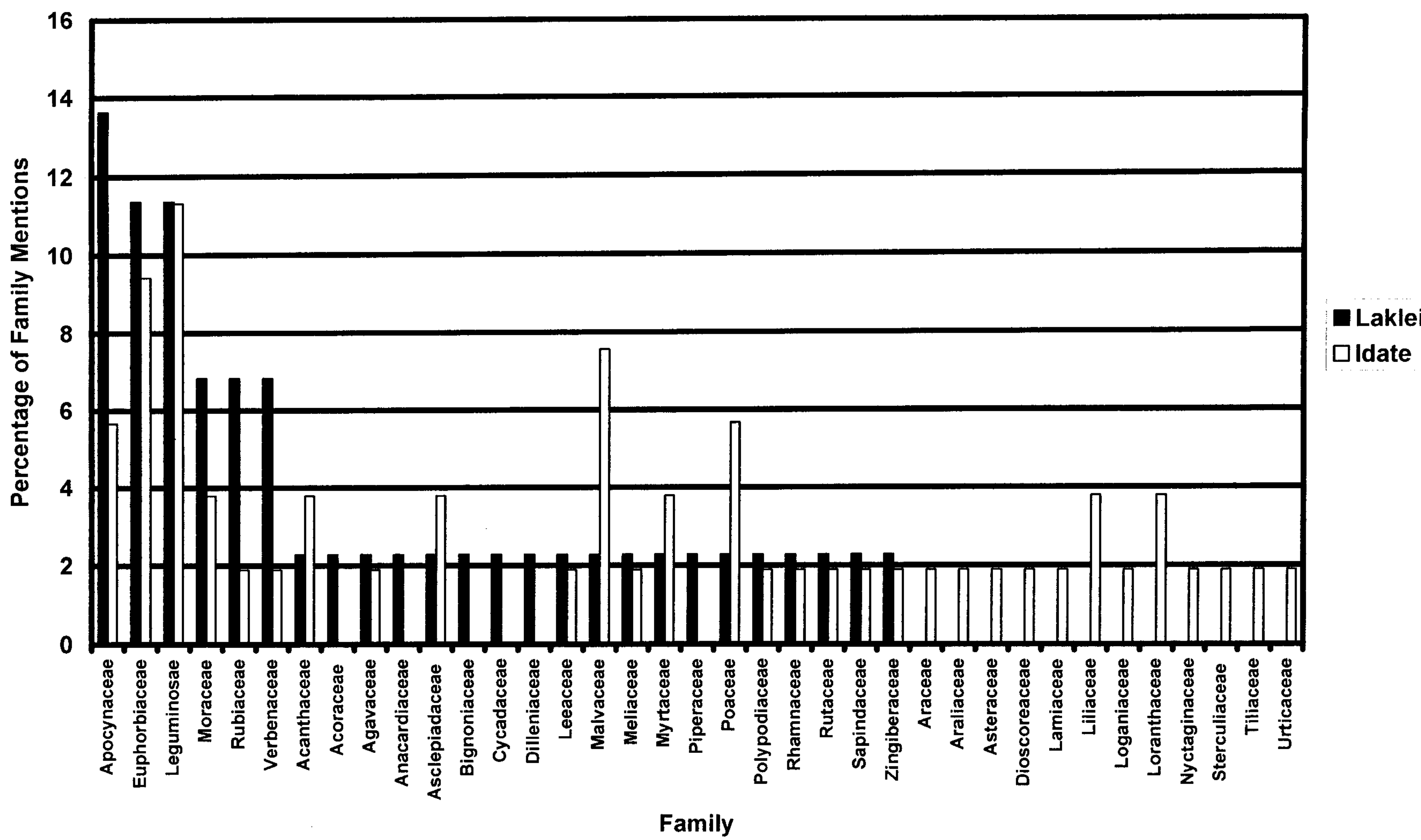

Figure 3.2 Frequency of plant family mentions for medicinal and poisonous plants collected in both Laklei and Idate.

Table 3.5 The 11 medicinal plant species used in both Laklei and Idate and their specific uses.

Botanical Name	Specific Uses in Laklei[1]	Specific Uses in Idate[1]
Aegle marmelos Correa	**diarrhea**, dysentery, veterinary medicine	**diarrhea**
Alstonia scholaris (L.) R. Br.	helminth worm infection, **malaria**, UTI	**malaria**, migraine
Calotropis gigantea (L.) W. T. Aiton	constipation, **urinary tract infection**	foreign body extraction, inflammation, **urinary tract infection**
Cassia fistula L.	asthma, cough, fever, **snake bite**, worm infection, **wounds**	dysentery, **snake bite**, **wounds**
Drynaria quercifolia (L.) J. Sm.	asthma, cough	migraine
Jatropha curcas L.	asthma, urinary tract infection	cough, lactation stimulant
Mallotus philippensis (Lam.) Mull. Arg.	fractures, haemorrhagic fever, prolonged menstruation, wounds	dysenterry
Nauclea orientalis (L.) L.	diarrhea, **hepatitis**, malaria	arthritis, cough, **hepatitis**
Psidium guajava L.	dysentery, urinary tract infection	hernia, nausea
Timonius timon (Spreng.) Merr.	**migraine**	infertility, **migraine**, poor eye sight, smelly nose
Ziziphus species Mill.	urinary tract infection, veterinary medicine	diarrhea, dysenterry

[1] Specific uses in bold were common to both Laklei and Idate.

few medicinal plant species in common with a low percentage of species with similar uses when compared to the literature.

The percentages for habitat and habit mentions between the two villages are verysimilar. Open forest was the most common collection habitat for both Laklei and Idate which accounted for 67% and 66% of mentions respectively (Figure 3.3). Trees were used most commonly in both villages (64%, 44%) (Figure 3.4). Leaman (1996) and Treyvaud Amiguet *et al.* (2004) also found a very high selection of forest species however, trees were not the most used heavily in either study. The most often selected habits were shrubs and herbs respectively for Leaman (1996) and Treyvaud Amiguet *et al.* (2004), with selection of habit being more evenly distributed than in our study. The high frequency of selection of trees in our study may indicate a unique preference for tree species amongst East Timorese informants.

Bark and leaves are the most commonly used plant part in both villages (Figure 3.5). However, Idate had a more diverse use of plant parts which included wood and thorns; both of which were absent in the medical tradition of Laklei. Mahyar *et al.* (1991), suggests that the high frequency of the use of leaves in traditional medicine of South East Asian cultures may be one of its defining characteristics. Mahyar *et al.*'s (1991) suggestion is supported by Leaman (1996) where leaves were used in 52% of all medicinal plant remedies used by the Dayak people of Borneo. Although leaves were not the most often used plant part, they were heavily used by both Laklei and Idate.

Decoctions, macerations and no preparation method were the most common preparations in both Laklei and Idate (Figure 3.6). However, preparations such as boiling and burning occurred in Laklei only and heating, hot water percolations, and drying were methods employed in Idate only. In addition, discrepancies exist between the frequency of

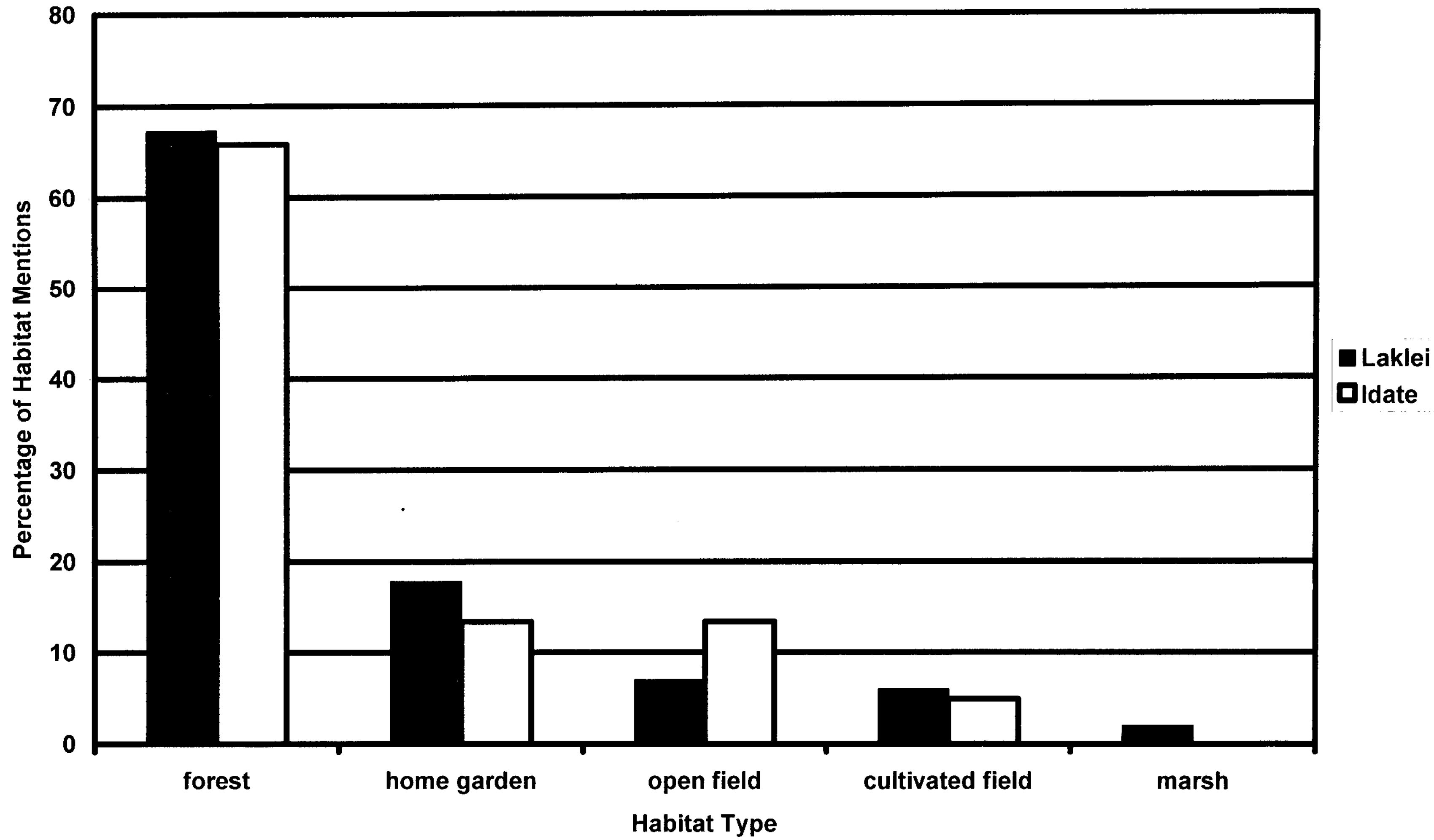

Figure 3.3 Frequency of habitat mentions for medicinal and poisonous plants collected in both Laklei and Idate.

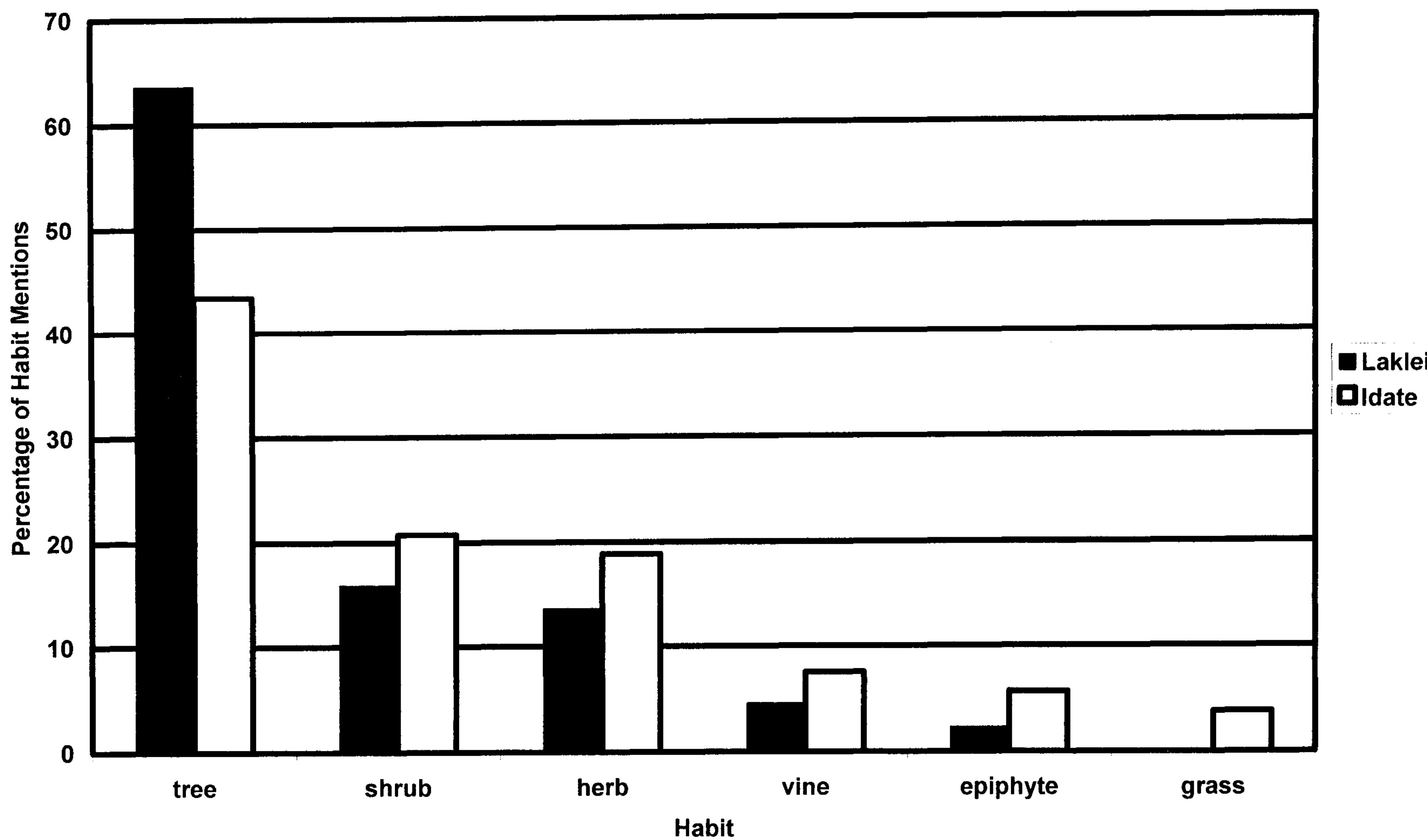

Figure 3.4 Frequency of habit mentions for medicinal and poisonous plants collected in Laklei and Idate

