MOLLUSCAN FAUNA OF THE ORDOVICIAN CHAUMONT FORMATION NEAR BRAESIDE, ONTARIO

A thesis

Presented to the

Department of Geology

University of Ottawa

In partial fulfillment

of the requirements for the Degree

Master of Science

in Geology

by

Miriam Steele

April, 1966

CONTENTS

ABSTRACT

Well preserved, silicified molluscs, abundant in limestones of the Middle Ordovician Chaumont Formation near Braeside, Ontario are here described in detail. There are 9 species of pelecypods, 15 gastropods and 9 cephalopods. Specimens are sufficiently common to permit assessment of morphological variations in several species and the present material suggests that many previously erected species may be conspecific. Fine textured silicification has resulted in perfect replacement of delicate internal and external features. Many of these characteristics, although usually not preserved in coarsely silicified or non-silicified fossils are necessary for accurate generic and specific identification. The following new species are described: Cyrtodonta ripana, Cyrtodonta ? perplexa, Whitella ottawana, Clionychia naba, Trochonema wilsonae, Raphistomina fissurata.

INTRODUCTION

A silicified molluscan fauna from the Chaumont Formation was collected from exposures east of a quarry, two miles west of Braeside, Ontario, on lot 16, Concession A, McNab Township, Renfrew County (fig. 1). Unusual preservation of these fossils affords an excellent opportunity to study and record previously unknown taxonomic details, which contribute to the palaeontology and biostratigraphy of the Ottawa Valley. Many stratigraphic problems in the Middle Ordovician of Eastern Ontario can only be solved by the application of sound palaeontology and biostratigraphy.

The quarry is near the top of a hill which slopes gently toward the Ottawa River to the northeast and toward flat-lying land to the southwest. Pleistocene beach deposits containing abundant pelecypod shells occur on the flanks of the hill and indicate that it was at times an island in the Champlain Sea. Previous to this, glacial ice covered the region but appears to have caused little alteration of the original topography, for flat surfaces of limestone at three levels surrounding the quarry display striations and polishing as the only glacial modifications.

The material was collected from less than 1000 sq. ft. in a section about 2 ft. thick. The rock which is a dark grey limestone containing calcite stringers becomes fragmentary when weathered and is a brown-buff colour on exposed surfaces. All visible fossils were collected from these flat-lying beds which vary from 1/2 inch to 6 inches thick in a very few feet.

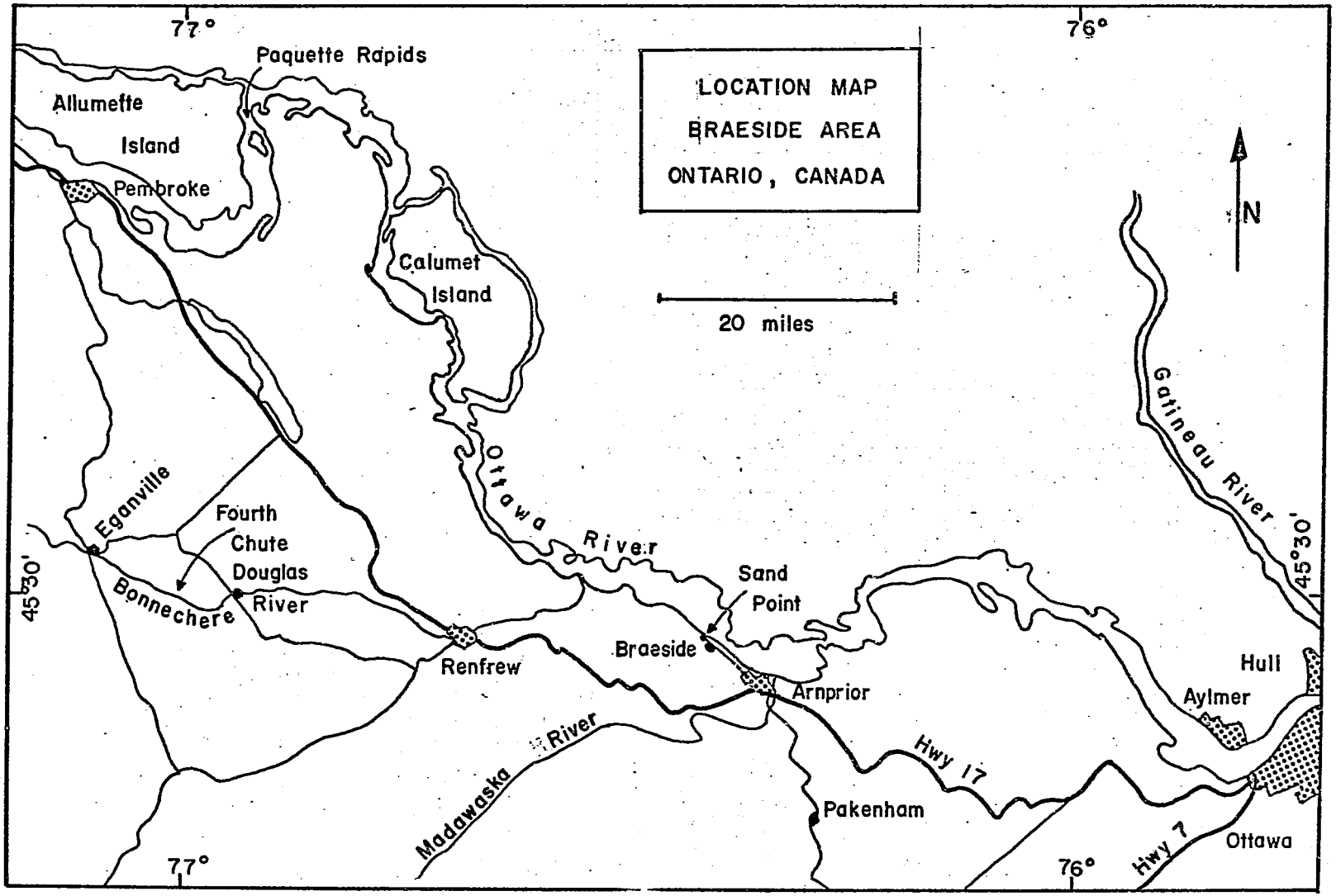

77°
76°
Paquette Rapids
Allumette
Island
Pembroke
LOCATION MAP
BRAESIDE AREA
ONTARIO, CANADA
N
20 miles
Calumet
Island
Gatineau River
Ottawa River
Eganville
Fourth
Chute
Douglas
River
Bonnechere
45°30'
Sand
Point
Braeside
Renfrew
Arnprior
Hull
Aylmer
Madawaska River
Hwy 17
Pakenham
Hwy 7
Ottawa
77°
76°
45°30'

FIGURE 1.

These rocks contain fossils of most invertebrate phyla but beautifully preserved pelecypods and gastropods are most abundant in genera, species and number. Fine textured, selective silicification of shells of both these groups has preserved delicate internal and external features, rarely found on coarsely silicified or non-silicified specimens but most important for accurate generic and specific identifications. As pelecypods and gastropods from the Middle Ordovician of the Ottawa Valley are usually poorly preserved (Wilson, 1951, p. 2, 1956, p. 2), the present fauna contributes valuable information on morphology and growth of several pelecypod and gastropod species. Several species of cephalopods are present but are not as well preserved or as numerous as the other molluscs and add little to existing knowledge. Silicified brachiopods and bryozoa are abundant; corals, although silicified, are poorly preserved and scarce. Echinoderms, trilobites and ostracods are common and well preserved but not silicified.

Stratigraphy

The following remarks on stratigraphical position of the Braeside beds were supplied by G.W. Sinclair (personal communication).

> "The Wilderness stage of the Mohawkian is represented in the Ottawa Valley by four formations which are usually identified with those defined in New York. This identification is at least approximately correct, and may be accepted until a better classification is proposed. These formations are, from bottom to top: Pamelia, Lowville,

Chaumont and Rockland.

The three lower formations are seen in the Braeside outlier, the Pamelia along the road in Sand Point, the Lowville in a small quarry of the golf course grounds, and the Chaumont capping the hill. I have seen no beds in this region which seemed to be Rockland, although further east, near McLaren Landing, Miss Wilson has described a section which goes that high.

The fauna which you have studied from the Braeside quarry is clearly from beds of the Chaumont. Lowville elements are completely lacking, in spite of the lithic similarity of your beds to some which are found in the Lowville. It may be that in the future we will want to subdivide the Chaumont, but until that step is taken your beds should be referred to the Chaumont Formation, and dated as being of middle to late Wilderness age.

These beds have at times been referred to as Leray, or as Leray-Rockland, a usage which I do not feel to be useful. Also, I see no advantage in referring to the Mohawkian as Ottawa."

From Dr. Sinclair's remarks above, the importance of palaeontological studies in the Middle Ordovician is apparent. Solution of facies and biostratigraphic problems follows only when palaeontological analysis comparable to that found in this thesis is achieved at other localities.

Table of Formations of the Ottawa Valley according to G.W. Sinclair (personal communication)

STAGE	FORMATION
RICHMOND	RUSSELL
EDEN-MAYSVILLE	CARLSBAD
	GLOUCESTER
	COLLINGWOOD
	UN-NAMED "UPPER COBOURG"
BARNEVELD	"COBOURG"
	SHERMAN FALL
	HULL
WILDERNESS	ROCKLAND
	CHAUMONT
	LOWVILLE
	PAMELIA
CHAZY "SENSU LATO"	
BEEKMANTOWN "SENSU LATO"	

At present this table is unpublished but it will appear soon in a Bulletin of the Geological Survey of Canada in which the complete fauna from Braeside is to be described.

The Braeside fauna is similar to those from other localities in the Ottawa Valley. In 1845 Sir William E. Logan collected fossils from limestones at Paquette Rapids (fig. 1). He submitted these to J.W. Salter of the Geological Survey of the United Kingdom who described the fauna in 1859.

The following molluscs collected by Logan at Paquette Rapids are also found at Braeside:

Pelecypoda	Ctenodonta nasuta (Hall) sensu Salter
	Tancrediopsis contracta (Salter)
Gastropoda	Helicotoma planulata Salter
	Lophospira serrulata (Salter)
	Hormotoma salteri canadensis Ulrich and Scofield
	Raphistomina
	Trochonema
Cephalopoda	Loganoceras regulare (Billings)

Elkanah Billings (1853) described Chaumont fossils from limestones at Paquette Rapids and the Fourth Chute of the Bonnechere River (fig. 1). Vanuxemia inconstans Billings, a very common species at Braeside, was here first studied from Fourth Chute. Several species of Cyrtodonta were reported from both Paquette Rapids and Fourth Chute but only one species has been discovered at Braeside. Other species of mollusca originally described by Billings from Paquette Rapids are also found at Braeside. They are Monomuchites decrescens (Billings) 1857, Loganoceras regulare (Billings) 1857, and Tancrediopsis abrupta (Billings) 1862.

The Braeside fauna is similar to those from other localities in the Ottawa Valley. In 1845 Sir William E. Logan collected fossils from limestones at Paquette Rapids (fig. 1). He submitted these to J.W. Salter of the Geological Survey of the United Kingdom who described the fauna in 1859.

The following molluscs collected by Logan at Paquette Rapids are also found at Braeside:

Pelecypoda	Ctenodonta nasuta (Hall) sensu Salter
	Tancrediopsis contracta (Salter)
Gastropoda	Helicotoma planulata Salter
	Lophospira serrulata (Salter)
	Hormotoma salteri canadensis Ulrich and Scofield
	Raphistomina
	Trochonema
Cephalopoda	Loganoceras regulare (Billings)

Elkanah Billings (1853) described Chaumont fossils from limestones at Paquette Rapids and the Fourth Chute of the Bonnechere River (fig. 1). Vanuxemia inconstans Billings, a very common species at Braeside, was here first studied from Fourth Chute. Several species of Cyrtodonta were reported from both Paquette Rapids and Fourth Chute but only one species has been discovered at Braeside. Other species of mollusca originally described by Billings from Paquette Rapids are also found at Braeside. They are Monomuchites decrescens (Billings) 1857, Loganoceras regulare (Billings) 1857, and Tancrediopsis abrupta (Billings) 1862.

Alice E. Wilson mapped the geology of the St. Lawrence Lowland and published several papers on the Palaeozoic faunas of that region. Fossils from Braeside, 25 miles west of this map-area, were not studied. However, Wilson did include fossils previously collected by Logan and Billings from Paquette Rapids and Fourth Chute, also west of her map-area.

Acknowledgements

I am deeply indebted to Dr. G.W. Sinclair of the Geological Survey of Canada for indicating the problem and supplying the Braeside material and for untiring guidance and advice throughout the project.

I wish to thank Professor D.L. Dineley of the Department of Geology, University of Ottawa, for advice and critical reading of the manuscript. Thanks are also extended to other members of the staff at the University of Ottawa who critically read the dissertation. I am grateful to Catherine M. Hunt for assistance in drafting the necessary text figures and to Dr. D.J. McLaren of the Geological Survey of Canada for the loan and instruction in the use of Polaroid equipment.

Office and laboratory facilities were made available by the Geological Survey of Canada and the material described in this thesis is the property of the Geological Survey. Access to the Canadian type collections enabled more accurate specific comparisons than might otherwise have been obtained from published information.

Methods of Study

About 500 pounds of rock were processed in 2000 ml. glass beakers containing 10-15% formic acid. Periodically the liquid and clay-sized particles were decanted; residual mud was washed from the specimens and fresh water and acid were added. Once effervescence had ceased the insoluble material was washed and placed in cardboard trays to dry. Because dried silicified specimens are very fragile and crumble when handled, the fossils were impregnated with alvar, thus strengthening the shell for normal handling.

Unetched cephalopod specimens were sawed through the centres in a dorsal-ventral direction and internal surfaces were polished.

For photographing, specimens were coated lightly with ammonium chloride. The fossils were held in plasticine, illuminated from the upper left and lower right directions and photographed from above.

SYSTEMATIC PALAEONTOLOGY

PELECYPODA

Cyrtodonta ripana n. sp.

Plate I, figures 1-8

Plate II, figures 1-5

Material

7 specimens with both valves, three attached, four separated; 18 left valves, 19 right valves.

Holotype: P 1 (Pl. I, figures 1-4); both valves separated.

Paratypes: P 2 - P 15:

Both valves: P 2 (Pl. I, figures 5-8), P 7 (Pl. II, figure 3), P 9, P 15: P 2, P 15 separated; P 7, P 9 attached.

Left valves: P 3, P 6, P 10 (Pl. II, figure 4), P 11 (Pl. II, figure 5), P 13, P 14: P 13 small left valve.

Right valves: P 4 (Pl. II, figure 1), P 5, P 8 (Pl. II, figure 2), P 12, P 15: P 8 with bryozoa adhering to the exterior surface.

Diagnosis

Cyrtodonta with moderately thick shell. Moderately tumid with a weak umbonal ridge. Hinge line straight. 2-4 anterior lateral teeth; 2 or 3 posterior lateral teeth.

Description of Holotype

Exterior

Holotype relatively tumid, obliquely subquadrate to elliptical. Anterior margin forming a 47° angle with the hinge line; posterior

margin forming a 123° angle with the hinge line. Individual shells relatively thick. Hinge line straight with a narrow external ligamental area behind the beak; no lunule or escutcheon present. Beak incurved, small but prominent; situated close to the anterior end. Umbo broadly rounded; umbonal ridge weak, extending obliquely toward the posterior ventral margin. Surface of the shell sloping steeply from the umbonal ridge to the anterior margin; sloping more gently to the posterior margin. Ventral margin broadly rounded; anterior margin straight; sinus absent. Growth lines concentric about the umbo; meeting in front of the beak, closely spaced posteriorly, more widely separated along the diagonal.

Hinge and diagonal lengths of Holotype at different periods of growth as seen from the growth lines (fig. 1):

Length of hinge line in mm	Length of diagonal in mm
17	24
19	29
21	34

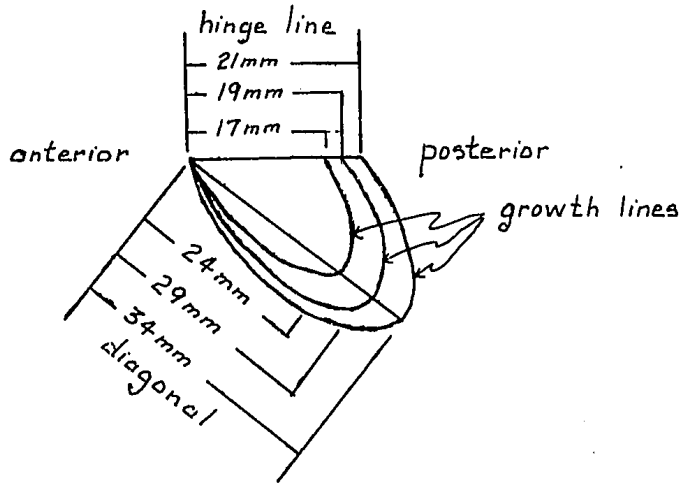


Figure 3

Diagrammatic illustration of growth of Holotype P 1

Interior

Hinge plate yoke-shaped, narrow in the centre and expanded at each end. Anterior lateral teeth on the hinge plate, immediately beneath and in front of the beak; three in each valve, moderate size, nearly straight and sub-parallel to the hinge line. Posterior lateral teeth at the posterior extremity of the hinge plate; nearly straight and oblique to the hinge line. Anterior adductor scar distinct, subcircular; situated beneath the anterior lateral teeth on the floor of the valve. Posterior adductor scar larger than the anterior adductor scar; very faint; situated behind the posterior lateral teeth on the floor of the valve.

Species Variations

Anterior margin of the shell often possesses a sinus, either slight or pronounced, midway between the dorsal and ventral margins.

Pronounced sinus - Paratype P 2 (Pl. I, figures 5, 6)

Weaker sinus - Paratypes P 10 and P 11

Thickness of the shell varies slightly.

Paratypes P 2 (Pl. I, figures 5-8) and P 10 (Pl. II, figure 4) - shells slightly thicker than the holotype

Size, shape and number of the anterior lateral teeth vary with each individual.

Paratype P 2 (Pl. I, figures 5, 6) - three moderately large, curved teeth; anterior portion of each tooth sub-parallel to the hinge line and the posterior

portion oblique to the hinge line.

Paratype P 11 (Pl. II, figure 5) - four moderately small, slightly curved teeth situated oblique to the hinge line.

Paratype P 10 (Pl. II, figure 4) - two anterior teeth of moderate size and a large socket.

Paratypes P 5 and P 14 have a faint narrow depression on the inside of the shell under the umbonal ridge.

Many shells have a depression, about the width of the muscle scar, parallel to the anterior margin of the shell. The depression, either prominent or obscure extends from the muscle scar to the middle of the shell.

Prominent depression - Paratypes P 2, (Pl. I, figures 5, 6) P 8, P 10, P 12, P 15

Weak depression - Paratypes P 5, P 14

Measurements:

Specimen	Anterior angle in degrees	Posterior angle in degrees	Length of hinge line in mm	Length of diagonal in mm	Greatest length parallel to hinge line in mm	Width in mm
Holotype Pl:	47	123	21	34	31	13
Paratypes P2:	57	?	21	33	27	12
P3:	50	127	21	37	32	13
P4:	64	133	20	36	32	12
52:	52	?	20	35	?	11
P6:	50	?	21	37	?	?
P7:	49	128	19	32	28	11
P8:	63	130	20	34	29	12
P9:	50	125	20	34	30	13
P10:	57	121	22	38	35	12
P11:	51	117	20	34	30	11
P12:	62	135	19	32	29	12
P13:	56	118	16	22	21	9
P14:	46	?	19	35	30	11
P15:	55	?	22	36	?	12

Discussion

Length of hinge line, length of diagonal and width are relatively constant for all specimens. Anterior and posterior angles vary nearly 20°. In figure 4 (hinge line in mm vs diagonal in mm) all points but one are concentrated in a small area. This indicates a mature population with one juvenile specimen. In figure 5 (anterior angle in degrees vs hinge line in mm X diagonal in mm) the resulting vertical line suggests that the anterior angle is an independent variable. Spacing of the growth lines show that maximum growth occurs along the diagonal and that small additions to the hinge line occur at its posterior end (figure 3). The anterior and posterior angles increase with age, but the resulting angle size (as seen from figure 5) is independent of the size of the shell (figure 5).

Several specimens have encrusting bryozoans attached to the outer surface (Pl. II, figure 2). Bryozoan stems grow from the encrusting forms. Several specimens have branching tubes, possibly worm tubes attached to the inner surface of the shell.

Discussion of Species of *Cyrtodonta* Previously Recorded from the Ottawa Area

From Leray - Rockland Beds at Paquette Rapids in the Ottawa River

Cyrtodonta rugosa Billings: (Billings, 1858, p. 432). Designated as genotype by Wilson (1956, p. 29). Holotype and two paratypes. The present species compared with *C. rugosa* is