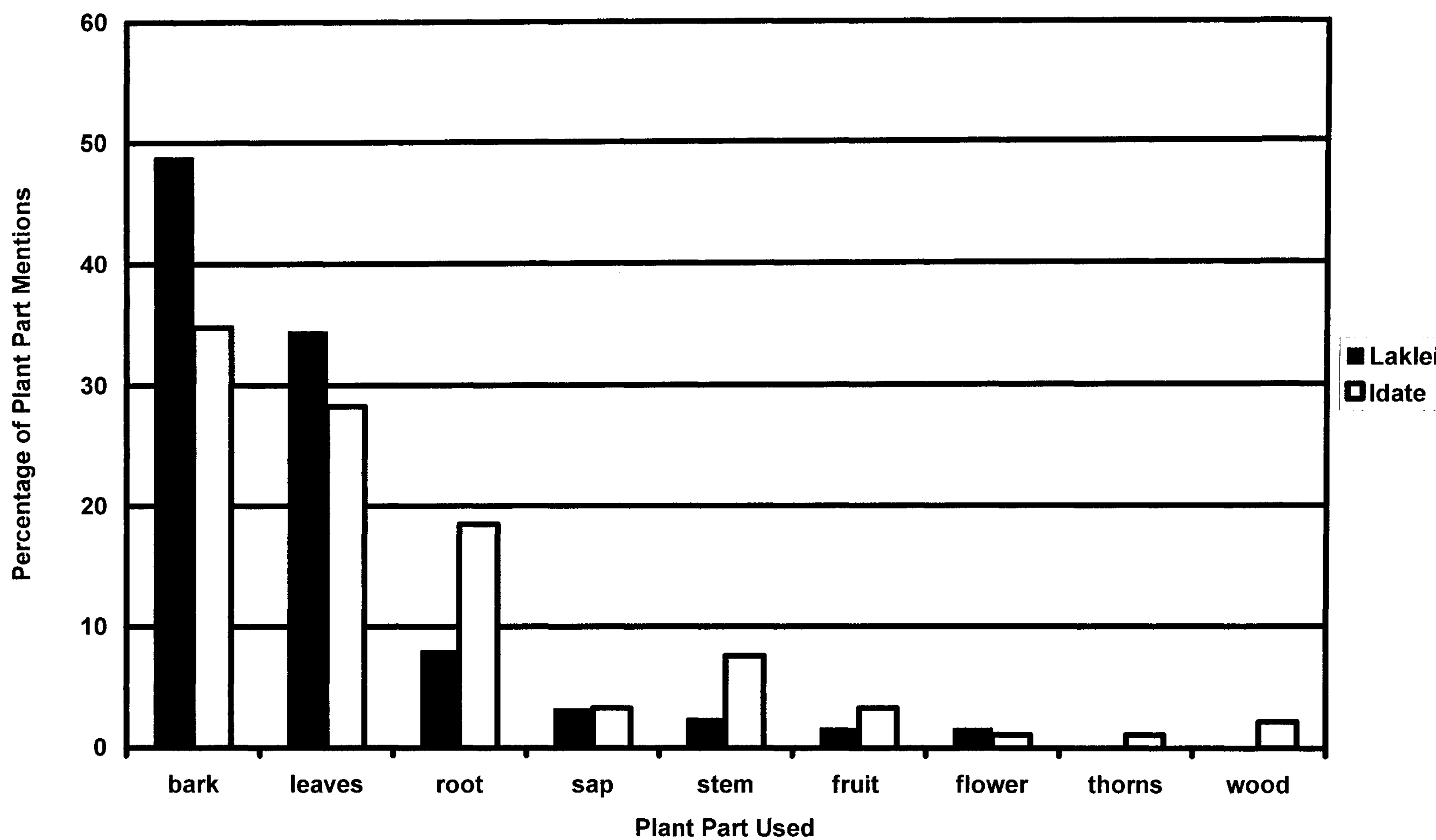

Figure 3.5 Frequency of plant part mentions for medicinal and poisonous plants collected in Laklei and Idate.

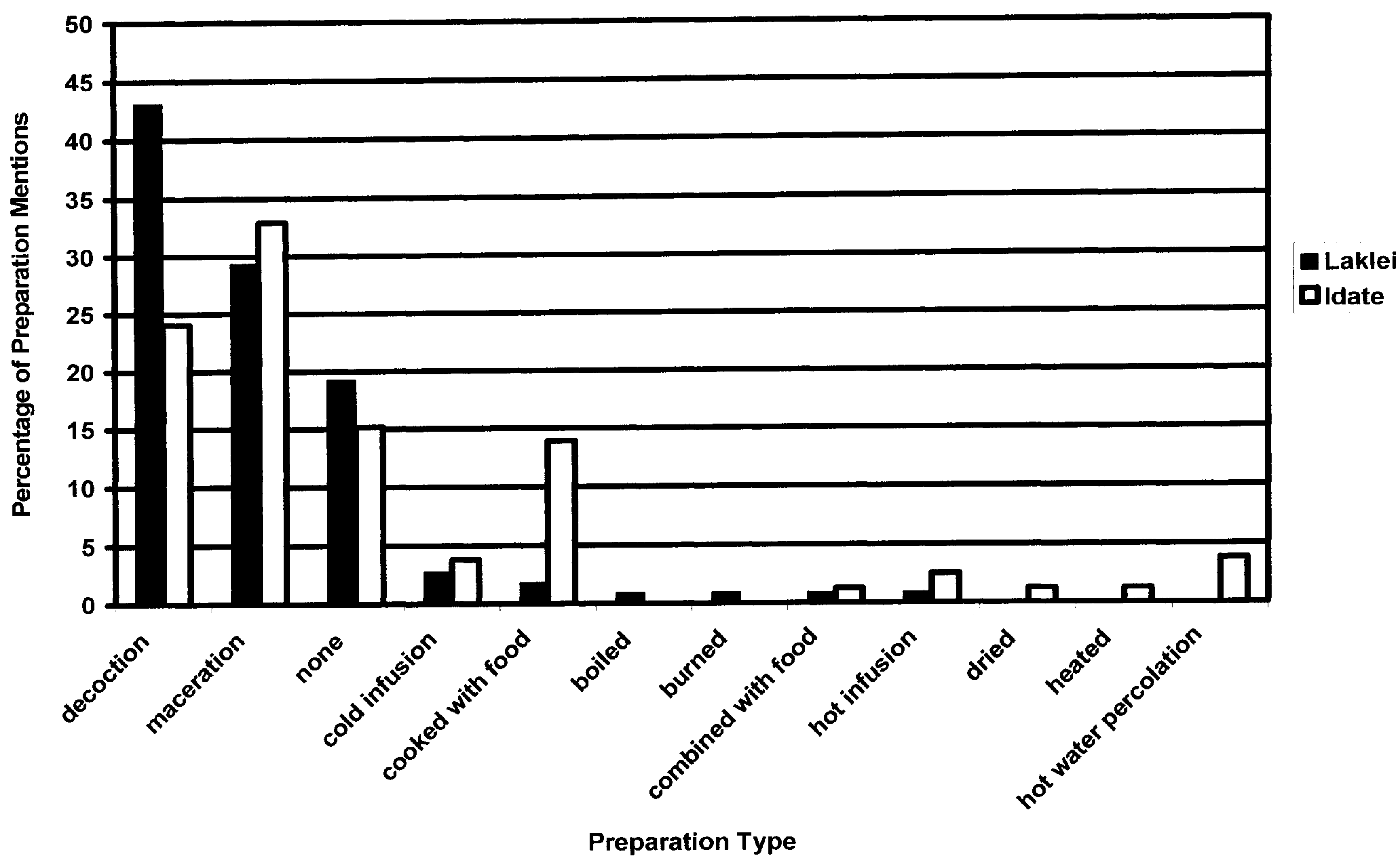

Figure 3.6 Frequency of method of preparation mentions for medicinal and poisonous plants collected in Laklei and Idate.

use of decoctions between Laklei (43%) and Idate (24%) and also 'cooked with food' (2%, 14%) preparation category. Routes of administration were relatively similar between villages with the exceptions that, although drinking was the most common route in both villages, it was nearly twice as common in Laklei and eating was used nearly twice as often in Idate. Furthermore, smoking and blowing were unique to Idate while steams were only employed in Laklei (Figure 3.7).

Using Chi-square analysis we determined that the number of mentions for plant part used and method of preparation were dependent upon the culture (Table 3.6). In other words, plant parts used and method of preparation varied significantly between Laklei and Idate. These results indicate differences between the medicinal plant traditions of the two cultures. However, habit, habitat and route of administration mentions were independent of the culture considered. It is not surprising that habit and habitat were not different as both cultures are located within similar monsoon type forest. The uniformity in route of administration types may indicate a defining feature of the ethnobotany of East Timor as a whole where drinks, poultices, topical applications and remedies which are eaten are prevalent.

In Laklei, 12 of the informants were male and 4 informants were female. In Idate, 7 of the informants were male and 2 were female. There was no clear relationship between age and average number of mentions or percentage of medicinal plant mentions in either village (Table 3.7). In both villages, men had a greater average number of mentions and also provided the majority of medicinal plant mentions (Table 3.8). In Phillips and Gentry's (1993a) work detailing ethnobotanical knowledge in Peru, a strong correlation was found between the age of informants and amount of plant knowledge where older informants clearly knew more. Furthermore, Begossi *et al.* (2002) also found that older informants and,

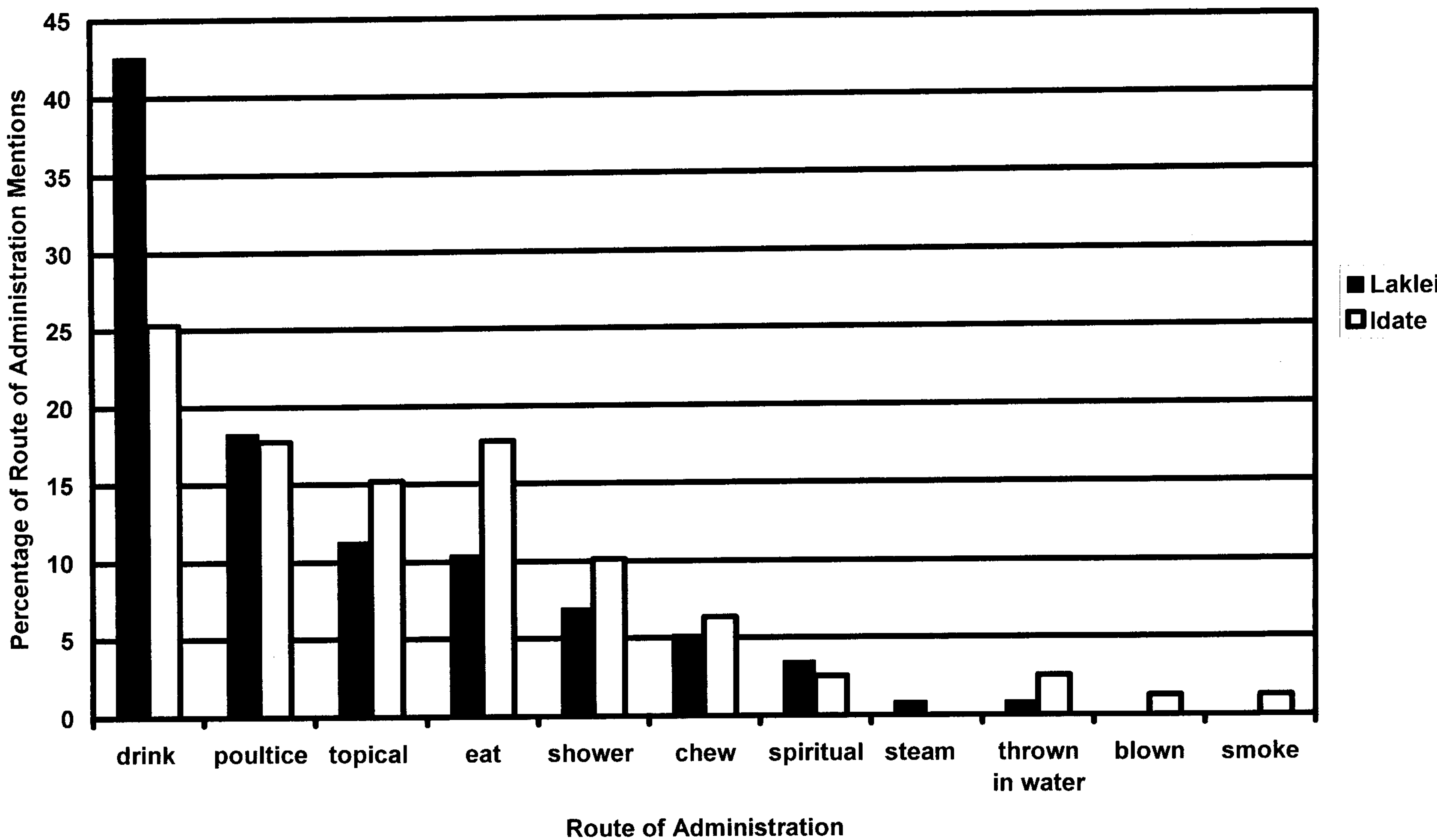

Figure 3.7 Frequency of route of administration mentions for medicinal and poisonous plants collected in Laklei and Idate.

Table 3.6 Differences and similarities in medicinal plant tradition between Laklei and Idate cultures.

Mention Category	Degrees of Freedom	X^2 Test Statistic	p value
Method of Preparation[a]	4	17.74	0.0014*
Plant Part Used[b]	3	11.58	0.0090*
Habit[c]	3	4.58	0.2050
Habitat[d]	3	4.51	0.2118
Route of Administration[e]	5	7.40	0.1925

[a] cold infusion, boiled, burned, combined with food, hot infusion, dried, heated and hot water percolation data pooled
[b] sap, stem, fruit, flower, thorn and wood data pooled
[c] grass, epiphyte and vine data pooled
[d] cultivated field and marsh data pooled
[e] chewed, spiritual, steam, thrown in water, blown and smoked data pooled
* p value is significant

Table 3.7 Average number of mentions per age class with percentage of total medicinal plant mentions in brackets for Laklei and Idate.

Years of Age	20-30	30-40	40-50	50-60	60-70
Laklei	N/A	6.6 (32.7%)	14 (13.9%)	7.5 (14.9%)	7.8 (38.6%)
Idate	2 (2.4%)	10.3 (37.8%)	10 (12.2%)	12.5 (30.5%)	7 (17.1%)

Table 3.8 Average number of mentions for female and male informants with percentage of total medicinal plant mentions in brackets for Laklei and Idate.

	Female Informants	**Male Informants**
Laklei	5.75(22.8%)	8.67 (77.2%)
Idate	1.5 (3.7%)	11.3 (96.3%)

similar to our study, male informants had a greater degree of ethnobotanical knowledge. Trends relating to age and amount of medicinal plant knowledge may have been revealed if the sample size had been increased.

The 'informant consensus factor' was calculated for all usage categories. However, only those with defined values in both cultures are reported (Table 3.9). The usage categories with the highest values in Laklei were Infections/Infestations and in Idate, Digestive System Disorders had the highest consensus. Several usage categories had values of 0 or were undefined as the number of mentions was equal to the number of plant taxa thereby creating a denominator of 0 in the calculation of the 'informant consensus factor'.

The 'informant consensus factor' values for both villages are low relative to the findings of other studies using the same methodology. Treyvaud Amiguet *et al.* (2004) found that for a group of Q'eqchi' Maya healers, 10 of the 17 values were greater than 0.65. Heinrich *et al.* (1998) used the same factor and similar usage category groupings while studying the Maya, Nahua and Zapotec of Mexico. Their findings were that respectively 1 of 9, 2 of 8, and 7 of 9 of the values were greater than 0.65 for these groups (Heinrich *et al.* 1998).

Possible explanations for the low 'informant consensus factor' values in the villages may be attributable to 1) a high degree of secrecy concerning medicinal plant use in East Timor or 2) loss of traditional botanical knowledge as a result of increased exposure to modern medical facilities. The collection of medicinal plants was all done with individual informants because they were not comfortable identifying medicinal plant species in the presence of informants from other family groups. There was one exception to this practice when two closely related informants participated in the same collection trip. All of the

Table 3.9 Informant consensus values for 10 usage categories for Laklei and Idate

Usage Category	**Laklei**	**Idate**
Infections/Infestations	0.567	0.083
Inflammations	0.500	0
Injuries	0.375	0
Digestive System Disorders	0.455	0.429
Respiratory System Disorders	0.333	0
Genitourinary System Disorders	0.250	0.111
Muscular-Skeletal System Disorders	0.250	0
Nervous System Disorders	0	0.333
Veterinary Medicine	0	0

informants had acquired their knowledge of medicinal and poisonous plants from close relatives, which were in most cases their grandfather, grandmother, father or mother. In rare instances, knowledge of medicinal plants was learned during dreams in which ancestors contacted the informants. There were no instances of receiving medicinal plant knowledge from individuals outside of the informant's family group. Furthermore, after the collection of medicinal plants, the informants would often conceal the specimens in a bag and assert that no other people were to see the samples. This was meant to keep the identity of the plants secret.