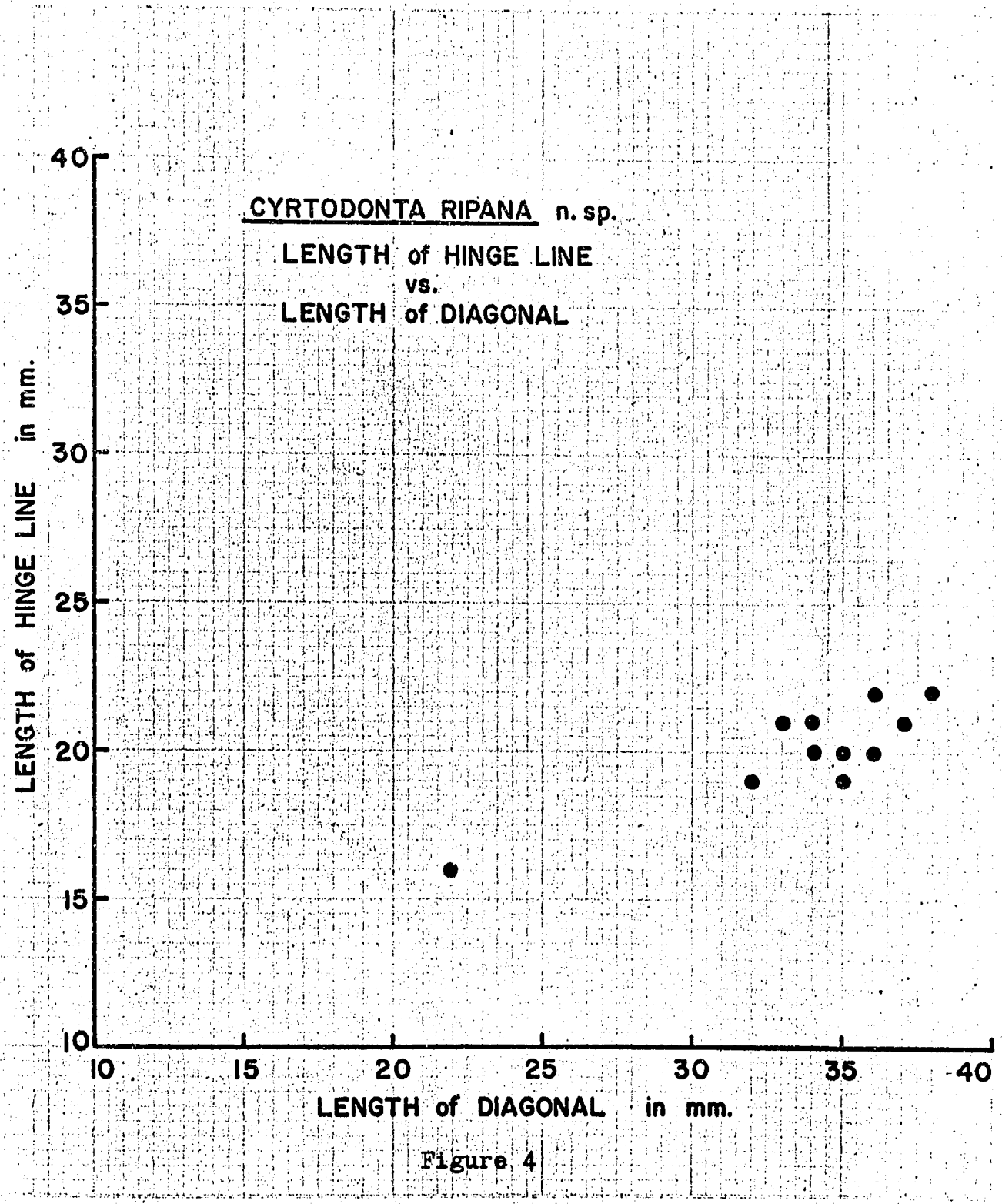

CYRTODONTA RIPANA n. sp.
LENGTH of HINGE LINE
vs.
LENGTH of DIAGONAL
LENGTH of HINGE LINE in mm.
40
35
30
25
20
15
10
10
15
20
25
30
35
40
LENGTH of DIAGONAL in mm.

Figure 4

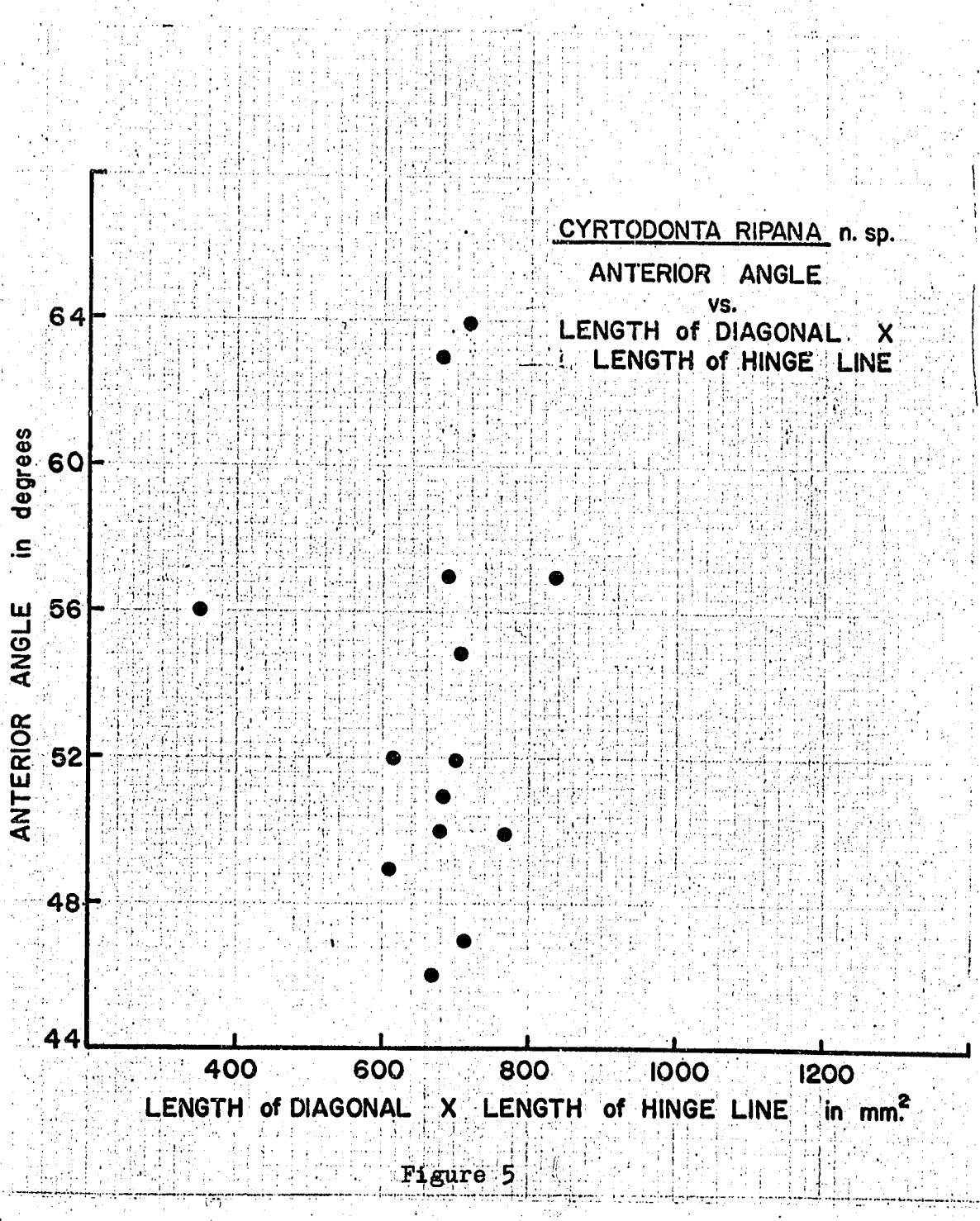

CYRTODONTA RIPANA n. sp.
ANTERIOR ANGLE
vs.
LENGTH of DIAGONAL X
LENGTH of HINGE LINE
ANTERIOR ANGLE in degrees
64
60
56
52
48
44
400
600
800
1000
1200
LENGTH of DIAGONAL X LENGTH of HINGE LINE in mm.²

Figure 5

larger, more elliptical, more tumid, and has a beak that is situated closer to the anterior end.

C. canadensis Billings: (Billings, 1858, p. 434). The holotype is a large silicified specimen lacking all of the hinge line, beak and most of the posterior periphery. The paratype is a fragment showing the beak, anterior teeth and part of the hinge line. The present species compared with C. canadensis is is smaller, has more prominent, anterior teeth, steeper sloping anterior, and beak situated closer to the anterior end.

C. angusta Wilson: (Wilson, 1956, p. 31). Holotype and paratype are separated valves of one specimen. The present species compared with C. angusta is larger and has larger anterior teeth.

C. affinis minuta Wilson: (Wilson, 1956, p. 31). The holotype and paratype are silicified specimens showing only external surfaces. The present species is larger than C. affinis minuta.

C. simplex Wilson: (Wilson, 1956, p. 41). Holotype and two paratypes. The present species compared with C. simplex is larger, more tumid, has larger anterior and posterior teeth, and beak situated closer to the anterior end.

C. obtusa (Hall): (Billings, 1858, p. 436). Hypotypes belong to the genus Vanuxemia.

C. spinifera Billings: (Billings, 1858, p. 435). Holotype and paratypes belong to the genus Vanuxemia.

The genus Vanuxemia compared with Cyrtodonta usually has a more prominent beak situated closer to the anterior end. The anterior adductor scar in Vanuxemia is carved out of the hinge plate; in Cyrtodonta it is situated on the floor of the valve (Ulrich, 1894, p. 550). C. spinifera Billings and C. obtusa (Hall) sensu Billings appear to have characteristics intermediate between the genus Cyrtodonta and the genus Vanuxemia. Because the anterior adductor scars are carved out of the hinge plate, C. spinifera Billings and C. obtusa (Hall) sensu Billings are here assigned to the genus Vanuxemia. However, the shells are moderately thin and the beaks are less prominent and situated closer to the anterior end than is usual with mature specimens of the genus Vanuxemia. Immature specimens of Vanuxemia from Braeside, although smaller than C. spinifera and C. obtusa, also have these characteristics. Billings thought that the specimens from Paquette Rapids were conspecific with Ambonychia obtusa Hall and that all belonged to the genus Cyrtodonta. The species A. obtusa Hall is based on a steinkern (Hall, 1847, p. 167) and since comparison with steinkerns is difficult, it is possible that the fossils from Paquette Rapids are not the same species as A. obtusa Hall.

Present material from Braeside indicates that considerable variation is possible within one species. It is therefore possible

that more abundant material from Paquette Rapids might suggest an amalgamation of all or several of the species of Cyrtodonta recorded from that locality.

From Areas Other than Paquette Rapids

Many species of Cyrtodonta from the Ottawa area have been based on specimens showing only external features, but, because several genera appear similar externally, positive generic identification cannot be made on this basis. The material from Bracside indicates that considerable variation is present within one species. Specific comparison between specimens from different areas is therefore difficult unless assemblages showing variations within the species are present.

The following species, based on type specimens showing only external features, are much smaller than the species from Bracside: C. affinis Ulrich sensu Wilson, C. breviscula Billings, C? planumbona Wilson, C.? pudica Wilson, C. rocklandensis Wilson, C.? subquadrata Wilson, C. affinis and C.? pudica from Lowville beds on Merivale Road, Ottawa, both appear wide with respect to diagonal length and are possibly the same species. Compared with the specimens from Bracside C. subcarinata Billings is narrower and has an umbonal ridge that is more angular; C. mediocris Wilson is larger; C. glabella (Ulrich) sensu Wilson and C. oviformis Ulrich sensu Wilson are wider. C. modesta Wilson appears similar externally but since internal structure is not seen and variations are unknown specific comparison is impossible. C. mediocris, C. glabella, C. oviformis and C. modesta, from Mechanicsville near Ottawa may all be conspecific.

Material is too poor to permit comparison with Ulrich's species and the following occurrences from the Ottawa area are questionable: C. affinis Ulrich, C. glabella (Ulrich), C. oviformis Ulrich. A partially visible hinge line on C. oviformis positively assigns this species to the genus Cyrtodonta but definite generic affinities of the other 10 specimens are unknown.

These species of Cyrtodonta from areas other than Paquette Rapids have been based on single specimens usually showing only poorly preserved external surfaces. This is poor material on which to base new species, for comparisons with other specimens, particularly from different areas, are difficult.

Cyrtodonta ? perplexa n. sp.

Plate II, figures 6-9

Material

One specimen, Holotype P 16. Both valves separated; lower anterior side of left valve missing; anterior margin of right valve poorly preserved.

Diagnosis

Species similar to Cyrtodonta ripana n. sp. but with a larger, thicker shell, coarser teeth, an escutcheon, more deeply excavated muscle scar.

Description

Exterior

Shell relatively tumid with a sub-elliptical outline.

Anterior margin forming a 60° angle with the hinge line; posterior margin forming a 125° angle with the hinge line. Shell of each valve very thick. Hinge line straight behind the beak but curving above the anterior lateral teeth immediately beneath and in front of the beak. Cardinal area with a narrow escutcheon but no lunule. Ligament external; situated behind the beak. Beak incurved, small but prominent; situated close to the anterior end. Umbo broadly rounded; umbonal ridge weak. Surface of the shell sloping steeply from the umbonal ridge to the anterior margin; sloping gently to the posterior margin. Ventral margin broadly rounded. Posterior margin with an indentation immediately beneath the posterior teeth. Growth lines concentric about the umbo; strong near the margin but weaker on older parts of the shell.