During Portuguese colonial times, the use of traditional medicine was the only medical treatment available to East Timorese living in rural areas. Traditional botanical knowledge was therefore valuable and could be sold to other family groups if the knowledge was kept secret. On several occasions, an informant shared the relative value of a remedy, for example it might equate to the value of a buffalo. While traditional remedies are no longer bought and sold between family groups, the secrecy that surrounds this traditional botanical knowledge still remains. By not sharing medicinal plant knowledge freely, it is more likely that informants will use different species thereby reducing consensus.

Several authors have addressed the urgency to document ethnobotanical knowledge of cultures whose botanical traditions are still intact (Boom 1987, 1990, Lebbie and Guries 1995, Phillips and Gentry 1993a, Schultes 1991). Schultes (1991) comments that "When our civilization arrives…the products of our culture are rapidly adopted and, often even in one generation, replace what has for hundreds of years been part of their culture". He notes that this occurrence is particularly true concerning the use of medicinal plants. East Timor has been under colonial rule or control by an occupying power for over 400 years, under the Portuguese, Japanese and more recently the Indonesians. The rapid increase in infrastructure and government services under Indonesian control, such as hospitals and clinics, has reduced the dependence on and the knowledge of the natural world in East Timor. Whereas in the past each community in East Timor would have a recognized traditional healer and spiritual leader or shaman, presently many communities lack both. Hospital clinics are now present in the districts of East Timor and most sub districts thereby reducing the relevance of traditional botanical knowledge. This factor contributes to the weakening of medicinal plant traditions and may be responsible for low consensus amongst informants.

A one tailed paired t-test was used to determine if the average 'informant consensus factor' for Laklei was significantly greater than that for Idate. Usage categories in which one of the two consensus values was either undefined or not applicable were not used in the calculation. The null hypothesis that the average 'informant consensus factor' for Laklei is not significantly greater than that for Idate was rejected (Table 3.10). Therefore, the medicinal plant tradition is more clearly defined in Laklei where informants are more likely to use the same plants species when treating similar illnesses.

The medicinal plant tradition of Laklei is well defined relative to Idate. The Laklei culture may traditionally have placed a greater emphasis on intensive experimentation with the local flora where plants were tested for their medicinal benefits. Plants that were ineffective were discarded and only effective traditional medicines were retained resulting in fewer taxa being used and therefore higher consensus. Furthermore, communication from elders to adults and youth may be stronger in the Laklei culture where medicinal plant knowledge was transferred more effectively. In this way, future generations would not have to repeat the same experimentation.

Another possible reason is differing amounts of exposure to government medical services and erosion of traditional knowledge. Laklei is a difficult village to access as it is

Table 3.10 Results of a paired t-test comparing informant consensus values between Laklei and Idate.

	Laklei	Idate
Mean	0.303	0.106
Variance	0.041	0.027
Hypothesized Mean Difference	0	
Degrees of Freedom	8	
t Stat	2.196	
P value one-tail	0.030	
t Critical one-tail	1.860	

on the south side of the country, whereas the major urban centres of Baucau and Dili are both on the north coast. The road system is underdeveloped and is plagued by serious erosion damage and washouts. Furthermore, a one day hike was required to reach Laklei after a full day of driving to reach the trailhead. Idate however, was reached after a relatively short drive east from Dili and a 2 hour hike from the trailhead. Due to the proximity of Idate to Dili, modern medical services are available. A nurse from a nearby community makes weekly trips to Idate to assess medical needs in the community and to administer medications and vaccinations. Idate therefore has a greater reliance upon modern medicine which may have accelerated the loss of traditional botanical knowledge resulting in a less defined medicinal plant tradition and lower consensus.

Most importantly, secrecy surrounding medicinal plant use varied considerably between the two groups. In Idate, medicinal plant knowledge was very secret where information was only passed vertically from elders to youth prominently noted by the elders not allowing specific uses to be made public (see Table 3.2). This difference in secrecy between the cultures had direct effects on informant consensus. By not openly sharing knowledge of medicinal plants, the likelihood of using several different plant species within a culture is increased thereby reducing consensus measures.

3.4 Conclusions

To our knowledge, this research represents the first time Trotter and Logan's (1986) informant consensus factor has been used to determine statistically whether or not medicinal plant traditions vary between cultural groups. Consensus among informants for Laklei was significantly greater than that for Idate thus inferring distinct medicinal plant traditions exist. This conclusion is supported by comparisons between the differences in medicinal plant use concerning plant part used and method of preparation. Furthermore, of the 86 medicinal plant species collected, only 11 were used in both cultures.

CHAPTER 4

FATALUKU ETHNOBOTANY AND THE EAST TIMORESE MILITARY RESISTANCE

4.1 Introduction

In May 2002, East Timor emerged as the newest nation in the world after a long and brutal Indonesian occupation which was responsible for the loss of approximately 100, 000 to 200, 000 East Timorese lives (Cotton 2001). Throughout the Indonesian occupation, the East Timorese resistance, then known as Forças Armadas da Libertação Nacional de Timor Leste (FALANTIL), led an armed struggle against the Indonesian army. During the early years of the occupation, FALANTIL had control of a significant portion of the country but was eventually pushed east into the more remote jungle regions of the Lautem District. A long guerilla conflict was fought in the forests of Lautem where small groups of FALANTIL forces evaded Indonesian troops for nearly 20 years in some cases.

It was essential during the resistance for all FALANTIL soldiers and supporters to ensure a complete working knowledge of useful forest plants to provide food and traditional medicines. The objective of this chapter is to document the use of medicinal plants by a third unique East Timorese indigenous people, the Fataluku, and the contributions that this knowledge made to the East Timorese resistance during the Indonesian occupation.

This research was conducted in the proposed Conis Santana National Park which is located along the south coast of the Lautem District of East Timor. The proposed park is the largest continuous forest block in East Timor and is therefore of critical importance to conservation. East Timor is primarily monsoon forest and savanna, however the study area also includes small pockets of evergreen rainforest, semi-evergreen rainforest and moist deciduous forests (Monke *et al.* 1997, Whitmore 1975).

While this area does represent the largest continuous forest block in East Timor, the area has been disturbed in some places by illegal logging and swidden agriculture (Whistler 2001). The region is a mosaic of primary and secondary forests and small patches of cleared land. One of the most striking features of the region is the extensive karst topography and the rugged Paichau, meaning 'Pig Head' in the indigenous language Fataluku, Mountains that follow the long axis of the island. Furthermore, the area is also remarkable for the extensive wetlands around the community of Mehara (Whistler 2001). This wetland region is noteworthy for its extensive swamps and Lake Ira Laluro, East Timor's largest lake.

In 2000, the United Nations Transitional Authority in East Timor (UNTAET) implemented Regulation 2000/19, which declared 15 sites as 'Protected Natural Areas' (PNA) as the first step toward environmental protection in East Timor (UNTAET 2000). Such regulations had not been developed by the occupying Indonesian Government and were therefore a priority. Several PNA were established along the southern coast of Lautem District between Lore, Tutuala and Jaco Island which provided the platform for seeking national park status for the region (UNTAET 2000). In September 2003, the Ministry of Agriculture, Forestry and Fisheries of East Timor in collaboration with New South Wales Parks and Wildlife Service and Bird Life International of Australia, submitted a proposal to protect a large area of continuous forest that includes Jaco Island and a swath of land between Lake Ira Lalaro and Tutuala, and the mentioned PNA (Ministry of Agriculture, Forestry and Fisheries, Republica Democratica de Timor-Leste *et al.* 2003). Several communities are within the proposed protected area's borders and include Tutuala, Mehara and Maupitine. Full national park status is now being sought for the area with Conis Santana National Park being the proposed name.

Extensive research has been undertaken to document traditional use of medicinal plants throughout the Malay archipelago (Elliott and Brimacombe 1987, Grosvenor *et al.* 1995, Hirschhorn 1983, Holdsworth and Wamoi 1982, Leaman *et al.* 1995). However, due to the political instability of East Timor over the last three decades, there has been little biological research of any kind in the country. While preliminary botanical inventories (Whistler 2001) and bird surveys (Trainor 2002) have been completed in the study area, literature concerning the use of medicinal plants in the region is absent.

The recent trend in ethnobotany has been to shift from descriptive accounts of plant use by indigenous people to hypothesis testing. This was made possible through the development of consensus indices such as those created by Phillips and Gentry (1993a, 1993b). Descriptive ethnobotanies, not using hypothesis testing methodologies, are still relevant in exceptional instances where the number of informants interviewed is too low to allow for consensus calculations. While this paper does not utilize quantitative methods it is a relevant contribution to ethnobotanical literature because the research 1) is undertaken in a biodiversity hotspot relative to other habitats in East Timor and 2) describes medicinal plant use in a post-conflict country which has recently emerged as the newest nation in the world.

4.2 Methods

4.2.1 General Methods

The study consisted of a field trip through the proposed Conis Santana National Park from March 18 – 26, 2004. Former FALANTIL soldiers were hired as route finders through the forest, as specified trails were non-existent. The Informant for the study was selected by the Chief of a nearby village on the basis that he was the most knowledgeable member of the community concerning the use of medicinal plants. During unstructured interviews, medicinal and poisonous plants were collected. Local name, plant part used, method of preparation and indications of treatment use were recorded. The medical conditions treated by the medicinal plants were categorized according to the method developed by Cook (1995).

4.2.2 Voucher Specimens

Voucher specimens of all mentioned plants were collected in triplicate and stored in 70% alcohol and later dried. One set of vouchers is stored at each of the Universidade Nacional Timor Lorosae'e, Dili, East Timor; the Northern Territory Herbarium, Darwin, Australia; and the University of Ottawa, Ottawa, Canada. Identifications were made by Andrew Mitchell of Australian Quarantine and Dr. Dale Dixon of the Northern Territory Herbarium.

4.2.3 The Informant

The Informant was between 60 and 70 years of age and spoke both Bahassa Indonesian and the local language Fataluku. His spirituality was animist. As is the case with most East Timorese living in rural areas, he was a peasant farmer whose most important crops were corn and cassava. While the Informant's home village was a remote community in the area of the proposed park, his community had been relocated by the Indonesian Government to a roadside location, during the 1970s. Relocation programs like this were common in East Timor during resistance times as a means of controlling the East Timorese and crippling the ability of local people to support resistance forces with food and supplies.

As a youth, the Informant had been trained by an elder in medicinal and traditional plant use. Although the training was informal, the Informant became an apprentice of the elder and was required to prepare a written account of the knowledge in Bahassa Indonesian. At the present time, the Informant's teacher lives by himself in the community's traditional territory within the proposed park, residing in limestone caves and surviving by hunting and gathering in the forest and swidden agriculture.

4.2.4 Ethical Approval

Prior to undertaking field activities, the District Administrator for Lautem District was consulted and asked for permission to work in the research area. Furthermore, a meeting was held to explain the objectives of the research and receive consent from the village Chief and elders. Ethical approval was granted by the University of Ottawa Ethics Committee with the understanding that the Informant's identity would be kept confidential. The Ministry of Agriculture, Forestry and Fisheries of East Timor was consulted prior to conducting research, however, collecting permits were not issued as regulations have yet to be developed.

4.3 Results and Discussion

In total 40 plant species were collected of which 35 were used to treat human ailments, 2 were used for veterinary purposes and 3 were poisons (Table 4.1). 20 of the medicinal plants were identified to species, 13 to genus and 3 to family and 4 were not identified to any level. The most commonly mentioned families were the Leguminosae (4 species) and the Euphorbiaceae (3 species). When compared to other ethnobotanical studies, the number of medicinal plants mentioned is exceptionally high. For example, Giday *et al.* (2003) described the medicinal use of 33 species used by 17 key informants of the Zay people of Ethiopia. Long and Li (2004) documented the use of medicinal plants by the Red headed Yao people of China where they listed only 66 medicinal plant species used by healers, herbalist and elders in seven districts.

The most commonly mentioned usage categories were Infections/Infestations, Injuries and Muscular/Skeletal System Disorders (Table 4.2). The high number of mentions

Table 4.1 Family, botanical name, Fataluku name and specific uses of 40 medicinal and poisonous plant species collected in the proposed Conis Santana National Park.

Family	Botanical Name	Voucher	Fataluku Name	Specific uses
Anacardiaceae	*Mangifera indica* L.	SC 268	Payahi	wounds
Apocynaceae	*Alstonia species B* R.Br.	SC 279	Wiahara	diarrhea
	Cerbera manghas L.	SC 295	Amibya	lactation stimulant
Araceae	*Monstera species* Adans.	SC 274	Nae nae rasa	wounds
Araliaceae	*Schefflera species B* J.R.Forst. & G.Forst.	SC 294	Latuporo	veterinary medicine
	Schefflera species C J.R.Forst. & G.Forst.	SC 296	Tufutu	fractures
Arecaceae	*Cocos nucifera* L.	SC 269	Vata mimiraka	fractures
Caricaceae	*Carica papaya* L.	SC 311	Muu	malaria
Crassulaceae	*Bryophyllum species* Salisb.	SC 300	Pipivalikerekere	ear infections
Cucurbitaceae	*Momordica species* L.	SC 308	Kapinu	malaria
Cycadaceae	*Cycas species* L.	SC 277	Beku	wounds
Dioscoreaceae	*Dioscorea bulbifera* L.	SC 283	Churailahoo	wild game poison
Euphorbiaceae	*Aleurites moluccana* (L.) Willd.	SC 272	Pokuru	post partum bleeding, internal bleeding
	Euphorbia atoto G.Forst.	SC 303	Foy hasa reku reku	low quality breast milk
	Jatropha curcas L.	SC 302	Mutu mutu mimi raka	urinary tract infection
Lamiaceae	*Leucas species* R.Br.	SC 291	Muka muka	sores, eye trauma
Lecythidaceae	*Barringtonia asiatica* (L.) Kurz	SC 298	Coru	inflammation
Leeaceae	*Leea indica* Merr.	SC 266	Motiir	diarrhea
Leguminosae	*Albizia lebbeck* (L.) Benth.	SC 289	Iparakuliku	pink eye
	Derris sp. B Lour.	SC 307	Cha	fish poison
	Pterocarpus indicus Willd.	SC 275	Makari	mouth sores
	Tamarindus indicus L.	SC 293	Kaylemu	sore joints
Loranthaceae	*Amymea species B*	SC 305	Laki soru aku	Urinary tract infections
Malvaceae	*Hibiscus species* L.	SC 267	Varu	wounds

Table 4.1 Continued

Family	**Botanical Name**	**Voucher**	**Fataluku Name**	**Specific uses**
Meliaceae	unknown	SC 284	Pepuru	veterinary medicine
Meliaceae	*Azadirachta indica* A. Juss.	SC 286	Erua	sore joints
Menispermaceae	*Tinospora smilacina*	SC 306	Shururu	lice infestation, snake bite
Myristicaceae	unknown	SC 287	Paunete	fish poison
Piperaceae	*Piper species* L.	SC 288	Tarukukurisa	itching
Poaceae	unknown	SC 278	Severoo	weight loss
	Imperata cylindrica (L.) P.Beauv.	SC 280	Beerasa	helminth worm infection
Polypodiaceae	*Drynaria quercifolia* (L.) J. Sm.	SC 282	Sa-pu	throat infections
Rubiaceae	*Pavetta species* L.	SC 265	Lalamoo	tuberculosis
	Nauclea orientalis (L.) L.	SC 270	Savele	pink eye, post partum bleeding, internal bleeding
Rutaceae	*Citrus hystrix* D. C.	SC 299	Ami churuku	hepatitis, inflammation
Verbenaceae	*Gmelina philippensis* Lam.	SC 292	Kapuasamaru	hepatitis
unknown	unknown	SC 281	Ai-anu	muscle relaxant
unknown	unknown	SC 276	Luluparoo	wounds
unknown	unknown	SC 304	Pia pia	dysentery
unknown	unknown	SC 271	Tua tua hikari	cough

Table 4.2 Frequency of usage category mentions for medicinal and poisonous plant species collected in the proposed Conis Santana National Park

Usage Category	Frequency Mentioned (%)
Infections/Infestations	24
Injuries	17
Muscular-Skeletal System Disorders	11
Poisons	7
Digestive System Disorders	7
Preganancy/Birth/Puerperium Disorders/Effects	7
Skin/Subcutaneous Cellular Tissue Disorders	7
Genitourinary System Disorders	4
Inflammations	4
Veterinary Medicines	4
Culture Bound Syndromes	2
Nutritional Disorders	2
Poisoning Disorders	2
Respiratory System Disorders	2

of both Injuries and Muscular/Skeletal System Disorders is a reflection of the Informant's accumulated experience treating FALANTIL soldiers and East Timorese civilians wounded during altercations with the Indonesian army. While on the field trip, we met a family who had homesteaded within the park. During the Indonesian occupation, the father was returning home along a jungle path from the district capital, Los Palos. The man was ambushed by a group of Indonesian soldiers patrolling the area and was left for dead after a vicious machete attack. Fortunately, the man made it back to his homestead where his wife was able to treat him using traditional medicine. Incidents such as this commonly resulted in serious life threatening wounds such as severe blood loss and fractures. Treatments used include those which act as coagulants and remedies to mend bone fractures. An unidentified vine, used to treat wounds that are bleeding heavily was cut into a foot long section and sap was extruded onto the wound by blowing into one of the cut ends. Poultices were made from the fruit of coconut (*Cocos nucifera*) and from the bark of *Schefflera species B* and applied to broken bones before being secured firmly in place with cloth.