Measurements:

length of hinge line - 24 mm
length of diagonal - 43 mm
greatest length parallel to hinge line - 30+mm
anterior angle - 60°
posterior angle - 125°

Interior

Hinge plate yoke-shaped, narrow in the centre and expanded at each end; dorsal margin straight along the hinge line and ventral margin arched. Anterior lateral teeth very coarse, straight and oblique to the hinge line; situated on the hinge plate immediately beneath the beak. Right valve with three simple teeth, two large

tooth anterior to a small tooth. Left valve with two large teeth. Posterior tooth of the left valve wide, containing a "V"-shaped indentation, occupied by the small tooth of the right valve when valves closed. Front tooth of the left valve with an excavation on the anterior side, occupied by the front tooth of the right valve when valves closed. Posterior lateral teeth very coarse, four in each valve; situated oblique to the hinge line at the posterior end of the hinge plate. Floor of the valve with a prominent depression about the width of the muscle scar; extending parallel to the anterior margin of the shell from the muscle scar to the middle of the shell. Low ridge about 8 mm wide, adjacent to the inner boundary of the depression, extending from beneath the umbo to the middle of the shell.

Discussion

This specimen, although closely related to Cyrtodonta, is questionably assigned to that genus. Compared with Cyrtodonta it has a larger, thicker shell, coarser teeth, escutcheon, and more deeply excavated anterior muscle scar. Because these may be features emphasized by old age or disease, a new genus, although strongly suggested, should not be erected on the basis of one specimen.

Vanuxemia inconstans Billings

Plate III, figures 1-14

1858 Vanuxemia inconstans BILLINGS? p. 438, fig. 15, 16.

1956 Vanuxemia inconstans Billings, WILSON, p. 46, pl. VI, fig. 3-5.

Material

27 right valves, 14 left valves; specimens well preserved, various sizes. Hypotypes: P 17 - P 35:

Right valves: P 17 (Pl. III, fig. 1, 2), P 18 (Pl. III, fig. 3, 4), P 19 (Pl. III, fig. 5, 6), P 21 (Pl. III, fig. 8-10), P 23 (Pl. III, fig. 13), P 24 (Pl. III, fig. 14), P 26, P 27, P 30, P 31, P 32, P 33, P 34, P 35.

P 17, P 18, P 19: small right valves.

P 24: bryozoa adhering to exterior surface.

Left valves: P 20 (Pl. III, fig. 7), P 22 (Pl. III, fig. 11, 12), P 25, P 28, P 29.

Description

Exterior

Shell tumid. Large specimens sub-ovate with the shell gradually expanding from the umbo to the ventral margin (Pl. III, fig. 9, 12); small specimens more circular (Pl. III, fig. 1-6). Shell of all specimens thick. Beak prominent and incurved; in large specimens situated above the anterior end of the hinge plate (Pl. III, fig. 8, 11, 13) but in smaller specimens situated slightly behind the anterior end (Pl. III, fig. 2, 3). Umbo broadly rounded. Hinge line straight or gently curved; in some specimens curving slightly over the anterior teeth (Pl. III, fig. 8). Cardinal area gently arched; no lunule or escutcheon present. Ligamental area externally situated behind the beak; sometimes having faint longitudinal striations (Pl. III, fig. 8, 13). Posterior and ventral margins

broadly rounded. Anterior region of small specimens broadly rounded or projecting forward beyond the hinge line (Pl. III, fig. 2, 3); curvature and prominence of this area decreasing with size of the specimens. Immediately beneath the beak of large specimens anterior margin forming a depression into which the hinge plate projects as a small anterior ear (Pl. III, fig. 10). Ornamentation limited to strong concentric growth lines.

Measurements

Hypotypes	Length of hinge line in mm	Length of diagonal in mm
P 17	8	13
P 19	11	20
P 20	17	28
P 21	19	30
P 22	19	30
P 23	24?	37
P 24	19	29
P 25	16	28
P 26	21	31
P 28	22	35
P 29	17	29
P 30	18	28
P 31	13	22
P 32	10?	17
P 33	17	27
P 34	22	32
P 35	15	25

Interior

Hinge plate yoke-shaped, narrow in the centre and expanded at each end; dorsal margin straight along the hinge line and ventral margin arched. Anterior teeth two to four in number, elongate, slightly curved and often striated (Pl. III, fig. 7, 8, 13); situated above the anterior muscle scar, at the anterior end of the hinge plate.

Two or three posterior teeth situated oblique to the hinge line at the posterior end of the hinge plate; elongate, straight or very slightly curved but seldom striated. Anterior adductor impression circular and strong; in large specimens embedded in the hinge plate (Pl. III, fig. 7, 8, 11, 13) but in smaller specimens partially or wholly on the floor of the valve (Pl. III, fig. 2, 3, 5). Posterior adductor impression faint or absent; circular to elliptical and situated on the floor of the valve beneath the posterior end of the teeth. Pallial line not seen.

Discussion

This species is highly variable. Figure 6 showing a linear relation between the length of the hinge line and the diagonal suggests a life assemblage with mature and immature individuals. Young specimens are circular with submarginal beaks and mature specimens are ovate with marginal beaks. This suggests that the umbonal and lower posterior regions grow more quickly than other areas of the shell. Circular, immature specimens with submarginal beaks and muscle scars partially or wholly on the floor of the shell resemble the genus Cyrtodonta. However, the anterior surface of a young Cyrtodonta slopes at a constant angle from the umbonal ridge to the margin of the shell. The inner anterior surface near the margin of a young Vanuxemia turns out slightly and as size increases the hinge plate appears to expand into this area and incorporate the anterior adductor impression.

Several specimens have encrusting bryozoa attached to the outer surface of the shell (Pl. III, fig. 14). Bryozoan stems grow

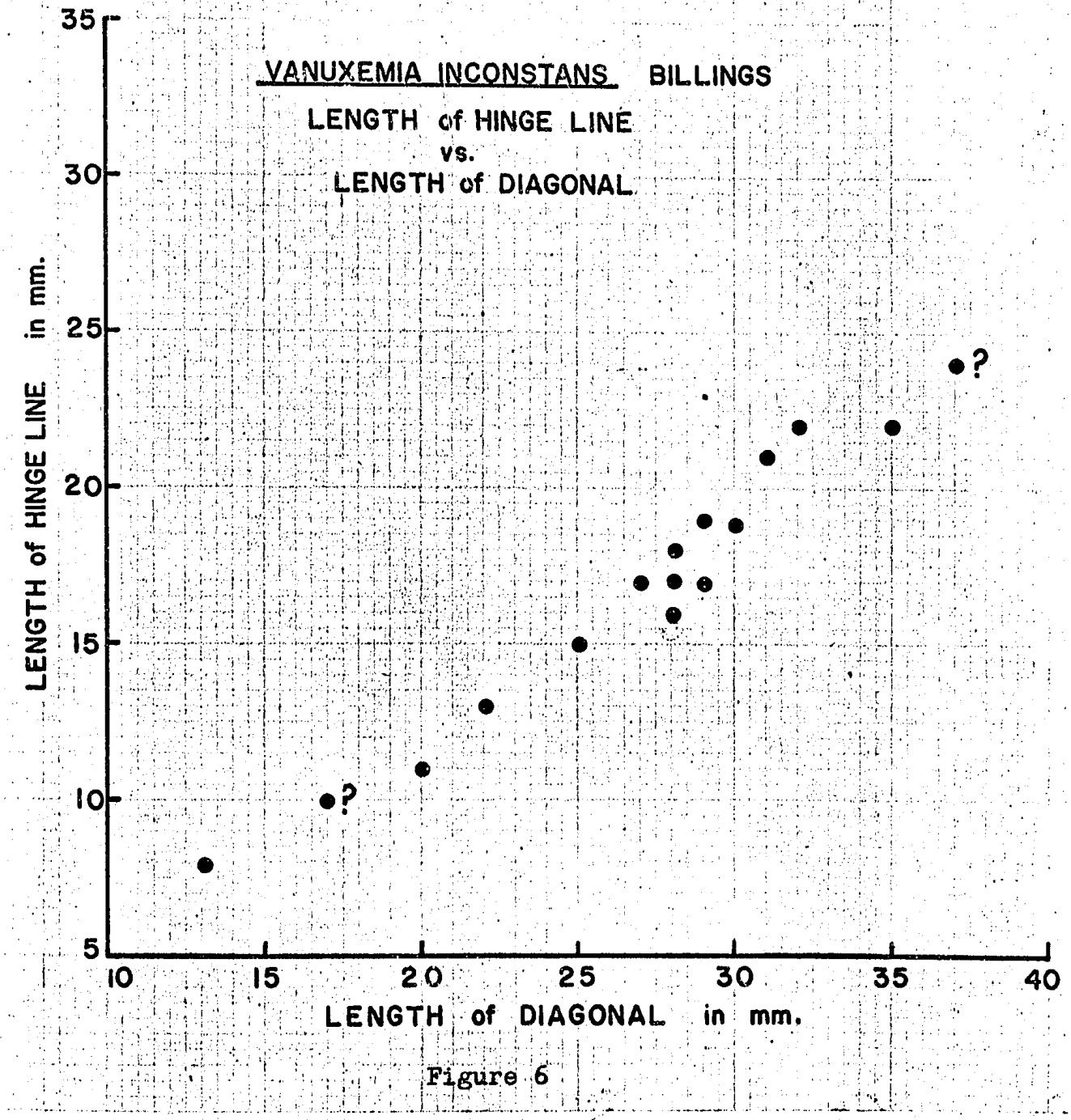

VANUXEMIA INCONSTANS BILLINGS
LENGTH of HINGE LINE
vs.
LENGTH of DIAGONAL
LENGTH of HINGE LINE in mm.
35
30
25
20
15
10
5
?
?
10
15
20
25
30
35
40
LENGTH of DIAGONAL in mm.

Figure 6

from the encrusting forms. Several specimens have branching tubes, possibly worm tubes attached to the inner surface of the shell.

Discussion of Species of Vanuxemia Previously Recorded from the Ottawa Area

V. inconstans Billings: (Billings, 1858, p. 438). Genotype. Syntypes from Leray-Rockland beds at Fourth Chute, Bonnechere River. Specimens incomplete showing poorly preserved hinge plate but no interior. Mature specimens from Bracside appear similar to V. inconstans.

V. phascola Wilson: (Wilson, 1956, p. 48). Holotype and paratype silicified specimens from Leray-Rockland beds at Paquette Rapids in the Ottawa River. Paratype too poorly preserved for generic identification. Holotype medium size with beak situated behind the anterior margin, similar to juvenile forms of Vanuxemia from Bracside. Until further study this name should be retained as a separate species.

Several species of Vanuxemia from the Ottawa area have been based on steinkerns or specimens showing only poorly preserved external surfaces. Because comparison with other shells is difficult steinkerns are poor material on which to base new species. However, specific comparison with other steinkerns may be possible on size, shape and horizon where found . Several genera appear similar externally, so positive generic identification cannot be made solely on the basis of external features.

The following species based on steinkerns are recorded from the Ottawa area: V. canadensis Wilson, V. parvula Whitcaves, V. skeadensis Wilson, V. subercata Ulrich sensu Wilson. Species based on specimens showing only poorly preserved external surfaces are: V. ampla (Ulrich) sensu Wilson, V. rotundata (Hall) sensu Wilson, V. tutrix Wilson. Material is too poor to permit comparison with species of Hall and Ulrich and the following occurrences from the Ottawa region are questionable: V. rotundata (Hall), Cyrtodonta ampla Ulrich, V. subercata Ulrich.