Of the Infections/Infestations usage category, malaria, hepatitis and pink eye were the most commonly mentioned specific uses. The Informant noted that malaria is an easily curable disease whose treatment is very common knowledge in East Timor. Papaya (*Carica papaya*) leaves or the leaves of *Momordica species* were boiled in water and the decoction drank or used as a shower and drank in the respective remedies. The decoction was very bitter and bad tasting but highly effective. The small intestines of the cuscus (*Phalanger species*), a small nocturnal marsupial, were also used to treat malaria. While collecting medicinal plants, the two FALANTIL guides constantly scanned dead standing trees for signs of the cuscus' nest. When a nest was spotted, one of the men climbed the large dead standing trees unaided and removed the cuscus by the tail. The primary reason for hunting the cuscus was for the meat, however, the small intestines can be boiled or roasted and eaten to treat malaria. It was believed that the small intestine has curative properties because the cuscus feeds heavily on *Derris species* and *Tinospora smilacina*. *T. smilacina* is used traditionally in Australia to treat infections and inflammatory conditions and was found to have significant anti-inflammatory activity by Li *et al.* (2003, 2004). Furthermore, *Derris spp.* are traditionally used as fish poisons throughout South East Asia and have highly active compounds known as rotenones (de Padua *et al.* 1999).

Two other animal preparations to treat dysentery and to increase a person's energy were used. A mollusk, known as 'Moosapeleku' in Fataluku, was dried and then ground into a fine powder which was then combined with cooked corn and eaten to treat dysentery. The rubbery gum like material, known as 'Puku kafu lai kafu' in Fataluku, used by birds to fasten nests to rock faces was boiled in water and the decoction drank to give a person increased energy. This remedy was said to make the body feel light and enables the patient to work hard.

The two veterinary medicines, *Schefflera species A* and the unidentified Meliaceae species were respectively used to treat goats and dogs with mange, and also as a general tonic cure for sick livestock. The root of *Dioscorea bulbifera* was either cooked or used raw to poison wild animals such as pigs and dogs. The root was combined with food such as rice or cassava and then left on game trails. Once dead, the meat of the game animal is edible, however, it was mentioned that the toxins accumulate in the organs making them inedible. In the case of the unidentified Myristicaceae and *Derris species,* the root and bark or stem only were used in the respective preparations. The macerated plant material was added to small confined bodies of water such as tidal pools or creek pools in the dry season. These preparations are effective poisons for shrimp and fish such as eels.

Several remedies were mentioned where the plant part used to treat the illness closely resembled condition characteristics in both colour and appearance indicating the importance of the Doctrine of Signatures. *Euphorbia atoto*, a small herb growing in sandy soils, had very white sap and was used to treat mothers with poor quality breast milk. A decoction of the leaves after cooling is rubbed on a mother's breast. The leaf of *Drynaria quercifolia*, an epiphytic fern, closely resembles a bird's feather and was used to treat sore throats which were described as feeling as though a feather is caught in the patient's throat. A section of the fern's root was chewed on and the saliva was then swallowed. Lastly, the leaves of *Bryophyllum species* were crushed and the resulting sap was applied to ear infections. The Fataluku name is 'Pipivalikerekere' which literally means 'goat's ear that is many colours' because the leaves closely resemble an ear.

Most of the plants mentioned are regarded as effective remedies for common ailments; however, they are not sacred nor do they have a spiritual nature. As the objective of the research was not to document sacred or spiritual use, this topic was not raised during ethnobotanical interviews. However, on one occasion the Informant went out of his way to make sure that one sacred plant was collected and ethnobotanical information recorded. *Amymea species B*, 'Laki soru aku' in Fataluku, is an epiphytic plant which grows on large trees and was collected in a heavily forested area. 'Laki-soru' is a species of bird and 'aku' is literally excrement. This species gets its name because it was believed that the seed of the plant is eaten by birds and then grows in trees where it is excreted. A decoction of the leaves and stem was drunk and showered upon patients with serious urinary tract infections, which are life threatening if left untreated. 'Laki soru aku' is a sacred plant with unique healing powers. It was believed that the power of the plant would have been compromised if its unique spiritual importance was not recognized or respected. When the plant was collected, the Informant described in detail its power and requested that several photographs be taken to document the occasion. Although this was the only plant described as having spiritual powers, a much larger portion of the Informant's complete pharmacoepia likely has a connection to the spiritual world where the healing properties are believed to originate from a supernatural force.

The plants were analyzed according to frequency of use with respect to plant habitat and habit, plant part used, method of remedy preparation and route of administration (Figures 4.1 through 4.5). Of the useful plant species, 53% were trees while vines and herbs were both used in over 10% of the mentions (Figure 4.1). Heavily forested areas were mentioned often (88%) while cultivated fields, beaches and dry steam beds accounted respectively for 5%, 5% and 3% of the mentioned plants (Figure 4.2). Leaves (36%) and bark (26%) were the most commonly used plant part (Figure 4.3). When the bark is used, the outer tissue is removed and the inner bark is collected and prepared. The bark is commonly taken from the tree in long strips and then dried in the sun thereby preserving the remedy for future use.

Decoctions were used for 41% of the uses (Figure 4.4). Macerating (23%) the plant material with a stone or using a traditional mill was also common. No preparation was required for 18% of the uses which were usually sap remedies administered topically or treatments that were chewed or eaten. The most common method of administration was a drink which was used for 27% of the remedies (Figure 4.5). Other oral routes include eating (8%) or chewing (4%). For all oral administrations, the Informant asserted it was critical that the patient not eat anything prior to taking the remedy. The most common external administration was showering (22%) but topical routes (20%) and poultices (12%) were also used. The only example of combining medicinal plants in a remedy was that of adding the

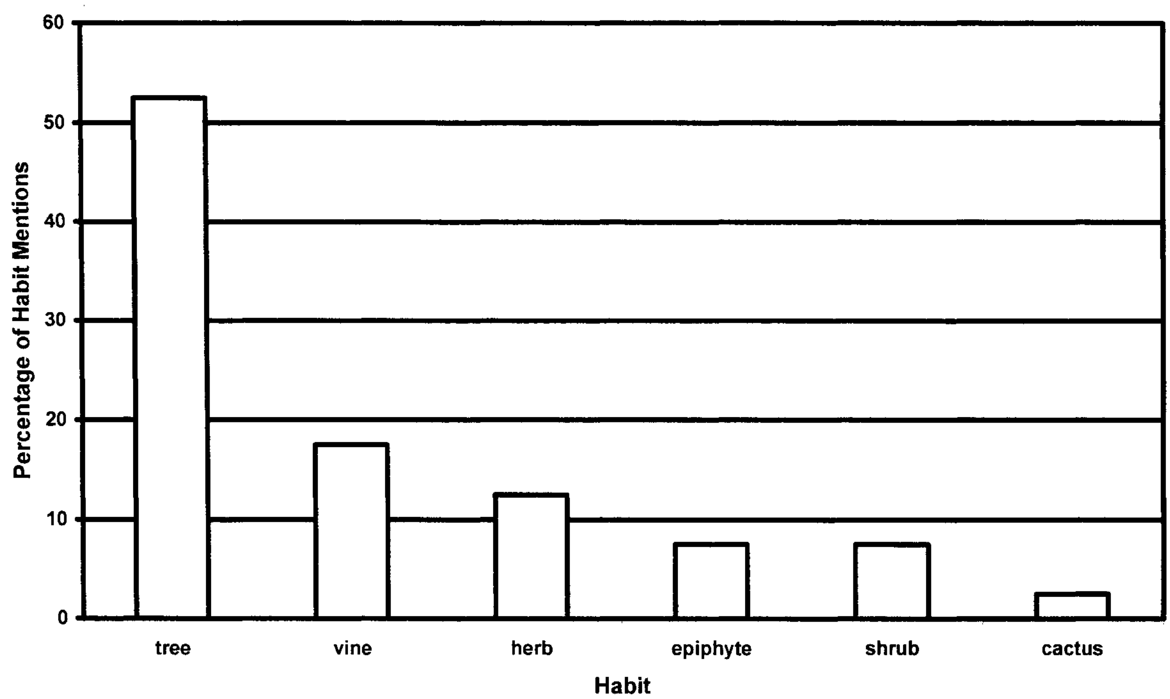

Figure 4.1 Frequency of habit mentions for 40 medicinal and poisonous plant species collected in the proposed Conis Santana National Park.

4.2 Frequency of habitat mentions for 40 medicinal and poisonous plant species collected in the proposed Conis Santana National Park

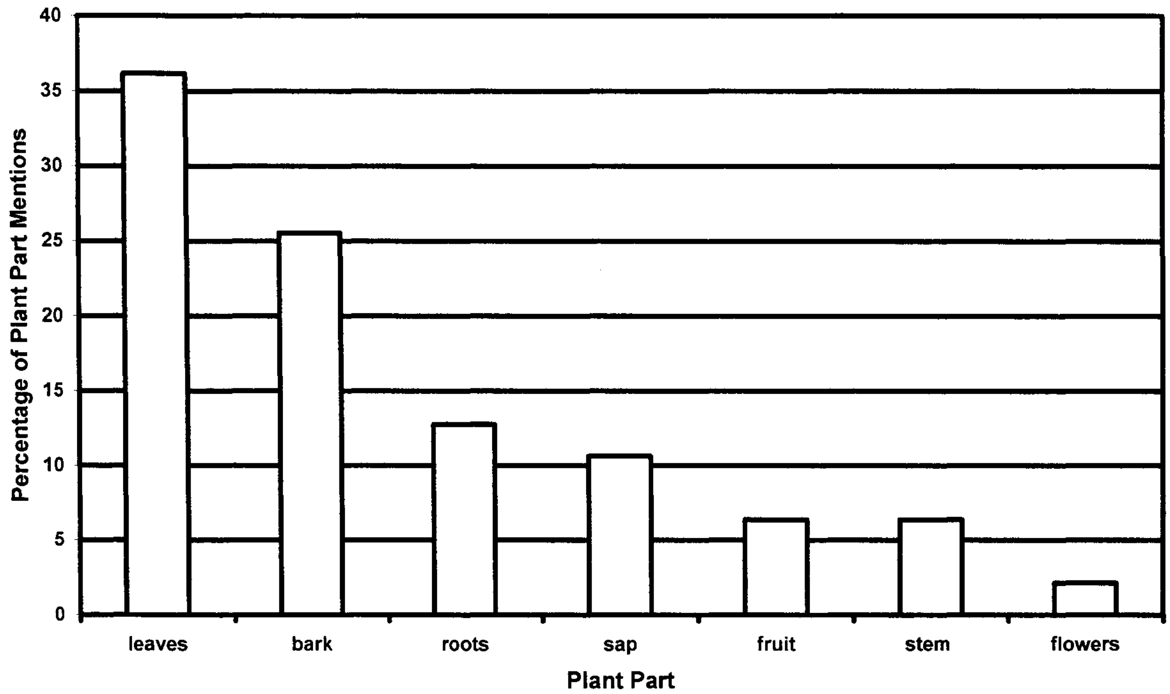

Figure 4.3 Frequency of plant part used for 40 medicinal and poisonous plant species collected in the proposed Conis Santana National Park

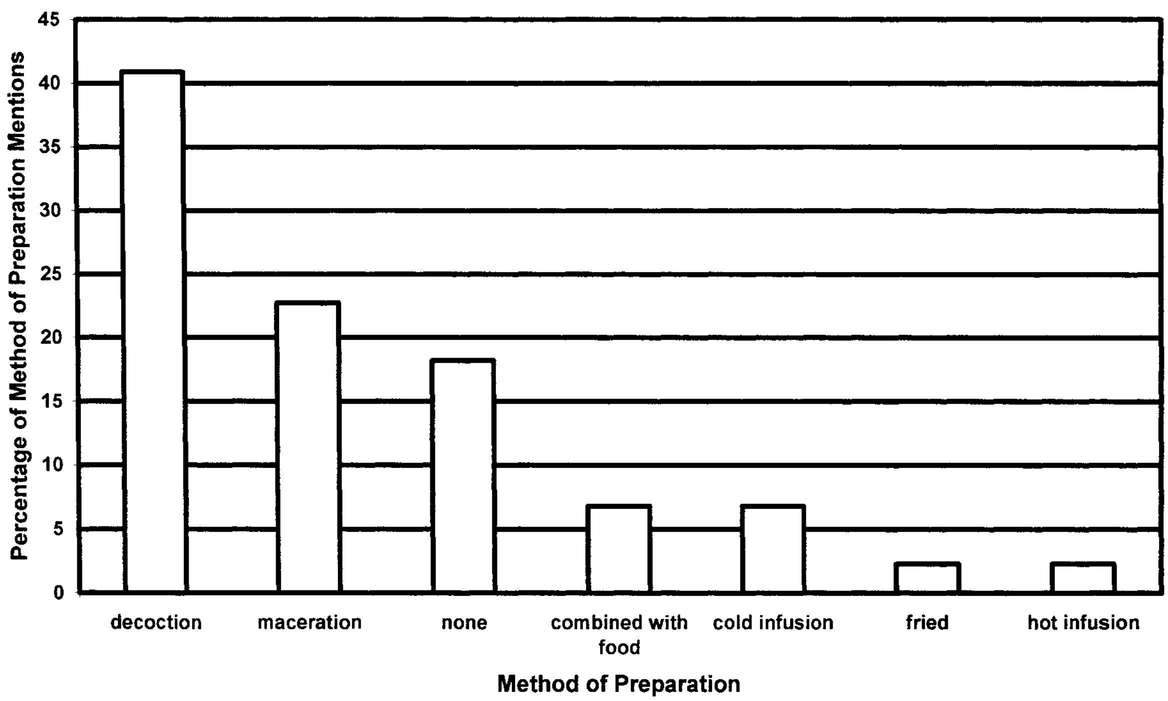

Figure 4.4 Frequency of method of preparation mentions for 40 medicinal and poisonous plant species collected in the proposed Conis Santana National Park.

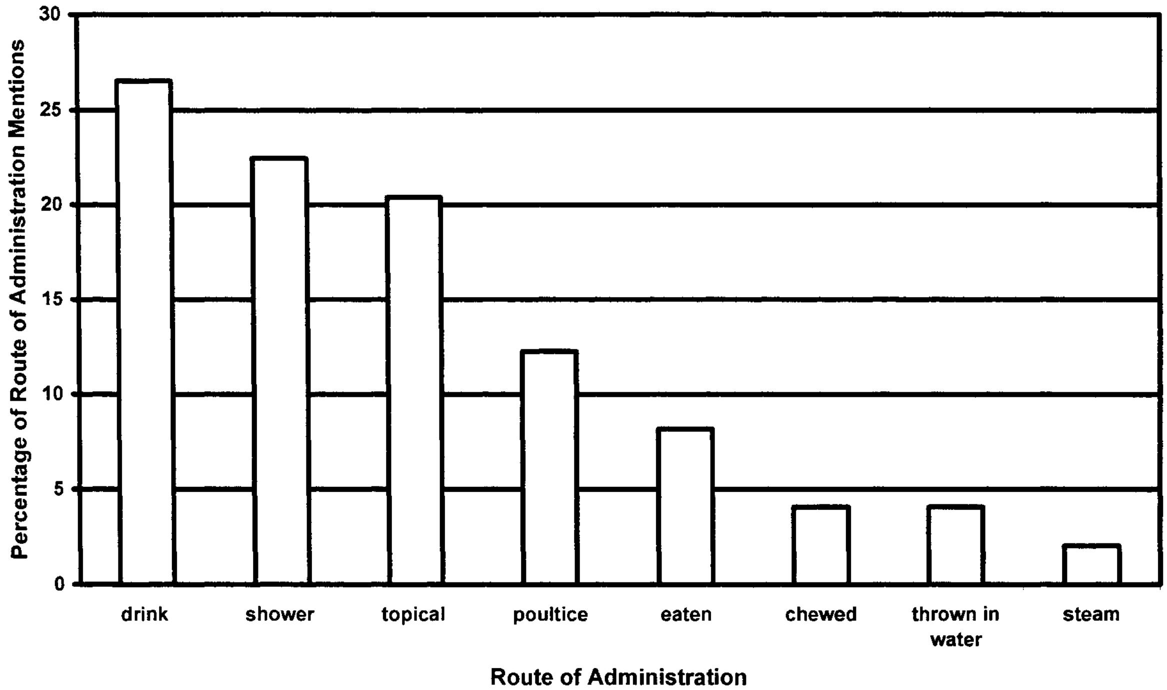

Figure 4.5 Frequency of route of administration mentions for 40 medicinal and poisonous plant species collected in the proposed Conis Santana National Park.

bark from *Aleurites moluccana* to that of *Nauclea orientalis* to treat internal and post partum bleeding.

Several of the plants mentioned by the Informant have been used by other cultures as medicinal plants and have also been investigated for pharmacological activity. For example, *Pterocarpus indicus* is used to treat "sores and minor wounds" in an unspecified South-East Asian country as cited by Khan and Omoloso (2003) and was found to have significant antibacterial activity. *Dioscorea bulbifera* is a traditional Chinese remedy for sore throat and also for tuberculosis as mentioned by Gao *et al.* (2002) who found that extracts had anti-tumor effects. While the traditional uses of plants mentioned in this study are not always the same in other countries, independent medicinal plant traditions using the same species suggests a degree of consensus. Furthermore, pharmacological investigation of these plants confirms their chemical activity.

The medicinal plant species collected were markedly different from the medicinal plant collections made with the Laklei and Idate cultures described in Chapter 3. Of the 40 plants collected, over 70% were different species that were not collected with the Laklei or the Idate people. This unique pharmacopeia is most likely due to differing site conditions and unique cultures. In general conditions at Conis Sanatana National Park include 1) high annual rainfall, 2) low human presence and therefore human disturbance, 3) an overall healthier ecosystem where large patches of primary and extensive stands of secondary forest exist relative to the study sites in Chapter 3. All of these defining characteristics contribute to significant differences in the flora of Conis Santana National Park and therefore the medicinal plants collected. Furthermore, as demonstrated in Chapter 3, different cultural groups may have significantly different medicinal plant traditions where the plant species used will be unique. While the medicinal plant species and habitat of collection differ from other areas in East Timor, several similarities exist. For example, the most frequently used plant part (leaves and bark), preparation method (decoctions, macerations and no preparation), habitat (forest) and route of administration (drink) were the same for the Idate, Laklei and Fataluku people. These similarities may indicate unifying characteristics of the East Timorese medicinal plant tradition in general.

The Informant's knowledge of medicinal and poisonous plants is a result of the degree to which he had to rely on the natural environment during the recent political unrest. It was common for entire villages to flee to the mountains to seek refuge from the brutality that began when the Indonesian army invaded in 1975 and continued through to the violence that followed the referendum in August of 1999. Many East Timorese can recount stories of having to survive in the forest under harsh conditions, where they were forced to live on papaya leaves for months at a time as it was too dangerous to return to roadside communities where Indonesian forces had control. Traditional medicine was relied upon heavily to treat ailments since seeking medical attention in city centres such as Dili and Baucau was not an option as these were the strongholds of the Indonesian occupation force. The reliance on the natural environment by FALANTIL soldiers was even greater as they were actively pursued by Indonesian forces in the forest. They could not carry adequate equipment, and as one former FALANTIL soldier stated: "During an ambush, you only had time to grab your gun and flee".

Many East Timorese have a working knowledge of useful plants, however the knowledge of the Informant is exceptional for two key reasons. First, he had a mentor who instructed him on useful plants and their various preparations. Secondly, he grew up and later lived in close proximity to the stronghold of the East Timorese resistance army, FALANTIL. The Informant was not a FALANTIL soldier himself, but provided critical support to the resistance by caring for sick soldiers and passing on his knowledge of medicinal plants.

While making the plant collection and conducting interviews, it was apparent that the two former FALANTIL soldiers also knew some remedies by the fact that they were able to clarify certain details. However, younger members of the expedition clearly had little or no knowledge of the plants. This presents a serious obstacle to maintaining traditional medicinal plant knowledge. Fostering interest in medicinal plants among younger members of the community is made difficult by the hospital in the district capital of Los Palos. The pharmaceutical drugs and western treatments offered by the hospital are rendering knowledge of local medicinal plants and their uses obsolete in the eyes of the youth.

4.4 Conclusions

Initiatives to preserve traditional botanical knowledge in the area of the proposed Conis Santana National Park are needed. Projects would be aided by increasing the research effort to document the botanical knowledge of elders from the communities adjacent to the proposed park and solitary individuals residing in otherwise abandoned villages within the park. It will not be enough to solely conserve this unique traditional botanical knowledge without conserving the forest where the plants are harvested. Serious threats to conservation in the area include illegal logging and swidden agriculture. Increased protection in the form of national park status for the area is needed and strict conservation rules which limit destructive forest practices need to be developed.

CHAPTER 5

INSECTICIDAL ACTIVITY OF PLANTS COLLECTED USING AN ETHNOBOTANICAL APPROACH

5.1 Introduction

Testing ethnobotanical knowledge of medicinal and useful plants has often been heralded as the most effective method of identifying potential pharmaceuticals and other useful compounds for consumer use (Balick 1996). While there are instances where ethnobotanical leads have resulted in successful pharmaceutical drugs, the likelihood of uncovering novel compounds with large scale commercial potential is very low (Crook and Clapp 1998). Laboratory analysis of plants gathered using an ethnobotanically guided approach can, however, make a very valuable contribution to people living in developing nations. By examining plants with traditional medicinal or insecticidal uses, traditional knowledge can be tested and, in some instances, validated. Furthermore, plants which have promise as affordable phytomedicines and natural insecticides can be identified and promoted for use by local people where pharmaceuticals or chemical insecticides are either unavailable or too expensive (Heinrich 2000).

Several studies have tested ethnobotanical knowledge and have revealed that traditional knowledge concerning chemically active plants can be very accurate (de Madureira *et al.* 2002, Hernandez *et al.* 2003). Leaman *et al.* (1995) showed that plant remedies with greater informant consensus had significantly greater anti-malarial activity. Otero *et al.* (2000a, 2000b, 2000c) documented the traditional use of medicinal plants to treat snake bites in Columbia and concluded that several of the tested plants had significant venom neutralizing and anti-haemorrhagic effects. Furthermore, ethnobotanically guided research can also be used to test informant knowledge of agricultural land races. Teshome *et* *al*. (1999) concluded that informant knowledge was very accurate at predicting storability, measured as resistance to grain weevil, of sorghum land races in Ethiopia.

Traditionally used natural insecticides were collected in East Timor while working with local East Timorese non-governmental organizations (NGOs). Our hypothesis was that plants identified as natural insecticides by East Timorese NGOs would have significantly greater insecticidal activity than a control group of medicinal plants also collected in East Timor. This hypothesis was tested through the use of an acute toxicity bioassay.

5.2 Materials and Methods

5.2.1 NGO Background Information

The natural insecticide plant collection was made with two East Timorese NGOs; Halarae and Yayasan HAK. Halarae's main mission is to meet the development needs of small communities in East Timor with particular attention to food security issues. Training rural East Timorese communities in better agricultural methods is part of Halarae's focus which includes instruction in the use natural insecticides.

Yayasan HAK or the 'Foundation of Law, Human Rights and Justice', is primarily concerned with the promotion of human rights in East Timor. Specific activities include offering legal help to East Timorese people and publicizing human rights issues. In addition to their political role, Yayasan HAK is involved in community development and training farmer groups in agricultural methods and the use of natural insecticides.

5.2.2 Traditional Use of Natural Insecticides

Both Halare and Yayasan HAK use a similar method of preparation. Plant material is first chopped into small pieces and then macerated into a fine paste using a mill. Cold water is added to the macerated plant material and allowed to infuse. Yayasan HAK informants allow the material to infuse for 24 hours, whereas the Halarae informant mentioned that the longer the material is allowed to infuse the greater the strength of the insecticide.

Before application, the cold infusions from each plant species (15 for Yayasan HAK and 11 for Halarae) are combined in equal parts. The mixture is then applied to either rice paddies, home gardens or swiddens by hand or using a hand sprayer when available. Neither organization specified specific crop pests as the target of the natural insecticides.

5.2.3 Voucher Specimens and Plant Collections

Voucher specimens were collected when possible in triplicate. One set of the voucher specimens is now stored at the National University of East Timor, Dili, East Timor; The Northern Territory Herbarium, Darwin, Australia; and the University of Ottawa, Ottawa, Canada. Identifications were made by Andrew Mitchell of Australian Quarantine and Dr. Dale Dixon of the Northern Territory Herbarium. Litre quantities of leaves, bark, stem or fruit for each plant species mentioned were collected and stored in 95% ethanol upon collection.

5.2.4 Extractions

The preserved plant samples (100g) were combined with an additional litre of 95% ethanol and macerated in a food processor. The ethanolic extracts were then filtered through a buchner using Whatman #1 paper and, using a rotary evaporator, ethanol was removed from the samples. The plant extracts were then frozen and placed in a freeze drier for 48 hours to remove water. All resulting crude extracts were powders. Crude extracts were then redissolved using 70% ethanol to a concentration of 10 mg/ml.

5.2.5 Insecticidal Bioassays

Acute toxicity bioassays with mosquito larvae were used to test extracts for insecticidal activity (Bernard *et al.* 1995). Tests of 3 replicates were done on all extracts. A combination of the 15 plant species used by Yayasan HAK and a combination of 10 of the 11 plant species used by Halarae as well as the control group of 10 medicinal plants used to treat urinary tract infections by East Timorese traditional healers were also tested. Piperine, a positive control, and an additional natural insecticide, *Arenga pinnata* were also tested. *Aedes atropalpus* (Culicidae), the rock hole breeding mosquito, was used as the test organism during the toxicity assays. Second instar larvae (10) were pipetted into each of four beakers with extract concentrations of 100 ppm, 10 ppm, 1 ppm and a control of 0 ppm. Mortality of the mosquito larvae was then counted after 24 hours.

5.2.6 Statistical Analysis

Average acute toxicity for each individual plant was calculated using the 3 replicates. With the program 'S Plus 6.2 the Kruskal-Wallis rank sum test (one way non-parametric ANOVA) was used to determine if average acute toxicity was significantly different between the two treatments (i.e. the ethnobotanically selected natural insecticides and the control group of traditionally used medicinal plants) at 100 ppm and at 10 ppm.

5.3 Results and Discussion

Of the 11 and 15 species used respectively by Halarae and Yayasan HAK, 3 species were common to both groups; *Alstonia scholaris*, *Annona species* and *Nicotiana tabacum*. Only *Annona species* was collected with both NGOs and tested twice, *Alstonia scholaris* and *Nicotiana tabacum* were only collected once with Yayasan HAK. For the testing of the 'Halarae Combination', *Nicotiana tabacum* and *Alstonia scholaris* from the Yayasan HAK collection was used. Futhermore, the *Dalbergia species* collected with Halarae was not collected in quantities suitable for extraction, therefore it was not tested.

Leaves are the most commonly used plant part as a natural insecticide (Table 5.1, 5.2). For 70% of the control plants used to treat urinary tract infections the bark is used

Table 5.1 Natural insecticides used by Yayasan Hak with vernacular name in Sa'ani, the plant part used and tested and other traditional uses mentioned by Yayasan Hak informants.

Family	Species	Voucher Number	Vernacular Name	Plant Part Used/Tested
Annonaceae	*Annona species*	SC #178	Dai ate	leaves
Apocynaceae	*Alstonia scholaris* (L.) R. Br.	SC #187	Weuhu	leaves
Araceae	*Amorphophallus sp.* Blume ex Decne.	SC #188	Lia	leaves, root
Asteraceae	*Cosmos species.* Cav.	SC #181	Darefufu	flowers, leaves, stem
Euphorbiaceae	*Euphorbia species* L.	SC #177	Latu bonuku	leaves, stem
Leguminosae	*Derris species C* Lour.	SC #179	Cai omara	leaves, stem
Leguminosae	*Entada phaseoloides* (L.) Merr.	SC #184	Hei	flowers, leaves, stem
Leguminosae	*Derris species D* Lour.	SC #182	Cai bi	leaves, stem
Meliaceae	*Melia azedarach* L.	SC #189	Buttnatel	leaves
Piperaceae	*Piper species* L.	SC #186	Maluhu	leaves, stem
Simaroubaceae	*Brucea species* J.F.Mill.	SC #190	Ero	leaves
Solanaceae	unknown A	SC #183	Diribau	leaves, stem
Solanaceae	*Nicotiana tabacum* L.	SC #185	Tobaco	leaves, stem
unknown	unknown B	SC #191	Butuatala	root
Zingiberaceae	unknown C	SC #180	Lobanarika	leaves, root

Table 5.2 Natural insecticides used by Halarae with vernacular name in Kemak, the plant part used and tested and other traditional uses mentioned by the Halarae informant.

Family	Species	Voucher Number	Vernacular Name	Plant Part Used/Tested
Annonaceae	*Annona species*	SC #194	Ai-kase	leaves
Apocynaceae	*Alstonia scholaris* (L.) R. Br.	SC #197	Soti	bark, leaves
Apocynaceae	*Nerium oleander* L.	SC #198	Ai-hetun	leaves, stem
Arecaceae	unknown species D	SC #202	Tali	leaves
Bignoniaceae	*Tecoma species* Juss	SC #195	Ai-hetun gamen	leaves
Lecythidaceae	*Planchonia species* Blume	SC #196	Baganasa	bark
Leguminosae	*Dalbergia species* L.f. *	SC #199	Ai-tuha fuik	stem, leaves
Leguminosae	*Albizia species* Durazz.	SC #192	Samtuku fuik	bark
Loganiaceae	*Strychnos lucida* R.Br.	SC #193	Kot	leaves, stem
Solanaceae	*Datura metel* L.	SC #200	Babotek	leaves
Solanaceae	*Nicotiana tabacum* L.	SC #201	Ai-baku	leaves, stem

* not tested using the acute bioassay

(Table 5.3). The symptoms of the urinary tract infections may include painful urination, urine that is cloudy or bloody, pain in the back near the kidneys and swollen genitals.