Whitella ottawana n. sp.

Plate IV, figures 3-6

Material

One specimen, Holotype P 36. Both valves, separated; cardinal area and umbonal region of the right valve and lower anterior region of the left valve missing.

Diagnosis

Whitella obliquely subquadrate and tumid; with a thin shell, anteriorly situated beak, wide escutcheon, steeply sloping surface from the umbonal ridge to the anterior margin, pronounced anterior sinus, small anterior teeth, no posterior teeth.

Description

Exterior

Shell obliquely subquadrate and tumid. Anterior margin forming a 60° angle with the hinge line; posterior margin forming a

125° angle with the hinge line. Shell of each valve thin. Hinge line straight; cardinal area with a wide escutcheon but no lunule. Beak incurved, small but prominent; situated very close to the anterior end of the hinge line. Umbo tumid; umbonal ridge broadly rounded, extending toward the ventral margin of the shell. Surface of the shell sloping steeply from the umbonal ridge to the anterior margin and sloping gently to the posterior margin. Ventral margin broadly rounded; anterior and posterior margins almost parallel and nearly straight, although anterior margin with a pronounced sinus a little above midway between the dorsal and ventral margins of the shell. Growth lines strong, concentric about the umbo; meeting in front of the beak, closely spaced posteriorly and more widely separated along the diagonal.

Measurements:

length of hinge line - 24 mm

length of diagonal - 43 mm

greatest length parallel to hinge line - 30 mm

anterior angle - 60°

posterior angle - 125°

Interior

Hinge plate very narrow except for a slight expanded area in front of the beak. Two very small anterior teeth in each valve situated on the expanded region of the hinge plate. Internal surface with a faint ridge at the posterior end of the hinge line; ridge adjacent to a slight internal depression in the posterior upper

corner of the shell; oblique to the hinge line and meeting it about two-thirds the distance from the anterior margin. Anterior adductor scar distinct and circular; situated in front of the teeth on the floor of the valve. Inner edge of the scar partially outlined by a slight ridge extending from beneath the hinge plate. Posterior adductor scar faint; situated on the floor of the valve at the posterior end of the hinge line. Pallial line visible beneath the anterior adductor scar of the right valve.

Discussion

This specimen with its thin shell, escutcheon, small anterior teeth and no posterior teeth appears to belong to the genus Whitella. As in Whitella an internal and external ligament is present; the internal part occurring along the posterior third of the hinge line, occupying the small internal depression and supported by the adjacent ridge. The present species compared with previously described species of Whitella has the beak closer to the anterior end. The external shape is similar to Cyrtodonta but has a steeper sloping anterior surface and a more pronounced sinus in the anterior margin.

Clionychia naba n. sp.

Plate V, figures 1-4

Material

One incomplete left valve, Holotype P 37; fragments of the beak region of 6 other specimens.

Diagnosis

Clionychia obliquely subquadrangular and tumid. Longer with respect to height and larger than other recorded species.

Description of Holotype

Exterior

Shell obliquely subquadrangular and tumid. Posterior margin broadly rounded; ventral margin not preserved; anterior margin broadly rounded with a distinct indentation immediately beneath the beak (Pl. V, fig. 3). Shell thin. Hinge line straight. Beak prominent; aligned with the hinge line at the anterior end of the shell. Umbo broadly rounded. Umbonal ridge wide but poorly defined; extending obliquely toward the posterior ventral extremity. Surface of the shell sloping steeply from the umbonal ridge to the anterior margin; more steeply sloping near the hinge line than near the ventral margin. Growth lines present near the margin of the shell; constricted beneath the beak (Pl. V, fig. 4) and more separated ventrally.

Measurements:

length of diagonal - 57 mm

greatest length parallel to the hinge line - about 50 mm

greatest height - about 35 mm

Interior

Hinge plate edentulous at the anterior end, missing at the posterior end; 3 mm wide at a point 35 mm behind the beak, becoming narrower toward the anterior end and disappearing at the beak

(Pl. V, fig. 3). Area behind the beak hollowed into an elongate depression (Pl. V, fig. 1, 3) with growth lines projecting forward in the depression and curving back slightly beneath the beak (Pl. V, fig. 3). Floor of the valve very poorly preserved.

Discussion

Good specimens of Clionychia are rare because the shell is very thin and seldom preserved. Much of the former work: Hall (1861), Whitfield (1895), Ulrich (1894), Wilson (1956) was therefore based on steinkerns. The present specimen, is longer with respect to height and larger than any previously recorded.

Discussion of Species of Clionychia Previously Recorded from the Ottawa Area

C.? ottawaensis Whiteaves, C.? gibbosa Whiteaves, C. subundata Ulrich sensu Wilson are smaller than the species from Braeside. C. subundata Ulrich sensu Wilson, from Paquette Rapids, is a silicified specimen with the entire margin including the hinge line missing. Synonomy with Ulrich's species is questionable for the outline of the Ottawa specimen is not as oblique as that of the holotype. C. undata (Emmons) sensu Wilson is a poorly preserved steinkern of the anterior region of a specimen from Leray beds, Gloucester Township. As it is larger than the holotype therefore, synonomy with Emmons' species is questionable. This specimen is about the same size as the Braeside specimen and from about the same horizon, and is possibly a steinkern of that species. Wilson (1956, Pl. VIII, fig. 14) also figured a similar, poorly preserved

steinkern from Leray beds at Val Tetreau as Ambonychia amygdalina Hall.

Modiolopsis ? sp.

Plate V, figures 5, 6

Material

Two incomplete specimens; one right valve, one left valve.

Hypotypes: P 38 (Pl. V, fig. 5, 6) left valve; P 39 right valve.

Description

Exterior

Shell slightly tumid; outline subovate with posterior end larger than the anterior end. Beak small, incurved, near the anterior end of the hinge line. Umbo small. Umbonal ridge missing on the left valve; on the right valve broadly rounded and extending obliquely toward the ventral posterior extremity of the shell. Hinge line straight behind the beak, but curving over the anterior lateral teeth immediately in front of the beak. Ligamental area narrow and external; occupying the cardinal area behind the beak. Anterior angle sharply rounded; ventral anterior edge straight, forming 33° angle with the hinge line. Posterior margin broadly rounded. Ornamentation limited to faint concentric growth lines.

Measurements:

Specimen	length of diagonal in mm	length of hinge line in mm	anterior angle in degrees[a]
P 38	38	23	33
P 39	29	?	32

Interior

Hinge plate thin with one indistinct tooth and socket immediately in front of the beak. Left valve with two well defined posterior lateral teeth at the posterior end of the hinge plate; tooth most dorsal in position appearing as an extension of the hinge plate and the ventral tooth extending from under the hinge plate. Posterior region of hinge plate of right valve partially missing but presence of posterior lateral teeth suggested. Anterior muscle scar not preserved in the left valve. In the right valve circular in shape although indistinct; situated near the anterior margin on the floor of the valve, beneath the anterior lateral teeth. Posterior adductor scar not seen.

Discussion

These specimens most closely resemble the genus Modiolopsis Hall (emend. Ulrich, 1924) but differ in the possession of posterior lateral teeth. Ulrich (1924, p. 187) described the genus as having only "a single undefined subrostral tooth and socket in each valve". Orthodesma, Modiodesma and Whitcavesia are similar in appearance but edentulous. Orthodesma also differs in having the dorsal and ventral sides of the valve nearly parallel, Modiodesma in having a ligament that is internal and external, Whitcavesia in having a large umbone.

Present specimens may represent a new genus but material is insufficient and preservation too poor for the definition of such.

Ctenodonta nasuta (Hall) (sensu Salter)

Plate IV, figures 1, 2

1847 Tellinomya nasuta HALL, p. 152, Pl. XXXIV, fig. 3a-c.

1856 Tellinomya nasuta HALL, p. 392, fig. 1-3.

1859 Ctenodonta nasuta (Hall), SALTER, P. 35, Pl. 8, fig. 1, 2.

1863 Ctenodonta nasuta (Hall), BILLINGS, p. 176, fig. 166.

1894 Ctenodonta nasuta (Hall), ULRICH p. 584, Pl. XLII, fig. 30.

1956 Ctenodonta nasuta (Hall), WILSON, p. 26, Pl. II, fig. 19, 20.

Material

Four moderately preserved specimens; 3 left valves, one right valve. Hypotype P 40; left valve, some of lateral region missing.

Diagnosis

Large Ctenodonta with an elongate shell, narrow posterior, subcentral beak, slightly arcuate hinge line, continuous series of teeth along the hinge plate.

Description

See Wilson (1956, p. 26). Wilson here describes the teeth as "straight and vertical at the outer ends, but becoming oblique toward the beak with tops directed outward". Teeth of present specimens are convexly curved outward near the outer ends, straight and oblique with tops directed outward near the beak, straight and vertical beneath the beak. Hypotype P 40 has a strongly impressed elongate scar in the underside of the hinge plate beyond the outer posterior teeth. Strong impressions are present in front of the

anterior teeth but preservation makes the shape indeterminable.

Discussion

Hall (1847, p. 153) based the genus Tellinomya on internal and external casts of T. nasuta from the Trenton of Middleville N.Y. In 1851 Salter proposed the name Ctenodonta for specimens having a hinge line with a "double series of bent teeth, connected by smaller ones beneath the beak" (see Salter, 1859, p. 34). Salter rejected the name Tellinomya as a synonym of Ctenodonta since Hall's specimens show no characteristics of the hinge and teeth. However, he accepted Hall's specific name nasuta, naming specimens from Paquette Rapids C. nasuta (Hall). Ulrich (1894, p. 518) considered Tellinomya and Ctenodonta to be congeneric. He rejected the preoccupied name Tellinomya in favour of Ctenodonta and defined the genotype as Ctenodonta nasuta (Hall). He also described (Ulrich, 1894, p. 585) C. nasuta var. robusta from Paquette Rapids. Robusta compared with nasuta has "the anterior end higher and larger and the posterior end shorter, so that the beaks, instead of being in front of the midlength are just behind that point, the muscular impressions are deeper and the hinge plate is on the whole narrower and much less constricted in the middle" (Ulrich, 1894, p. 585).

The present specimens are similar to C. nasuta (Hall) sensu Salter from Paquette Rapids (Salter, 1859, p. 35). Examination of Ulrich's holotype in the United States National Museum would determine if Salter's specimens belong to C. nasuta robusta and if conspecific with Ulrich's specimen, the name C. robusta should be adopted. Otherwise, a new name must be introduced and nasuta rejected, on the basis that nasuta refers to a cast showing no internal structures.

Tancrodiopsis contracta (Salter)

(Form "A" of McAlester)

Plate IV, figures 7, 8

1856 Tellinomya cuncata HALL, p. 392, fig. 6, 7.

1859 Ctenodonta contracta SALTER, p. 37, Pl. 8, fig. 4, 5.

1863 Ctenodonta contracta Salter, BILLINGS, p. 175, fig. 160a, b.

1956 Ctenodonta contracta Salter, WILSON, p. 23, Pl. II, fig. 7-9.

1963 Tancrodiopsis cuncata (Hall) McALESTER, p. 5, fig. 1-80.

Material

14 specimens in various states of preservation; 2 specimens with both valves attached, 4 right valves, 5 left valves 2 indeterminable valves. Hypotype P 41: right valve; well preserved.