The average acute toxicity was not significantly different between the treatments (ethnobtanically selected natural insecticides versus the control group of medicinal plants) at either 100 ppm or 10 ppm (Table 5.4). As expected the acute toxicity of extracts is relatively low for all of natural insecticides except *Annona species* and the control group of medicinal plants when compared to Piperine, a pure compound (Table 5.5, 5.6, 5.7). Of the 24 natural insecticides only 4 accessions had any toxic activity. These accessions are *Annona species, Derris species C* and *Melia azedarach.* The control group also demonstrated very low toxicity with only *Alstonia spectabilis* and *Sterculia foetida* being slightly active at 100 ppm. The combinations of all plant species used by Halarae and by Yayasan HAK have less toxicity than the 3 three active species individually. Combining the plant extracts actually decreases the toxicity rather than having a synergistic effect.

Two species which had surprisingly low acute toxicity were *Derris species D* and *Nicotiana tabacum*. While *Derris species C* was toxic at 100 ppm, *Derris species D* had no activity. These findings may relate to the specific species of *Derris* or such factors as collection location, or collection time. *Nicotiana tabacum* is commonly known for its insecticidal properties and has been used for this purpose since the late 17th century in Europe (Philogène *et al*. 2004). The amount of nicotine, the active compound in *N. tabacum*, may have been low in our specimen.

The three species that were found to be most acutely toxic, *Annona species*, *Derris species C*, and *Melia azedarach*, have well documented traditional uses as pesticides and poisons. Futhermore, their phytochemistry and activity as natural insecticides have been

Table 5.3 Control plants used traditionally in East Timor to treat urinary tract infections, as well as vernacular name and language, and plant part used and tested.

Family	**Species**	**Voucher Number**	**Vernacular Name**	**Language**	**Plant Part Used/Tested**
Acanthaceae	*Justicia gendarussa* L.	SC #112	Kahoris	Laklei	leave, stem
Apocynaceae	*Alstonia spectabilis* R. Br.	SC #148	Riit metan	Laklei	bark
Apocynaceae	*Wrightia pubescens* R. Br.	SC #151	Ai-litik metan	Laklei	bark
Apocynaceae	*Plumeria rubra* L.	SC #261	Santo Antoni	Tetum	bark
Bignoniaceae	unknown E	SC #109	Kiri kasa	Laklei	bark
Euphorbiaceae	*Jatropha curcas* L.	SC #166	Mirik malay	Laklei	bark
Leguminosae	*Pterocarpus indicus* Willd.	SC #209	Ai-naro	Idate	bark
Loranthaceae	*Amymea species*	SC #237	Bere liko teen	Idate	leaves
Sterculiaceae	*Sterculia foetida* L.	SC #314	Ai-nitas	Tetum	fruit
Tiliaceae	*Grewia species* L.	SC #210	Ai-kalina	Idate	bark

Table 5.4 Statistical analysis of differences in average acute toxicity at 100 ppm and 10 ppm of extract between ethnobotanically selected natural insecticides and a control group of traditionally used medicinal plants from East Timor using the Kruskal-Wallis rank sum test.

Concentration of Extract	Degrees of Freedom	p value
100 ppm	1	0.10[a]
10 ppm	1	0.61 [a]

[a] average acute toxicity was not significantly different between treatments

Table 5.5 Insecticidal activity of natural insecticide crude extracts collected with Yayasan Hak, a combination of all extracts and Piperine.

	Concentration of Extract							
Species	**0 ppm**		**1 ppm**		**10 ppm**		**100 ppm**	
Alstonia scholaris (L.) R. Br.	0.3	(0.6) [a]	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Amorphophallus sp. Blume ex Decne.	0.0	(0.0)	0.0	(0.0)	0.3	(0.6)	1.0	(0.0)
Annona species	0.0	(0.0)	0.0	(0.0)	9.7	(0.6)	10.0	(0.0)
Brucea species J.F.Mill.	0.0	(0.0)	0.0	(0.0)	0.3	(0.6)	0.3	(0.6)
Cosmos species Cav.	0.0	(0.0)	0.3	(0.6)	0.0	(0.0)	0.0	(0.0)
Derris species C Lour.	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	9.0	(1.7)
Derris species D Lour.	0.0	(0.0)	0.0	(0.0)	0.3	(0.6)	1.3	(0.6)
Entada phaseoloides (L.) Merr.	0.0	(0.0)	0.3	(0.6)	0.3	(0.6)	0.0	(0.0)
Euphorbia species L.	0.3	(0.6)	0.0	(0.0)	0.0	(0.0)	1.0	(1.0)
Melia azedarach L.	0.0	(0.0)	0.3	(0.6)	0.0	(0.0)	8.7	(1.5)
Nicotiana tabacum L.	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Piper species L.	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
unknown species A	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
unknown species B	0.0	(0.0)	0.0	(0.0)	0.3	(0.6)	0.0	(0.0)
unknown species C	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.3	(0.6)
Yayasan Hak Combination	0.3	(0.6)	0.0	(0.0)	0.0	(0.0)	2.3	(0.6)
Piperine	0.0	(0.0)	1.0	(1.7)	6.7	(0.6)	10.0	(0.0)

[a] Mosquito larvae mortality after 24 hours: mean (+/- SD) of three trials of 10 second instar larvae/trial.

Table 5.6 Insecticidal activity of natural insecticide crude extracts collected with Halarae, a combination of all extracts and Piperine.

	Concentration of Extract							
Species	**0 ppm**		**1 ppm**		**10 ppm**		**100 ppm**	
Albizia species Durazz.	0.0	(0.0) [a]	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Strychnos lucida R.Br.	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.7	(0.6)
Annona species	0.3	(0.6)	1.3	(1.5)	10.0	(0.0)	10.0	(0.0)
Tecoma species Juss	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.7	(0.6)
Planchonia species Blume	0.0	(0.0)	0.0	(0.0)	0.7	(0.6)	0.0	(0.0)
Nerium oleander L.	0.0	(0.0)	0.3	(0.6)	0.0	(0.0)	0.0	(0.0)
Datura metel L.	0.0	(0.0)	0.0	(0.0)	0.3	(0.6)	0.3	(0.6)
unknown species D	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Arenga pinnata[b] (Wurmb) Merrill	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Halarae Combination	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	3.0	(0.0)
Piperine	0.0	(0.0)	1.0	(1.7)	6.7	(0.6)	10.0	(0.0)

[a] Mosquito larvae mortality after 24 hours: mean (+/- SD) of three trials of 10 second instar larvae/trial.
[b] This natural insecticide was not used by Halare but was included with this data.

Table 5.7 Insecticidal activity of crude extracts of plants traditionally used in East Timor to treat urinary tract infections (control).

	Concentration of Extract			
Species	**0 ppm**	**1 ppm**	**10 ppm**	**100 ppm**
Alstonia spectabilis R.Br.	0.0 (0.0) [a]	0.0 (0.0)	0.0 (0.0)	5.0 (1.0)
Amymea species	0.3 (0.6)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Grewia species L.	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.3 (0.6)
Jatropha curcas L.	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	1.3 (0.6)
Justicia gendarussa L.	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Plumeria rubra L.	0.0 (0.0)	0.3 (0.6)	0.3 (0.6)	0.0 (0.0)
Pterocarpus indicus Willd.	0.0 (0.0)	0.3 (0.6)	0.0 (0.0)	0.0 (0.0)
Sterculia foetida L.	0.3 (0.6)	0.7 (0.6)	0.0 (0.0)	5.3 (0.6)
Unknown species E	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Wrightia pubescens R. Br.	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Piperine	0.0 (0.0)	1.0 (1.7)	6.7 (0.6)	10.0 (0.0)

[a] Mosquito larvae mortality after 24 hours: mean (+/- SD) of three trials of 10 second instar larvae/trial.

described in other studies. Species from the *Annona* genus have been reported to be used traditionally in India. The activities include emetic, astringent, insecticidal antihelminthic and antidysenteric as recorded by He *et al.* (1997) and Lewis *et al.* (1993). The high activity of *Annona* species is due to the presence of acetogenins. Acetognenins are found only in the family Annonaceae and have a diverse range of activities which include antitumor, antimalarial, insecticidal and antimicrobial (Alali *et al.* 1999, He *et al.* 1997).

Members of the *Derris* genus are well known by indigenous people in South East Asia as effective fish poisons (de Padua *et al.* 1999, Munoz *et al.* 2000). In East Timor the leaves and stem are macerated in traditional mills and then added to small confined bodies of water such as tidal pools to kill fish. *Derris* is probably most well known as an effective alternative to synthetically produced chemical insecticides (de Padua *et al.* 1999). *Derris* has strong insecticidal activity due to the presence of rotenone which is more insecticidal than other rotenoid compounds including deguelin, toxicarol and tephrosin (Regnault *et al.* 2004).

Melia azedarach, a close relative of the neem tree famous for its traditional medicinal use and proven insecticidal activity, originates from India, the middle East and China (Nakatani *et al.* 1995). The leaves of *M. azedarach* are stored with clothes to discourage damage from moths in Vietnam (Bohnenstengel 1999) and other traditional uses include anthelmintic, antiseptic and antipyretic as seen in Valladares *et al.* (1999). Several studies show that limonoids from *M. azedarach*, most notably azadirachtins and meliacarpins, are active insecticidal compounds. Extracts of *M. azedarach* have significant antifeedant, growth inhibition, insecticidal and repellant activity to insects (Bohnenstengel *et al.* 1999, Breuer *et al.* 2003, Hammad *et al.* 2000, Huang *et al.* 1995, Nakatani *et al.* 1995, Valladares *et al.* 1999).

5.4 Conclusions

Although the ethnobotanically selected natural insecticides did not have significantly greater acute toxicity at either 100 ppm or 10 ppm, there was a trend to greater activity of the insecticidal plants at 100 ppm. In addition,, the relative toxicity of the natural insecticides was determined. *Annona species*, *Derris species C* and *Melia azedarach* were shown to have high acute toxicity which is supported by the extensive literature concerning these species. The literature also supports relatively safe use of these species, while if novel indigenous species had been identified, they would need further testing for safety and toxicity concerns. None of the control plants were able to produce 100% toxicity at 100 ppm. East Timorese NGOs should focus efforts on increased cultivation of these species to supply effective and affordable alternatives to expensive and inaccessible chemical pesticides.

CHAPTER 6

GENERAL DISCUSSION AND DEVELOPMENT IN EAST TIMOR

6.1 General Discussion

This thesis is the first documentation of traditional use of plants in East Timor. While ethnobotanical research of East Timor's nearest neighbour, Indonesia, is extensive, East Timor has been neglected scientifically due to its' remoteness and political instability for several centuries. Documentation of useful plants was achieved with particular emphasis being placed on medicinal species and how medicinal plant traditions vary between cultures (Chapter 3 and 4). Data was analysed using quantitative and descriptive ethnobotanical methods where statistical tests and comparisons of species used showed that medicinal plant traditions do vary between cultures (Chapter 3 and 4). Those plants used as natural insecticides (Chapter 5) and in daily life (Chapter 2) were also recorded. Using an acute toxicity bioassay, we showed that ethnobotanically selected natural insecticides and plants used to treat urinary tract infections did not have significantly different toxicity (Chapter 5).

Indigenous use of biodiversity resources in East Timor was described to provide background information on the East Timorese way of life and to demonstrate the importance of plants in East Timorese culture (Chapter 2). Several topics were discussed with emphasis on East Timorese animist spirituality and the roles of spiritual healers, sacred houses and traditional law. Use of plants was described and revealed that while a wide array of food plants are present in East Timor, most remote mountain villages rely solely on such staples as corn, rice and cassava. Malnutrition is a concern as very few fresh fruits, vegetables, or protein sources such as beans or meat are eaten regularly. East Timorese living in rural areas are skilled rice and corn farmers, but homegardens are usually small or non-existent and contain few species. By planting plants with particular nutritional benefits, such as vitamin

A rich papaya, nutritional deficiencies can be lessened (Murthy *et al.* 1999, WHO 2000). Home garden education programs concerning how to develop them and their usefulness in meeting nutritional needs should be important international development objectives in East Timor.

An ethnobotanical survey of two unique cultures, the Laklei and Idate people, was undertaken to address whether or not medicinal plant traditions vary between cultures (Chapter 3). Using Trotter and Logan's (1986) informant consensus factor, consensus was calculated within each culture for a series of usage categories. The average of the informant consensus factors for each culture was then compared using a one-tailed paired t-test to see if the average informant consensus factor value for Laklei was higher than that for Idate. The null hypothesis, that average consensus for Laklei was not higher, was rejected. Therefore, Laklei, on average, had higher consensus amongst informants concerning what medicinal plants to use when treating specific disease categories inferring a medicinal tradition that is more defined. Number of mentions for method of preparation and plant part used depended on culture. Furthermore, of the 86 plant species collected only 11 were common to both villages where only 6 of the specific uses were the same.

Medicinal plant use of a third East Timorese indigenous culture, the Fataluku people, was documented (Chapter 4). Medicinal plants were collected with a Fataluku key informant who aided the East Timorese resistance during the Indonesian occupation by using traditional medicine to care for wounded soldiers. Several medicinal species were encountered which were not used by the Laklei or the Idate people. The uniqueness of the medicinal plants used by this Fataluku medicinal specialist is due in part to the differing floras but supports the conclusion of Chapter 3 that distinct cultures have unique medicinal plant traditions where the species used will vary. The uniqueness of the flora and the medicinal plant tradition of the area make the full protection of the proposed Conis Santana National Park extremely important due not only to its biological importance but also its cultural importance as a reservoir for traditionally used medicines of the Fataluku people.

Several general trends exist for the ethnobotany of East Timor. While statistical methods showed that medicinal plant traditions do vary significantly between cultures, the most commonly mentioned habit (tree), habitat (forest), plant part used (leaves and bark), usage category (Infections/Infestations), preparation method (decoction, maceration and none) and route of administration (drink) were the same for Laklei, Idate and Fataluku cultures. The medicinal plant tradition of East Timor contrasts strongly with the literature concerning informant consensus. Heinrich *et al.* (1998) and Treyvaud Amiguet *et al.* (2004) documented informant consensus in Central America which was considerably greater than the informant consensus among East Timorese informants in our study. Furthermore, separate cultures had a low overlap of medicinal species where the few species that did overlap rarely had similar usages compared to findings of Leonti *et al.* (2003) and Leporatti and Ivancheva (2003).

6.2 Relevance to the Development of East Timor

Ethnobotanical research has often been validated by its effectiveness at identifying useful plants including important materials such as rubber, pharmaceutical drugs and new crop varieties. However, ethnobotanically guided research has now emerged as a practical tool in international development projects. By documenting traditional botanical knowledge, 1) useful phytomedicines and 2) utility plants such as natural insecticides can be identified, 3) plans to develop and market natural products with international demand can be implemented and 4) conservation needs can be predicted.

6.2.1 Phytomedicines and Conservation of Traditional Botanical Knowledge

Traditionally used medicines identified in this study, especially those mentioned in more than one of the Laklei, Idate and Fataluku communities, have potential to provide safe, effective and affordable remedies to East Timorese people (Table 6.1). Farnsworth states that approximately 80% of the world relies upon traditional medicine for their primary health care (1985). While traditional medicine in East Timor is not relied upon as heavily as in the past, there still is a large segment of the East Timorese population that uses and relies heavily on traditional medicine; primarily in the remote mountainous regions.

As a result of this study a substantial contribution can be made to the development of East Timor through publishing a handbook with descriptions of the use of commonly mentioned medicinal and utility plants. By recording the traditionally used phytomedicines 1) this information can be made available to East Timorese in need of affordable, effective and safe alternatives to inaccessible western medication and 2) the traditional plant knowledge,which forms an important component of East Timorese culture, is preserved.

6.2.2 Natural Insecticides

The East Timorese economy is composed primarily of its agricultural sector (Hill 2001). Almost all rural East Timorese are subsistence farmers who plant corn or rice and other minor crops such as squash and cassava (Chapter 2). Some East Timorese farmers purchase synthetic pesticides in Dili but few are able to afford it as the per capita income of East Timor is only USD $300 per year, one of the lowest in the world (Hill 2001). Results from the acute toxicity bioassays (Chapter 5) indicated *Derris species A, Melia azedarach* and *Annona species A* to be highly insecticidal and should be preferentially used in place of other natural insecticides that did not show significant insecticidal activity (Table 6.1).