Diagnosis

Tancrodiopsis with a constricted posterior, central umbone strong adductor impressions, and chevron-shaped taxodont dentition having approximately equal numbers of teeth on both sides of the umbone.

Description

See McAlester (1963, p. 5, 10).

Measurements: Hypotype P 41: length - 12 mm

height at beak - 8 mm

Discussion

This species is usually described under the generic name Ctenodonta Salter for which C. nasuta (Hall), a large species is the

genotype. Beushausen (1895) proposed for smaller species the subgeneric name Tancrediopsis and Cossman (1897, p. 94) chose C. contracta Salter as the genotype (see McAlester, 1963, p. 4). McAlester also considered two genera to be represented and uses the name Tancrediopsis as proposed byBeushausen.

Hall (1856, p. 392) figured the species Tellinomya cuneata from Paquette Rapids. Salter (1859, p. 37) described Ctenodonta contracta a probable synonym for T. cuneata, also from Paquette Rapids. Due to priority McAlester (1963) re-erected cuneata, a name unused for more than 50 years except by Bassler (1915, p. 302). Because the type of cuneata has been lost, synonomy with contracta is subjective; availability of the type C. contracta Salter and general usage of the name indicates that C. contracta Salter should be the name for the species.

Tancrediopsis "abrupta" (Billings)

(Form "B" of McAlester)

Plate IV, figures 9, 10

1862 Ctenodonta abrupta BILLINGS, P. 46, fig. 48a, b, c.

1863 Ctenodonta abrupta BILLINGS, p. 175, fig. 161a, b.

1956 Ctenodonta abrupta Billings, WILSON, p. 21, Pl. II, fig. 3-6.

1963 Tancrediopsis "abrupta" (Billings), McALESTER, p. 12, fig. 3.

Material

9 specimens in various states of preservation; 3 specimens with both valves articulated, 2 right valves, 4 left valves.

Hypotype P 42; right valve, good preservation.

Diagnosis

Tancrediopsis similar to T. contracta (Salter) (Form "A" of McAlester) but with the umbo close to the posterior margin and with the posterior surface more steeply sloping from the umbo to the posterior margin of the shell. Internal differences are small. (McAlester, 1963, p. 10).

Description

See McAlester (1963, p. 5, 10).

Measurements: Hypotype P 42: length - 12 mm

height at beak - 9 mm

Discussion

McAlester (1963, p. 12) assigned this species provisionally to Tancrediopsis abrupta (Billings). The exteriors are similar but as neither the holotype nor paratypes of abrupta show internal structures, synonomy cannot be definitely determined.

GASTROPODA

Lophospira milleri (Miller)

Plate VI, figures 1-6

1847 Murchisonia bicincta HALL, p. 177, Pl. 30, fig. 5a-f.

1897 Lophospira bicincta (Hall), ULRICH and SCOFIELD, p. 964, Pl. 72, fig. 1-5.

1941 Lophospira milleri (Miller), KNIGHT, p. 179, Pl. 39, fig. 4a,b.

1951 Lophospira milleri (Miller), WILSON, p. 36, Pl. V, fig. 4.

Lophospira saffordi (Ulrich & Scofield), WILSON, p. 38, Pl. V, fig. 5.

Material

74 specimens, usually broken, various states of preservation; 42 large shells (diameter greater than 10 mm), 32 small shells (diameter less than 10 mm.)

Hypotypes: G 1 - G 10.

G 1 - G 6 (Pl. VI, fig. 1-6).

Description

Spire moderately high; having 5 or 6 tricarinate whorls coiled about a narrow umbilicus. Middle carina strongest, forming periphery of the shell. Upper and lower carinae situated about equal distances from the middle carina; upper carina about one third the distance between the upper suture and whorl periphery; separated from the preceeding whorl by a flat, slightly concave or slightly convex area. Upper and lower carina separated from the middle carina by concave areas, more strongly concave above the

periphery than below. Upper carina sharply differentiated (Pl. V, fig. 1, 2, 4) broadly rounded (Pl. VI, fig. 3, 5) or barely visible; lower carina obscure or slightly raised (Pl. VI, fig. 1, 2, 4); both usually more sharply defined on the early whorls. Peripheral carina rounded (Pl. VI, fig. 4, 5, 6) or trilineate (Pl. VI, fig. 2, 3); if trilineate having weak elevated lines margining a stronger central ridge. Base broadly rounded into the narrow umbilicus. Each whorl overlapping lower carina of the preceeding whorl. Growth lines faint or obscure; extending gently back from the upper suture and swinging strongly back from below the upper carina to the periphery; swinging strongly forward beneath the periphery and passing vertically into the umbilicus. Broad notch at the periphery (Pl. VI, fig. 1). Lip slightly thickened with inner lip reflexed about the umbilicus (Pl. VI, fig. 1).

Measurements:

Hypotypes	Height of spire in mm	Width of body whorl in mm	Apical angle in degrees
G 1	22+	23	65
G 2	18	18	70
G 3	19	19+	65
G 4	20+	22	70
G 5	26+	25	65
G 7	24	22	65

Discussion

Prominence of carinae is highly variable within the species. Peripheral carinae are rounded or trilineate where degree of roundness may be a peculiarity of the specimen or of preservation. Specimens with trilineate peripheral carinae have either sharply

defined or obscure upper and lower carinae indicating that this variation is a peculiarity of the specimen not a peculiarity of preservation.

Lophospira serrulata (Salter)

Plate VI, figures 7-11

1859 Murchisonia serrulata SALTER, p. 20, Pl. 4, fig. 1

1897 Lophospira serrulata (Salter), ULRICH and SCOFIELD, p. 968, Pl. 72, fig. 51-55, Pl. 73, fig. 57.

1951 Lophospira serrulata (Salter), WILSON, p. 38, Pl. V, fig. 8, 9.

Material

17 specimens, usually well preserved.

Hypotypes: G 11 - G 24

G 11 - G 13 (Pl. VI, fig. 7-11)

Description

Spire moderately high; having 5 or 6 whorls coiled about a narrow umbilicus with the last whorl having a tendency to uncoil (Pl. VI, fig. 7); each whorl with 4 carinae. Upper carina prominent; slightly less than half the distance from the preceeding suture to the second carina and separated from the upper suture by a slightly concave area. Second carina strongest, forming periphery of the whorl and separated from the upper carina by a strongly concave area; rounded, or trilineate with two weak elevated lines margining a stronger central one (Pl. VI, fig. 8, 10, 11) where the central line, especially on the early whorls often with a serrated edge (Pl. VI, fig. 10, 11). Third carina prominent; about

the same distance from the periphery as the upper carina and separated from the periphery by a strongly concave area. Fourth carina weakest; encircling the umbilicus and visible only on the body whorl (Pl. VI, fig. 8, 9); separated from the third carina by a slightly concave area. Growth lines prominent; extending gently back from the upper suture and swinging more sharply back below the upper carina to the periphery; swinging sharply forward to the third carina and from there extending sharply back, crossing the fourth carina and passing vertically into the umbilicus. Long slit resulting at the periphery. Inner lip greatly thickened but outer lip not as thick.

Measurements:

Specimen number	Height of spire in mm	Width of body whorl in mm	Apical angle in degrees
G 11	20+	24	75
G 14	20+	26	68
G 15	18+	24	70
G 17	14+	19	70

Discussion of Species of Lophospira Previously Recorded from the Ottawa Area

Lophospira helicteres (Salter): (See Salter 1859, p. 21 and Wilson 1951, p. 34). Cotypes are finely silicified specimens from Leray-Rockland beds at Paquette Rapids in the Ottawa River. The species is distinguished by its large size, tendency to uncoil and four obtuse carinae. The first carina, exposed on the top of the uncoiled whorl is otherwise obscured by the preceding whorl.

L. serrulata (Salter): (See Salter 1859, p. 29 and Wilson 1951, p. 38). Paratypes are finely silicified specimens from Leray-Rockland beds at Paquette Rapids in the Ottawa River. The species is distinguished by four sharply defined keels with serrated edges. The fourth keel encircles the umbilicus.

L. milleri (Miller): See Wilson (1951, p. 36). Hypotype coarsely silicified specimen from Leray-Rockland beds at Paquette Rapids in the Ottawa River. Growth lines are not seen. The upper carina is not as distinct as on the holotype but Braeside specimens show that prominence of carinae varies greatly within the species.

L. saffordi Ulrich and Scofield: (See Wilson 1951, p. 38). Hypotype coarsely silicified specimen from Leray-Rockland beds at Paquette Rapids in the Ottawa River. Wilson stated that compared with L. milleri this specimen is smaller, has backward directed growth lines at the periphery, more rapidly enlarging whorls and less prominent upper and lower carinae. However, the difference in size is not great; no growth lines are present on the specimen; the apical angle is within the range for L. milleri; prominence of carinae varies greatly within the species as seen from the Braeside specimens. Although Ulrich and Scofield have no illustration of L. saffordi they state that "the peripheral band (is) unusually prominent, upper and lower keels (are) both distinct", (1897, p. 982).

Because the upper and lower keels of the present specimen are indistinct and because L. saffordi is an upper Trenton form, synonomy with Ulrich and Scofield's species is questionable. This specimen appears to belong to the species L. milleri (Miller).

L. perangulata (Hall); (See Wilson 1951, p. 37). Hypotype coarsely silicified specimen from Leray-Rockland beds at Paquette Rapids in the Ottawa River. This specimen compared with L. milleri is smaller with a much fainter upper carina. Ulrich and Scofield record L. perangulata from Paquette Rapids and the specimen fits their description and drawings (1897, p. 972, pl. 73, fig. 1-7). However, comparison with Hall's description and drawing is difficult (1847, p. 41, Pl. 10, fig. 4).

L. medialis Ulrich and Scofield: (See Wilson 1951, p. 35). Hypotype coarsely silicified specimen, from Leray-Rockland beds at Paquette Rapids in the Ottawa River. Wilson stated that this specimen compared with L. perangulata has more compact form, fewer whorls and less pronounced angulation where the upper carina is absent and the lower carina indistinct. However, the form of the two specimens is essentially the same, the number of whorls is the same and both have prominent lower carina. Ulrich and Scofield (1897, p. 973) state that the lower carina of L. medialis is "generally quite indistinct". Because the lower carina of the present form is prominent, synonomy with L. medialis

is questionable. This specimen appears the same as L. perangulata sensu Ulrich and Scofield.

L. ventricosa (Hall): (See Wilson 1951, p. 39). Figured specimens (one specimen silicified and the other a steinkern) from Leray-Rockland beds at Paquette Rapids in the Ottawa River. Comparison with Hall's description and drawings is difficult but this specimen according to Wilson was identified by Billings and Wilson accepts the identification of Billings" who no doubt was familiar with Hall's species" (Wilson, 1951, p.39). She said that this species can be readily distinguished by its ventricose whorls. The silicified specimen compared with the hypotype of L. millari is larger with a more rounded peripheral carina, and slightly fainter upper and lower carinae .

L. peracuta Ulrich and Scofield: (See Wilson 1951, p. 36). Figured specimen from Leray-Rockland beds at Paquette Rapids in the Ottawa River. The species L. peracuta Ulrich and Scofield is distinguished by its sharply angular periphery and lack of upper and lower carinae (Ulrich and Scofield, 1897, p. 976). The present specimen however, has a distinct lower carina and very faint upper carina and appears the same as L. ventricosa (Hall) sensu Wilson.

L. procris (Billings): (See Billings 1862, p. 34 and Wilson 1951, p. 37). Holotype from Leray-Rockland beds at Paquette Rapids in the Ottawa River. Billings originally described

this specimen under the genus Murchisonia; Ulrich and Scofield referred the specimen to the genus Hormotoma; Wilson assigned it to the genus Lophospira. The genus Hormotoma Salter 1859 has a midwhorl periphery with slit and selenizone whereas the growth lines of this specimen pass almost vertically from suture to umbilicus indicating no slit or selenizone. This specimen compared with the genus Lophospira Whitfield, is too high with respect to the width, has whorls which are more rounded, vertical growth lines and no peripheral carina. A new genus may be represented.

Summary

L. helicteres (Salter): well defined species

L. serrulata (Salter): well defined species

L. millori (Miller) and L. saffordi Ulrich and Scofield sensu Wilson belong to the same species L. millori (Miller).

L. perangulata Ulrich and Scofield and L. medialis Ulrich and Scofield sensu Wilson belong to the same species L. perangulata Ulrich and Scofield.

L. ventricosa (Hall) sensu Wilson and L. peracuta Ulrich and Scofield sensu Wilson belong to the same species.

More material from Paquette Rapids may indicate gradations among L. millori (Miller), L. perangulata Ulrich and Scofield and L. ventricosa (Hall) sensu Wilson and suggest amalgamation of the species.

L. procris (Billings) does not belong to the genus Lophospira.

Comparison with species as described and illustrated by Ulrich and Scofield is difficult as numerous species have many similarities. One specimen might appear to fit the requirements of several species.

Trochonema wilsonae n. sp.

Plate VI, figures 12-15

Material

11 specimens, various states of preservation.

Holotype: G 25: (Pl. VI, fig. 12-14); relatively small specimen, outer lip region missing.

Paratypes G 26: (Pl. VI, fig. 15); medium sized specimen.

G 27: Relatively large specimen.

Paratypes G 26 and G 27 have complete inner and outer lips.

Diagnosis

Trochonema similar to T. umbilicatum var. canadensis Ulrich and Scofield but with (1) lower spire (2) more rounded carinae (3) smaller umbilicus (4) coarser, more distinct growth lines.

Description of Holotype

Holotype with a short spire, broad base and four or five whorls coiled about an open umbilicus; each whorl with five carinae. Top carina situated about one-third the distance from the preceeding whorl to the second carina and separated from each by a slightly concave area. Second carina situated a little above mid-whorl, very slightly in from the periphery. Third carina situated on the periphery, slightly below mid-whorl; separated from the second

carina by a wide, gently concave peripheral band. Second and third carinae more prominent than the first. Fourth carina weaker than the preceeding; bordering the umbilicus and separated from the third carina by a gently sloping, flat or slightly convex, area. Fifth carina nearly obscure; situated well within the steeply sloping umbilicus. Each whorl partially overlapping peripheral band of the preceeding whorl. Growth lines strongly oblique back from the upper suture to the second carina, gently concave forward on the peripheral band, strongly oblique back between the third and fourth carinae and steeply sloping into the umbilicus. Inner lip thickened and slightly reflexed about the umbilicus. Outer lip missing. Ornamentation limited to fairly coarse growth lines on the body whorl.

Description of Paratypes

Paratypes G 26 and G 27 are similar to the Holotype except for the presence of a broad shallow sinus on the peripheral band of the outer lip.

Measurements:

Specimen	length of diameter in mm	height of spire in mm.	apical angle in degrees
Holotype G 25	23	13	115
Paratypes G 26	27	14	110
G 27	30	15	112

Raphistomina fissurata n. sp.

Plate VII, figures 7-10

Material

4 specimens; one well preserved.

Holotype G 28: well preserved but with outer lip region missing.

Diagnosis

Raphistomina similar to R. lapicida but with (1) short peripheral selenizone and slit near the aperture (2) last whorl descending further below the periphery of the preceeding whorl (3) smaller umbilicus with the lip slightly reflexed about the umbilicus (4) stronger growth lines (5) slightly greater size.

Description of Holotype

Holotype with five whorls coiled about an open umbilicus, a gently convex spire, more strongly convex base, and angular periphery. Above the periphery: inner two-thirds of the whorl gently convex and outer third moderately concave. Below the periphery: outer surface slightly concave and inner surface strongly convex with the base sharply rounded into the umbilicus. Above the periphery: growth lines sharply oblique backward from the upper suture; appearing gently convex forward on the inner part of the whorl and gently concave forward on the outer part of the whorl. Growth lines near the aperture arching sharply back, forming a selenizone and short slit at the periphery, although older regions of the periphery rounded with no selenizone. Below the periphery: growth lines radial, appearing slightly concave forward near the periphery and gently convex forward near the umbilicus. Lip thickened and slightly reflexed about the umbilicus. Suture sharply incised beneath the preceeding whorl; forming a smoothly sloping spire with little interruption at the sutures except at the last

whorl which descends a little beneath periphery of the preceeding whorl. Ornamentation limited to growth lines, appearing coarser below periphery than above. Sharp break in the shell terminating growth lines in the last whorl; subsequent shell material growing from under the preceeding shell with growth lines reappearing beyond broken edge.

Measurements: length of diameter - 33 mm
height - 17 mm
spiral angle - 145°

Discussion

The present specimen of Raphistomina has a prominent selenizone and slit near the aperture, although Ulrich and Scofield when erecting the genus (1897, p. 942) claimed that no slit was present. The rounded periphery on older regions of the shell suggests that selenizone and slit were either not developed on earlier whorls, or if originally present were obliterated with age. Liospira, a genus with selenizone and slit, is closely related to the genus Raphistomina although compared with Raphistomina, Liospira has a nearly flat whorl profile with scarcely distinguishable sutures, and delicate surface markings including growth lines and revolving striae (Ulrich and Scofield, 1897, p. 953).

The sharp break in the la st whorl appears to be an injury subsequently healed by growth from under the broken edge. Separation between the body whorl and previous whorl may be emphasized by direction of this new growth.

Clathrospira subconica (Hall)

Plate VII, figures 11, 12

1847 Pleurotomaria subconica HALL, p. 174, 304, Pl. XXXVII, fig. 8a-c.

1863 Pleurotomaria subconica Hall, BILLINGS, p. 180, fig. 174.

1897 Clathrospira subconica (Hall), ULRICH AND SCOFIELD, p. 1006, Pl. LXIX, fig. 47-50, Pl. LXX, fig. 5, 6.

1841 Clathrospira subconica (Hall), KNIGHT, p. 78, Pl. 34, fig. 4a, b.

1951 Clathrospira subconica (Hall), WILSON, p. 57, Pl. VII, fig. 3.

Material

18 specimens, various sizes and states of preservation,

Hypotypes: G 29-G 34

G 29 Pl. VII, fig. 11, 12, G 31, G 33, G 34: large specimens with delicate ornamentation.

G 30, G 32; medium sized specimens lacking ornamentation.

G 29 and G 32 each have a sharp mended break in the shell of the body whorl.

Diagnosis

(1) Prominent selenizone at the periphery, lying just above the lower suture line. (2) Above the periphery, inner half of each whorl slightly convex, outer half more strongly concave. Underside of whorls broadly rounded. (3) Outer lip broadly notched. Inner lip reflexed about the umbilicus. (4) Ornamentation consisting of growth lines and fine transverse lines.

Description

See Ulrich and Scofield (1897, p. 1006). Hypotype G 29 has a sharp break in the shell of the body whorl. Subsequent growth appears from under the broken edge.

Measurement of Hypotype G 29:

height - 42+ mm

width - 46 mm

apical angle - 76°

Discussion

The sharp break in the last whorl appears to be an injury subsequently healed by growth from under the broken edge.

This specimen is large for the species but within the range given by both Hall (1847, p. 175) and Ulrich and Scofield (1897, p. 1006).

Tetranota cf. bidorsata (Hall)

Plate VII, figure 6

1847 Bucania bidorsata HALL, p. 186, Pl. 40, fig. 8a, 9.

1897 Tetranota bidorsata (Hall), ULRICH AND SCOFIELD, p. 877, Pl. 65, fig. 10-18.

1941 Tetranota bidorsata (Hall), KNIGHT, p. 347, Pl. 8, fig. 4.

1951 Tetranota bidorsata (Hall), WILSON, p. 30, Pl. IV, fig. 1, 2.

Material

7 incomplete, poorly preserved specimens, various sizes.

Hypotype G 35: (Pl. 5, fig. 6) specimen with most of body whorl missing but with flared outer lip preserved.

Description

Shell planispiral, compressed dorsal-ventrally. Dorsal surface with four rounded concentric ridges and a wide concave selenizone. Two prominent central ridges bordering the selenizone and separated from the less prominent lateral ridges by a concave area, slightly wider than the selenizone. Broadly rounded circum-umbilical ridge bordering umbilicus and separated from the lateral ridge by a concave area similar in width to the area separating the central and lateral ridges. Umbilicus not exposed on these specimens. Outer lip of Hypotype G 35 flaring into two subquadrate lobes with straight inner edges meeting at about 95° in a broad anterior sinus. Each addition of shell to the rim of the sinus slightly beneath the older shell. Rim of the sinus therefore slightly inturned and surface of the lobe gently convex. Aperture not exposed. Growth lines seen only on the lobes. Shell thin and often missing.

Discussion

This species is close to T. bidorsata. Poor preservation of both the holotype and present specimens makes comparison difficult although this specimen differs from the holotype by having a flared outer lip and by lacking a slit and tendency toward a double circum-umbilical salient (Knight 1941, p. 347). The outer lip of the holotype is not preserved and the Braeside material if better preserved might show a slit and double circum-umbilical salient. Compared with the Braeside specimens T. bidorsata as shown by Ulrich and Scofield (1897, Pl. LXV, fig. 15) has rounded, more laterally

flared lobes with a smaller sinus.

T. sexcarinata has strong growth lines and six prominent ridges, the outer pair not bordering the umbilicus.

Tetranota sp.

Plate VII, figures 1, 2

Material

One very small moderately well preserved specimen, Hypotype G 36.

Description

Dorsal surface with ridges, selenizone and concave areas similar to that of T. cf. bidorsata. Growth lines faint; on the dorsal surface extending obliquely back from the umbilical salient to the central ridge and traversing straight across the selenizone, suggesting a dorsal sinus but no slit; on the ventral surface extending vertically into the umbilicus. Outer lip not complete but appearing to flare into a small rounded lobe in front of the umbilical salient. Umbilical slope steep; having a slightly convex ventral surface. Whorl height about three times that of the preceeding whorl. Inner whorls not preserved. Height - 2 mm.

Discussion

This specimen is probably a juvenile form of the preceeding species T. cf. bidorsata.

Phragmolites ? sp.

Plate VII, figures 3, 4

Material

Two small, well preserved specimens.

Hypotypes: G 37 (Pl. VII, fig. 3, 4), G 38: both specimens with small inner whorls and apertures missing.

Description

Shell planispiral with a conspicuous dorsal keel and three or four loosely coiled whorls embracing only the keel of the previous whorl. Dorsal surface convex with convexity decreasing toward the keel until surface slightly concave at the base of the keel. Inner surface of the whorl almost vertical although very slightly convex; meeting the outer surface at an acutely angular edge. Each whorl about three times the height of the preceeding whorl. Ornamentation (including growth lines) absent.

Measurements:

largest diameter of the holotype - 7 mm

largest diameter of the paratype - 3 mm

Discussion

In comparison with the genus Phragmolites the present specimens have (1) no zig-zag surface ornamentation produced by periodical flaring of the aperture. (2) no slit occupying the centre of a bilineate keel.

A new genus may be represented. However, if these specimens belong to the genus Phragmolites, surface ornamentation has not been

preserved. The fossils are possibly too small to show a bilineate structure of the keel or an associated slit.