Table 6.1 List of priority useful plants of East Timor with potential for development into phytomedicines, natural insecticides and natural health products.

Botanical Name	Source Culture/NGO[1]	Usage Category[2]	Number of Mentions[3]	Recommendations for Future Use
Aegle marmelos	Idate	DIG	1	Phytomedicine
	Laklei	DIG, VET	3	
Aleurites moluccana	Fataluku	INJ, PRE	1	Phytomedicine
	Idate	PRE	1	
Alstonia scholaris	Idate	INF, NER	1	Phytomedicine Future research
	Laklei	GEN, INF	5	NHP[4]
Amymea species B	Idate	MUS	1	Phytomedicine
	Fataluku	GEN	1	
Annona species	Halarae	Insecticide	1	Natural insecticide
	Yayasan Hak	Insecticide	1	
Azadirachta indica	Idate	INF, RES	1	Phytomedicine Natural insecticide
	Fataluku	MUS	1	NHP
Calotropis gigantea	Idate	GEN, INF, INJ	4	Toxic
	Laklei	DIG, GEN	2	
Carica papaya	Fataluku	INF	1	Phytomedicine
Cassia fistula	Idate	DIG, INJ, POD	2	Phytomedicine Further research
	Laklei	INF, POD, RES, INJ	5	NHP
Derris sp. A	Yayasan Hak	Insecticide	1	Natural insecticide
Drynaria quercifolia	Fataluku	INF	1	Phytomedicine
	Idate	NER	1	
	Laklei	RES	2	
Imperata cylindrica	Idate	CIR	1	Phytomedicine
	Fataluku	INF	1	
Jatropha curcas	Fataluku	GEN	1	Toxic
	Idate	PRE, RES	2	
	Laklei	MUS, RES	2	
Leea indica	Laklei	INF	2	Phytomedicine
	Fataluku	DIG	1	
Mallotus philippensis	Idate	DIG	2	Phytomedicine Further Research
	Laklei	INF, INJ, MUS, PRE	6	NHP
Mangifera indica	Laklei	VET	1	Phytomedicine
	Fataluku	INJ	1	NHP

1- Non Governmental Organization
2- Usage categories used in Chapter 3
3- Number of mentions by the East Timorese informants in each culture/NGO
4- natural health product

Table 6.1 Continued

Botanical Name	**Source Culture/NGO**[1]	**Usage Category**[2]	**Number of Mentions**[3]	**Recommendations for Future Use**
Melia azedarach	Yayasan Hak	Insecticide	1	Natural insecticide
Nauclea orientalis	Fataluku	INF, INJ, PRE	1	Phytomedicine
	Idate	INF, MUS, RES	2	
	Laklei	DIG, INF	2	
Psidium guajava	Idate	DIG	1	Phytomedicine
	Laklei	DIG, GEN	1	NHP
Pterocarpus indicus	Idate	GEN	1	Phytomedicine
	Fataluku	SKI	1	
Timonius timon	Idate	GEN, ILL, NER, SEN,	2	Phytomedicine Further Research
	Laklei	NER	1	NHP
Ziziphus species	Idate	DIG	1	Phytomedicine
	Laklei	GEN, VET	2	

Azadirachta indica, commonly known as neem, was noticeably absent from the list of plant species used as natural insecticides by the two East Timorese NGOs. While making other ethnobotanical plant collections in East Timor, *A. indica* was mentioned as a traditional medicine. One informant used a decoction of the leaves as a drink and shower to treat sore joints. Another informant, from a different cultural group, used a cold infusion of the bark from *A. indica* as a shower to treat both fever and cough. The neem tree originates from southern Asia and is particularly well known in India where it has over 700 uses in Ayurveda and other medicinal traditions (Brahmachari 2004). Numerous compounds have been isolated from the neem tree, most notably azadirachtin, which has exceptional insecticidal and insect antifeedant activity (Aerts and Mordue 1997, Brahmachari 2004). Brahmachari (2004) states that neem has the greatest potential of any natural insecticide for providing a safe yet effective alternative to synthesized chemical pesticides.

Education programs concerning the use of *Derris species A, Annona species A, Melia azedarach* and especially *Azadirachta indica* should be developed and made available to subsistence farmers thus providing a readily available and effective alternative to chemical insecticides which are beyond the economic reality of most rural East Timorese.

6.2.3 Natural Health Products

Several plant species from East Timor, including traditionally used medicinals and other wild species, have commercial potential in emerging international natural health product markets. As of January 2004, natural health products (NHP) are considered as a new regulatory category under the Food and Drug Act in Canada, whereas they used to be considered either food or drugs on a case by case system. The new category permits rapid registration of traditional medicinal products at low cost, yet provides assurance of quality and safety for consumers. Canada is the first developed country to adopt this system. The implementation of programs, by international non-governmental organizations, aimed at developing a small scale economy around medicinal plants in East Timor for sale in Canada is possible if it is undertaken with certain considerations in mind.

1) Start conservatively with plants species where a natural health product monograph already exists (ex. ginger, turmeric, aloe, cayenne pepper and garlic). These plants are effective remedies that have already had toxicology issues addressed and will therefore make the obtaining of a product license easier and timelier.
2) Focus on value adding. Raw materials fetch very low prices but by processing the plant and attractively packaging it, considerable value is added to the product (Mahapatra and Mitchell 1997).
3) Consider how the marketing, quality monitoring and registration will be done and who will be responsible for it. Focus first on local markets. Internationally, it is unlikely that Canadian herbal companies will have resources to accept these products. Therefore, international non-governmental organizations need to consider a marketing and labeling program.
4) A key marketing feature is eco-labeling. Products can add value by using "organic", "fair trade" or "indigenous product" labels for which certification is required.
5) Adopt guidelines established by the World Health Organization for agricultural practices including planting, harvesting and packaging (WHO 2003).
6) Only use medicinal plants that have been grown either in plantations or home gardens as a means of preserving the wild population and making the industry sustainable.
7) Consider research programs that investigate the potential for non-monographed East Timorese plants of acquiring NHP registration (Table 6.1).

6.2.4 Identification of Conservation Needs

Several recommendations need to be considered with respect to conservation needs in East Timor. First, the East Timorese environment is highly degraded where a considerable area of the country has been altered through land clearing for agriculture and logging. Rehabilitation and reforestation projects need to be seriously considered to reverse alarming trends regarding land conversion not only to increase the health of the ecosystem but also to address the threat of diminishing resources for future East Timorese. Secondly, while conservation efforts are underway there are still no fully protected areas in East Timor. Several critical biological 'hot spots', such as the proposed Conis Santana National Park, contain some of the few remaining stands of primary forest in East Timor and are important habitat for unique medicinal plants. It is crucial that these last remaining expanses of continuous forest are protected for biological but also cultural reasons. Third, little is known concerning the complete biodiversity of the island as thorough scientific study has been impossible due to political instability. A thorough biological inventory is desperately needed to 1) identify habitats or species needing particular conservation and 2) to provide baseline data for future comparisons.

6.3 Future Work

This study is the first to focus on the documentation of traditional botanical knowledge in East Timor. While this research was able to document traditional plant use amongst 3 distinct East Timorese cultures, Fataluku, Idate and Laklei, there still remain many other cultures with their own medicinal plant traditions that may reveal other unique characteristics and plant species not used by other cultures. This field of research is particularly important at this time as East Timor is undergoing rapid development where a shift from traditional medical systems to a reliance on western treatments and concepts of healing is taking place faster than the traditional knowledge can be recorded.

LITERATURE CITED

Adger, W. N., K. Brown, R. Cervigni and D. Moran. 1995. Total economic value of forests in Mexico. Ambio. 24: 286-296.

Aerts, R. J. and A. J. Mordue. 1997. Feeding deterrence and toxicity of neem triterpenoids. Journal of Chemical Ecology. 23: 2117-2132.

Alali, F. Q., X. Liu and J. L. McLaughlin. 1999. Annonaceous acetogenins: recent progress. Journal of Natural Products. 62: 504-540.

Anderson, A. B. and D. A. Posey. 1989. Management of a tropical scrub savanna by the Gorotire Kayapo of Brazil. Advances in Economic Botany. 7: 159-173.

Balick, M. J. and R. Mendelsohn. 1992. Assessing the economic value of traditional medicines from tropical rain forests. Conservation Biology. 6: 128-130.

Balick, M. J. 1996. Transforming ethnobotany for the new millennium. Annals of the Missouri Botanical Garden. 83: 58-66.

Begossi, A. 1996. Use of ecological methods in ethnobotany: diversity indices. Economic Botany. 50: 280-289.

Begossi, A., N. Hanazaki and J. Y. Tamashiro. 2002. Medicinal plants in the Atlantic forest (Brazil): knowledge, use, and conservation. Human Ecology. 30: 281-299.

Bernard, C. B., H. G. Krishnamurty, D. Chauret, T. Durst, B. J. R. Philogene, P Sanchez-Vindas, C. Hasbun, L. Poveda, L. San Roman and J. T. Arnason. 1995. Insecticidal defenses of Piperaceae from the neotropics. Journal of Chemical Ecology. 21: 801-814.

Bohnenstengel, F. I., V. Wray, L. Witte, R. P. Srivastava and P. Proksch. 1999. Insecticidal meliacarpins (C-seco limonoids) from *Melia azedarach*. Phytochemsitry. 50: 977-982.

Boom, B. 1987. Ethnobotany of the Chacobo Indians, Beni, Bolivia. Advances in Economic Botany. 4: 1-70.

Boom, B. M. 1990. Useful plants of the Panare Indians of the Venezuelan Guayana. Advances in Economic Botany. 8: 57-76.

Boot, R. G. A. and R. E. Gullison. 1995. Approaches to developing sustainable extraction systems for tropical forest products. Ecological Applications. 5: 896-903.

Bouma G. and Kobryn, H. 2002. Assessing vegetation change in East Timor using landsat thematic mapper data. Murdoch University, School of Environmental Science, Australia. Technical Report No. 01/02.

Brahmachari, G. 2004. Neem- an omnipotent plant: a retrospection. ChemBioChem. 5:408-421.

Breuer, M., B. Hoste, A. D. Loof and S. N. H. Naqvi. 2003. Effects of *Melia azedarach* extract on the activity of NADPH-cytochrome C reductase and cholinesterase in insects. Pesticide Biochemistry and Physiology. 76:99-103.

Browder, J. O. 1992. The limits of extractivism: tropical forest strategies beyond extractive reserves. Bioscience. 42: 174-182.

Byg, A. and H. Balslev. 2001. Diversity and use of palms in Zahamena, eastern Madagascar. Biodiversity and Conservation. 10: 951-970.

Carneiro, R. L. 1978. The knowledge and use of rain forest trees by the Kuikuru Indians of Central Brazil. Pages 201-216 in R. I. Ford (ed.), The Nature and Status of Ethnobotany. University of Michigan Press, Ann Arbor, Michigan.

Chopra, J. 2000. The UN's kingdom of East Timor. Survival. 42: 27-39.

Cook, F.E.M. 1995. Economic botany data collection standard. Ed. H.D.V. Prendergast, Royal Botanic Gardens, Kew, United Kingdom.

Cotton, J. 2001. Against the grain: the East Timor intervention. Survival. 43: 127-142.

Crook, C. and R. A. Clapp. 1998. Is market-oriented conservation a contradiction in terms? Environmental Conservation. 25: 131-145.

Cunningham, A. B., E. Ayuk, S. Franzel, B. Duguma and C. Asanga. 2002. An economic evaluation of medicinal tree cultivation: *Prunus africana* in Cameroon. People and Plants Working Paper 10. UNESCO, Paris.

Cunningham, A. B. and F. T. Mbenkum. 1993. Sustainability of harvesting *Prunus africana* bark in Cameroon: a medicinal plant in international trade. People and Plants Working Paper 2. UNESCO, Paris.

Dafni, A. and E. Lev. 2002. The Doctrine of signatures in present-day Israel. Economic Botany. 56: 328-334.

de Madureira, M. D. C, A. P. Martins, M. Gomes, J. Paiva, A. P. da Cunha and V. do Rosario. 2002. Antimalarial activity of medicinal plants used in traditional medicine in S. Tome and Principe Islands. Journal of Ethnopharmacology. 81: 23-29.

de Padua, L. S., N. Bunyapraphatsara and R. H. M. J. Lemmens (Eds). 1999. Plant Resources of South-East Asia No 12(1). Medicinal and poisonous plants 1. Backhuys Publishers, Leiden, the Netherlands. 711pp.

Elliott, S. and J. Brimacombe. 1987. The medicinal plants of Gunung Leuser National Park, Indonesia. Journal of Ethnopharmacology. 19: 285-317.

Farnsworth, N. R., O. Akerele, A. S. Bingel, D. D. Soejarto, and Z. Guo. 1985. Medicinal plants in therapy. Bulletin of the World Health Organization. 63: 965-981.

Fernandez, E. C., Y. E. Sandi and L. Kokoska. 2003. Ethnobotanical inventory of medicinal plants used in the Bustillo province of the Potosi Department, Bolivia. Fitoterapia. 74: 407-416.

Ford, R. I. 1978. Ethnobotany: historical diversity and synthesis. Pages 33-49 in R. I. Ford (ed.), The Nature and Status of Ethnobotany. University of Michigan Press, Ann Arbor, Michigan.

Frei, B., M. Baltisberger, O. Sticher and M. Heinrich. 1998. Medical ethnobotany of the Zapotecs of the Isthmus-Sierra (Oaxaca, Mexico): documentation and assessment of indigenous uses. Journal of Ethnopharmacology. 62: 149-165.

Gao, H., M. Kuroyanagi, L. Wu, N. Kawahara, T. Yasuno, and Y. Nakamura. 2002. Antitumor-promoting constituents from *Dioscorea bulbifera* L. in JB6 mouse epidermal cells. Biological and Pharmaceutical Bulletin. 25: 1241-1243.

Giday, M., Z. Asfaw, T. Elmqvist and Z. Woldu. 2003. An ethnobotanical study of medicinal plants used by the Zay people in Ethiopia. Journal of Ethnopharmacology. 85: 43-52.

Grimes, A., S. Loomis, P. Jahnige, M. Burnham, K. Onthank, R. Alarcon, W. P. Cuenca, C. C. Martinez, D. Neill, M. Balick, B. Bennett and R. Mendelsohn. 1994. Valuing the rain forest: the economic value of nontimber forest products in Ecuador. Ambio. 23: 405-410.

Grosvenor, P. W., P. K. Gothard, N. C. McWilliam, A. Supriono and D. O. Gray. 1995. Medicinal plants from Riau Province, Sumatra, Indonesia. Part 1: uses. Journal of Ethnopharmacology. 45: 75-95.

Hammad, E. M. A., N. M. Nemer and N. S. Kawar. 2000. Efficacy of Chinaberry tree (Meliaceae) aqueous extracts and certain insecticides against the pea leafminer (Diptera: Agromyzidae). Journal of Agricultural Science. 134: 413-420.

Hall, P. and K. Bawa. 1993. Methods to assess the impact of extraction of non-timber tropical forest products on plant populations. Economic Botany. 47: 234-247.

He, K., L. Zeng, Q. Ye, G. Shi, N. H. Oberlies, G. Zhao, C. J. Njoku and J. L. McLaughlin. 1997. Comparative SAR Evaluations of Annonaceous acetogenins for pesticidal activity. Pesticide Science. 49:372-378.

Heinrich, M. 2000. Ethnobotany and its role in drug development. Phytotherapy Research. 14: 479-488.

Heinrich, M., A. Ankli, B. Frei, C. Weimann and O. Sticher. 1998. Medicinal plants in Mexico: healer's consensus and cultural importance. Social Science and Medicine. 47: 1859-1871.

Hernandez, T., M. Canales, J. G. Avila, A. Duran, J. Caballero, A. R. de Vivar and R. Lira. 2003. Ethnobotany and antibacterial activity of some plants used in traditional medicine of Zapotitlan de las Salinas, Puebla (Mexico). Journal of Ethnopharmacology. 88: 181-188.

Hill, H. 2001. Tiny, poor and war torn: development policy challenges for East Timor. World Development. 29: 1137-1156.

Hirschhorn, H. H. 1983. Botanical remedies of the former Dutch East Indies (Indonesia). Part I: eumycetes, pteridophyta, gymnospermae, angiospermae (monocotyledones only). Journal of Ethnopharmacology. 7: 123-156.

Holdsworth, D. and T. Rali. 1989. A survey of medicinal plants of the southern highlands, Papua New Guinea. International Journal of Crude Drug Research. 27: 1-8.

Holdsworth, D. and B. Wamoi. 1982. Medicinal plants of the Admiralty Islands, Papua New Guinea Part 1. International Journal of Crude Drug Research. 20: 169-181.

Huang, R. C., H. Okamura, T. Iwagawa, K. Tadera and M. Nakatani. 1995. Azedarachin C, a limonoid antifeedant from *Melia azedarach*. Phytochemistry. 593-594.

Kapur, S. K., A. K. Shahi, Y. K. Sarin and D. E. Moerman. 1992. The medicinal flora of Majouri-Kirchi forests (Jammu and Kashmir State), India. Journal of Ethnopharmacology. 36: 87-90.

Khan, M. R. and A. D. Omoloso. 2003. Anitbacterial activity of *Pterocarpus indicus*. Fitoterapia. 74: 603-605.

Lamont, S. R., W. H. Eschbaugh and A. M. Greenberg. 1999. Species composition, diversity, and use of homegardens among three Amazonian villages. Economic Botany. 53: 312-326.

Leaman, D. J. 1996. The medicinal ethnobotany of the Kenyah of East Kalimantan (Indonesian Borneo). Ph.D. dissertation, University of Ottawa, Canada. 353 pp.

Leaman, D. J., J. T. Arnason, R. Yusuf, H. Sangat-Roemantyo, H. Soedjito, C. K. Angerhofer and J. M Pezzuto. 1995. Malaria remedies of the Kenyah of the Apo Kayan, East Kalimantan, Indonesian Borneo: a quantitative assessment of local consensus as an indicator of biological efficacy. Journal of Ethnopharmacology. 49: 1-16.

Lebbie, A. R. and R. P. Guries. 1995. Ethnobotanical value and conservation of sacred groves of the Kpaa Mende in Sierra Leone. Economic Botany. 49: 297-308.

Leonti, M., O. Sticher and M. Heinrich. 2003. Antiquity of medicinal plant usage in two Macro-Mayan ethnic groups (Mexico). Journal of Ethnopharmacology. 88: 119-124.

Leporatti, M. L. and S. Ivancheva. 2003. Preliminary comparative analysis of medicinal plants used in the traditional medicine of Bulgaria and Italy. Journal of Ethnopharmacology. 87: 123-142.

Lewis, M. A., J. T. Arnason, B. J. R. Philogene, J. K. Rupprecht and J. L. McLaughlin. 1993. Inhibition of respiration at site I by asimicin, an insecticidal acetogenin of the pawpaw, *Asimina triloba* (Annonaceae). Pesticide Biochemistry and Physiology. 45:15-23.

Li, R. W., D. N. Leach, S. P. Myers, G. J. Leach, G. D. Lin, D. J. Brushett and P. G. Waterman. 2004. Anti-inflammatory activity, cytotoxicity and active compounds of *Tinospora smilacina* Benth. Phytotherapy Research. 18: 78-83.

Li , R. W., S. P. Myers, D. N. Leach, G. D. Lin and G. Leach. 2003. A cross-cultural study: anti-inflammatory activity of Australian and Chinese plants. Journal of Ethnopharmacology. 85: 25-32.

Long, C. and R. Li. 2004. Ethnobotanical studies on medicinal plants used by the Red-headed Yao people in Jinping, Yunnan Province, China. Journal of Ethnopharmacology. 90: 389-395.

Lykke, A. M. 2000. Local perceptions of vegetation change and priorities for conservation of woody-savanna vegetation in Senegal. Journal of Environmental Management. 59: 107-120.

Mahapatra, A. and C. P. Mitchell. 1997. Sustainable development of non-timber forest products: implication for forest management in India. Forest Ecology and Management. 94: 15-29.

Mahyar, U. W., J. S. Burley, C. Gyllenhaal and D. D. Soejarto. 1991. Medicinal plants of Seberida (Riau Province, Sumatra, Indonesia). Journal of Ethnopharmacolgy. 31: 217-237.

McNeely, J. A. 2005. Biological and cultural diversity: the double helix of sustainable development. In Arnason, J. T., P. Catlin, E. Small, P. T. Dang and J. D. H. Lambert (eds.), *Biodiveristy and Health: Focusing Research to Policy*. Proceedings of the International Workshop held in Ottawa, Canada, October 25-28, 2003. NRC Research Press, Ottawa, Ontario, Canada.

McWilliam, A. 2003. New beginnings in East Timorese forest management. Journal of Southeast Asian Studies. 34: 307-327.

Mendelsohn, R. and M. J. Balick. 1995. The value of undiscovered pharmaceuticals in tropical forests. Economic Botany. 49: 223-228.

Ministry of Agriculture, Forestry and Fisheries, Republica Democratica de Timor-Leste, New South Wales National Parks and Wildlife Service and Bird Life International. 2003. Proposal to establish a protected area network in Timor-Leste.

Modvig, J., J. Pagaduan-Lopez, J. Rodenburg, C. M. D. Salud, R. V. Cabigon and C. I. A. Panelo. 2000. Torture and trauma in post-conflict East Timor. The Lancet. 356: 1763.

Moerman, D. E. 1996. An analysis of the food plants and drug plants of Native North America. Journal of Ethnopharmacology. 52: 1-22.

Moerman, D. E. 1979. Symbols and selectivity: a statistical analysis of Native American medical ethnobotany. Journal of Ethnopharmacology. 1: 111-119.

Moerman, D. E. 1991. The medical flora of Native North America: an analysis. Journal of Ethnopharmacology. 31: 1-42.

Monk, K. A., Y. D. Fretes, and G. Reksodiharjo-Lilley. 1997. The Ecology of Nusa Tenggara and Maluku. Vol. V. The Ecology of Indonesia Series. Singapore: Periplus Editions (HK) Ltd.

Morris, K. 2001. Growing pains of East Timor: health of an infant nation. Lancet. 357: 873-877.

Munoz, V., M. Sauvain, G. Bourdy, J. Callapa, S. Bergeron, I. Rojas, J. A. Bravo, L. Balderrama, B. Ortiz, A. Gimenez and E. Deharo. 2000. A search for natural bioactive compounds in Bolivia through a multidisciplinary approach. Part 1. Evaluation of the anti-malarial activity of plants used by the Chacobo Indians. Journal of Ethnopharmacology. 69: 127-137.

Murthy, P. V. V. S., K. V. Lakshmi and M. S. Bamji. 1999. Impact of home gardening and nutrition education in a district of rural India. Bulletin of the World Health Organization. 77: 784.

Nakatani, M., R. C. Huang, H. Okamura, T. Iwagawa, K. Tadera and H. Naoki. 1995. Three new antifeeding meliacarpinins from Chinese Melia azedarach Linn. Tetraherdron. 43: 11731-11736.

Otero, R., R. Fonnegra, S. L. Jimenez, V. Nunez, N. Evans, S. P. Alzate, M. E. Garcia, M. Saldarriaga, G. Del Valle, R. G. Osorio, A. Diaz, R. Valderrama, A. Duque and H. N. Velez. 2000a. Snakebites and ethnobotany in the northwest region of Columbia Part I: traditional use of plants. Journal of Ethnopharmacology. 71: 493-504.

Otero, R., V. Nunez, J. Barona, R. Fonnegra, S. L. Jimenez, R. G. Osorio, M. Saldarriaga and A. Diaz. 2000c. Snakebites and ethnobotany in the northwest region of Columbia Part III: neutralization of the haemorrhagic effect of *Bothrops atrox* venom. Journal of Ethnopharmacology. 73: 233-241.

Otero, R., V. Nunez, S. L. Jimenez, R. Fonnegra, R. G. Osorio, M. E. Garcia and A. Diaz. 2000b. Snakebites and ethnobotany in the northwest region of Colombia Part II: Neutralization of lethal and enzymatic effects of *Bothrops atrox* venom. Journal of Ethnopharmacology. 71: 505-511.

Peters, C., A. H. Gentry and R. O. Mendelsohn. 1989. Valuation of an Amazonian rainforest. Nature. 339: 655-656.

Phillips, O. L. 1996. Some quantitative methods for analyzing ethnobotanical knowledge. Pages 171-197 in M. N. Alexiades, (ed.), Selected guidelines for ethnobotanical research: a field manual. The New York Botanical Garden, Bronx, New York, USA.

Phillips, O. and A. H. Gentry. 1993a. The useful plants of Tambopata, Peru: I. Statistical hypotheses tests with a new quantitative technique. Economic Botany. 47: 15-32.

Phillips, O. and A. H. Gentry. 1993b. The useful plants of Tambopata, Peru: II. Additional hypothesis testing in quantitative ethnobotany. Economic Botany. 47: 33-43.

Phillips, O., A. H. Gentry, C. Reynel, P. Wilkin and C. Galvez-Durand B. 1994. Quantitative ethnobotany and Amazonian conservation. Conservation Biology. 8: 225-248.

Pinedo-Vasquez, M., D. Zarin, P. Jipp and J. Chota-Inuma. 1990. Use-values of tree species in a communal forest reserve in northeast Peru. Conservation Biology. 4: 405-416.

Prance, G. T., W. Balee, B. M. Boom and R. L. Carneiro. 1987. Quantitative ethnobotany and the case for conservation in Amazonia. Conservation Biology. 1: 296-310.

Rawski, F. 2002. Truth-seeking and local histories in East Timor. Asia-Pacific Journal on Human Rights and the Law. 1: 77-96.

Philogène, B. J. R., C. Regnault-Roger and C. Vincent. 2004. Botanicals: yesterday's and today's promises. Pages 1-13 in Regnault-Roger, C., B. J. R. Philogène and C. Vincent. 2004. Biopesticides of Plant Origin. Lavoisier, Paris, France; Intercept, Hampshire, U.K.

Rohadi, D., R. Maryani, M. Widyana and I. Azhar. 2004. A case study of the production-to-consumption system of sandalwood (*Santalum album*) in South Central Timor, Indonesia. Pages 183-201 in Kusters, K. and B. Belcher (eds.), Forest products, livelihoods and conservation: case studies of non-timber forest product systems. Centre for International Forestry Research, Jakarta.

Rosoanaivo, P. 2005a. Prospects and problems of trading in medicinal plants: A case study of Madagascar. In Arnason, J. T., P. Catlin, E. Small, P. T. Dang and J. D. H. Lambert (eds.), *Biodiveristy and Health: Focusing Research to Policy*. Proceedings of the International Workshop held in Ottawa, Canada, October 25-28, 2003. NRC Research Press, Ottawa, Ontario, Canada.

Rosoanaivo, P. 2005b. Traditional medicine programmes in Madagascar. In Arnason, J. T., P. Catlin, E. Small, P. T. Dang and J. D. H. Lambert (eds.), *Biodiveristy and Health: Focusing Research to Policy*. Proceedings of the International Workshop held in Ottawa, Canada, October 25-28, 2003. NRC Research Press, Ottawa, Ontario, Canada.

Rossato, S. C., H. F. Leitao-Filho and A. Begossi. 1999. Ethnobotany of Caicaras of the Atlantic forest coast (Brazil). Economic Botany. 53: 387-395.

Salafsky, N., B. L. Dugelby, J. W. Terborgh. 1993. Can extractive reserves save the rain forest? An ecological and socioeconomic comparison of non-timber forest product extraction systems in Peten, Guatemala, and West Kalimantan, Indonesia. Conservation Biology. 7:39-52.

Schröder, J. 2001. NTFP use and sustainability: the example of *Prunus africana* in Cameroon. Pages 12-14 in ETFRN news: non-timber forest products, No. 32 2000/2001, European Tropical Forest Research Network, Wageningen, The Netherlands.

Schultes, R. E. 1991. The reason for ethnobotanical conservation. Pages 65-75 in Akerele, O., V. Heywood and H. Synge, (eds..), The Conservation of Medicinal Plants. Cambridge University press, Cambridge.

Shanley, P., L. Luz and I. R. Swingland. 2002. The faint promise of a distant market: a survey of Belem's trade in non-timber forest products. Biodiversity and Conservation. 11: 615-636.

Shinwari, Z. K. and S. S. Gilani. 2003. Sustainable harvest of medicinal plants at Bulashbar Nullah, Astore (Northern Pakistan). Journal of Ethnopharmacology. 84: 289-298.

Singh, Y. N. 1986. Traditional medicine in Fiji: some herbal folk cures used by Fiji Indians. Journal of Ethnopharmacology. 15: 57-88.

Southgate, D. and H. L. Clark. 1993. Can conservation projects save biodiversity in South America. Ambio. 22: 163-166.

Stewart, K. M. 2003. The African cherry (*Prunus africana*): from hoe-handles to the international herb market. Economic Botany. 57: 559-569.

Teshome, A., J. K. Torrance, B. Baum, L. Fahrig, J. D. Lambert and J. T. Arnason. 1999. Traditional farmers' knowledge of sorghum (*Sorghum bicolor* [Poaceae]) landrace storability in Ethiopia. Economic Botany. 53: 69-78.

Tobias, D. and R. Mendelsohn. 1991. Valuing ecotourism in a tropical rain-forest reserve. Ambio. 20: 91-93.

Trainor, C. 2002. A preliminary list of important bird areas in East Timor - interim list of priority sites for biodiversity conservation in Asia's newest country. BirdLife International – Asia Division.

Treyvaud Amiguet, V., J. T. Arnason, P. Maquin, V. Cal, P. Sanchez Vindas and L. Poveda. 2004. A consensus ethnobotany of the Q'eqhi Maya of southern Belize. Economic Botany (accepted).

Trotter, R.T. and M.H., Logan. 1986. Informant consensus: a new approach for identifying potentially effective medicinal plants. Pages 91-112 in N.L. Etkin (ed.), Plants in indigenous medicine and diet. Redgrave Publishing Company, Bedford Hill, New York.

Turner, N. J. 1988. "The importance of a rose": evaluating the cultural significance of plants in Thompson and Lillooet Interior Salish. American Anthropologist. 90: 272-290.

UNTAET. 2000. Regulation 2000/19 on protected places. United Nations Transitional Administration in East Timor.

Valladares, G. R., D. Ferreyra, M. T. Defago, M.C. Carpinella and S. Palacios. 1999. Effects of *Melia azedarach* on *Triatoma infestans*. Fitoterapia. 70: 421-424.

Whistler, A. 2001. Ecological survey and preliminary botanical inventory of the Tutuala beach and Jaco Island Protected Natural Areas, East Timor. A United Nations Transitional Administration in East Timor (UNTAET) paper.

Whistler, W. A. 1985. Traditional and herbal medicine in the Cook Islands. Journal of Ethnopharmacology. 13: 239-280.

Whitmore, T. C. 1975. Tropical rain forests of the far east. Oxford University Press, Great Britain.

World Health Organization. 2000. Turning the tide of malnutrition: responding to the challenge of the 21st century. World Health Organization, Geneva.

World Health Organization. 2003. WHO guidelines on good agricultural and collection practices (GACP) for medicinal plants. World Health Organization, Geneva.

Zwi, A. B. and D. Silove. 2002. Hearing the voices: mental health services in East Timor. The Lancet Supplement. 360: s45-s46.