Phragmolites sp.

Plate VII, figure 5

Material

One specimen, Hypotype G 38: preservation too poor for description or species identification.

Pterotheca expansa (Emmons) sensu Wilson

Plate V, figure 7

1842 Delthyris expansus EMMONS, p. 397, fig. 2.

1951 Pterotheca expansa (Emmons), WILSON, p. 33, Pl. II, fig. 19, 20.

Material

21 incomplete specimens

Hypotypes: G 39 (Pl. V, fig. 7), G 40.

Diagnosis

Apex gently incurved but without coiling. Interior platform about twice as broad as long with the two sides forming a right angle at the apex. Dorsal surface gently convex with a strong median crest passing back to the apex. Narrow sinus associated with the crest.

Description

See Wilson, 1951, p. 33.

Hormotoma salteri canadensis Ulrich and Scofield

Plate V, figure 8

1859 Murchisonia (Hormotoma) gracilis SALTER, p. 22, Pl. 5, fig. 1.

1863 Murchisonia (Hormotoma) gracilis Salter, BILLINGS, p. 183, fig. 178.

1897 Hormotoma salteri canadensis ULRICH AND SCOFIELD, p. 1016, Pl. 70, fig. 44-51.

1951 Hormotoma salteri canadensis Ulrich and Scofield, WILSON, p. 42, Pl. IV, fig. 4.

Material

4 large specimens (height 30-35 mm), 9 medium sized specimens (height 8-20 mm), 16 small specimens (height < 8 mm).

Hypotypes: G 41, G 42: large specimens having depressed band on large whorls.

G 43, G 44, G 45: small specimens.

Description

Spire very high; mature specimens having 13 or 14 bead-like whorls coiled about a narrow umbilicus. Middle of the large whorls occupied by a wide depressed band covering about one-fourth of the whorl; band obscure or absent on small whorls. Growth lines fine and often obscure; projecting sharply back from the upper suture and forward below the peripheral band. Sinus and perhaps a slit on the outer lip of large specimens; sinus barely visible in small specimens. Base rounded. Inner lip reflexed about and obscuring the umbilicus.

Measurements:

Specimen	Height of spire in mm	Width of body whorl in mm	Apical angle in degrees
G 41	25+	10	21
G 42	25+	9	20
G 43	8	3	20
G 44	8	3	20
G 45	5	2	19

Discussion

The present mature specimens are similar to Salter's paratypes. Immature specimens generally lack surface features but are otherwise similar.

Helicotoma planulata Salter

Plate V, figures 9, 10

1859 Helicotoma planulata SALTER, p. 14, Pl. 2, fig. 5-7.

1897 Helicotoma planulata Salter, ULRICH AND SCOFIELD, p. 1033, Pl. 74, fig. 16, 17.

1941 Helicotoma planulata Salter, KNIGHT, p. 144, Pl. 75, fig. [illegible]

1951 Helicotoma planulata Salter, WILSON, p. 64, Pl. XI, fig. 8-14.

Material

11 incomplete specimens

Hypotype G 46: (Pl. V, fig. 9, 10)

Diagnosis

(1) Spire compressed (2) Whorls nearly flat, rising above each other in step-like appearance. Each whorl about twice the diameter of the preceeding. Outer upper angle bluntly carinate (3) About half each whorl on the underside covered by succeeding whorl.

Umbilicus steep.

Description

See Salter (1859, p. 14).

Subulites cf. regularis Ulrich and Scofield

Plate V, figure 11

1897 Subulites regularis ULRICH AND SCOFIELD, p. 1072, Pl. 81, fig. 35, Pl. 82, fig. 47, 48.

1951 Subulites regularis Ulrich and Scofield, WILSON, p. 89, Pl. XV, fig. 4-7.

Material

29 poorly preserved specimens.

Hypotypes: G 47 (Pl. V, fig. 11), G 48.

Description

Spire high, apical angle small (about 13°). Whorls high; outer surface slightly convex and sutures shallow, barely indenting continuous slope of the whorls. Body whorl elongate and tapering; aperture and umbilicus not visible. No ornamentation visible.

Discussion

Subulites, Cyrtospira and Fusispira are treated as separate genera by Ulrich (1897). Knight (Index Fossils 1949, p. 477) treats the three as subgenera with intergrading characteristics in which: (1) Subulites has (a) high straight spire, (b) high, flat whorls (c) very narrow aperture, (2) Cyrtospira has (a) curved spire

(3) Fusispira has (a) more inflated whorls, (b) wider aperture. Different species of Subulites appear to be based on slight variations of the outer lip, aperture and gibbosity. Revision of the genus appears necessary.

Holopea sp.

Material

One specimen, too poorly preserved for description or comparison with formerly described species.

Hyolithes cf. baconi Whitfield

Plate V, figures 12-17

1877 Hyolithes baconi WHITFIELD, p. 77.

1882 Hyolithes baconi WHITFIELD, p. 225.

1920 Hyolithes baconi Whitfield, FOERSTE, p. 211, Pl. XXI, fig. 10, 11, Pl. XXII, fig. 10, 11.

Material

14 incomplete specimens, apex and apertures missing.

Hypotypes: G 48 - G 53:

G 48 (Pl. V, fig. 16); convex side showing ornamentation.

G 49 (Pl. V, fig. 17); flatter side showing ornamentation.

G 50-G 53; small speciments with flatter side showing conical shape of dissolved area.

Description

Cross-section sub-triangular; one side almost flat although very slightly convex (Pl. V, fig. 17); other side more strongly

convex having a rounded median ridge flanked on each side by a concave area (Pl. V, fig. 16). Ornamentation faint or absent. Shell striated transversely by growth lines; 6 occurring in 1 mm; having a slight upward curve on the convex side and a stronger upward curve on the flatter side. Transverse striae crossed by finer vertical striae; 10 occurring in 1 mm. Apex of the shell appearing to have conical thickenings; visible on etched specimens where one side of the shell often dissolved away in a conical shape toward the apex (Pl. V, fig. 12-15). Walls moderately thick although the flatter side usually thinner, dissolving away more readily.

Measurements:

Longest fragmental length about 17 mm,

apical angle about 20°.

Discussion

The present specimens, although smaller than H. baconi, display the same external shape and ornamentation. Conical thickenings in the apex of the shell have not formerly been described for the species.

CEPHALOPODA

Loganoceras regulare (Billings)

Plate VIII, figures 1-5

1857 Cyrtoceras regulare BILLINGS, p. 314.

1932 Loganoceras regulare (Billings), FOERSTE, Pl. 25, fig. 1A, B.

Loganoceras paquettense FOERSTE, Pl. 25, fig. 5A-C.

Manitoulinoceras? canadense FOERSTE, Pl. 25, fig. 8A, B.

1933 Loganoceras regulare (Billings) FOERSTE, p. 70.

Loganoceras paquettense FOERSTE, p. 72.

Manitoulinoceras? canadense FOERSTE, p. 127.

1961 Loganoceras regulare (Billings), WILSON, p. 101, Pl. XXXV, fig. 5-7.

Loganoceras paquettense Foerste, WILSON, p. 101, Pl. XXXV, fig. 3, 4.

Loganoceras? canadense (Foerste), WILSON, p. 100, Pl. XXXV, fig. 1, 2.

Material

Phragmocone pieces of two specimens.

Hypotypes: C 11 (Pl. VIII, figures 1-3)

C 12 (Pl. VIII, figures 4, 5)

Description

Small, circular, cyrtoconic shell with apical region less curved than the younger region. Size increase rapid with diameter of C 11 increasing from 3 mm to 11 mm in a ventral length 32 mm. Growth lines distinct; transverse (Pl. VIII, fig. 3) except on the venter

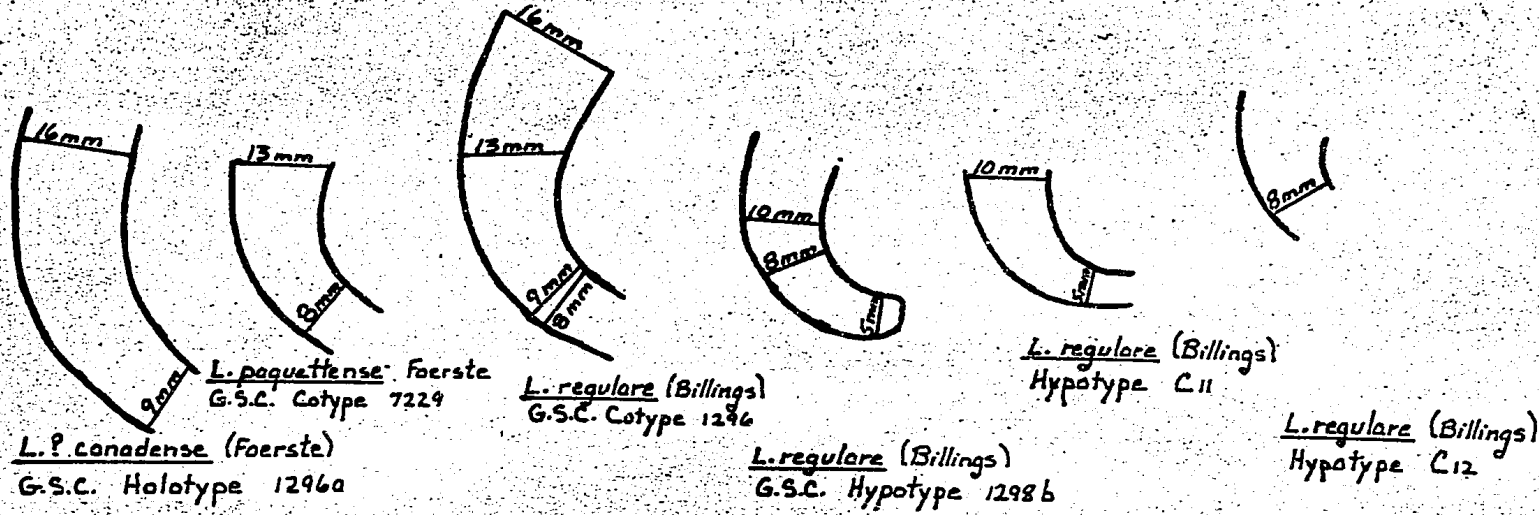
where a bend toward the apex indicates the hyponomic sinus (Pl. VIII, fig. 2); crowded dorsally, more separated ventrally. Septa concave. Distance between the septa indeterminable on C 11 but on C 12 at diameter 14 mm, 2 mm apart on the venter and 1 mm apart on the dorsum. Siphuncle about 1 mm across at septal diameter 11 mm and almost in contact with the ventral wall (Pl. VIII, fig. 1, 4).

Unusual septal development visible on C 12 (Pl. VIII, fig. 4) where one septum appears to have grown on two growth levels. Stepped appearance of septum results from an abrupt join of the two septal levels. Suture, continuous with upper level of the stepped septum indicates a once continuous septum at that level. Step also visible on underside of the septum as seen through a hole in the side of the conch. Surface of C 12 covered by an irregular bumpy growth (Pl. VIII, fig. 5).

Discussion

Foerste (1933, p. 70, 72) described L. regulare (Billings) and L. paquettense sp. nov. from Paquette Rapids and (1933, p. 127) described an internal cast of Manitoulinoceras ? canadense sp. nov. from La Petite Chaudiere, Ottawa. He stated that the conch of L. paquettense curves more strongly lengthwise and enlarges at a more rapid rate than that of L. regulare. Wilson (1961, p. 100) assigned M? canadense to Loganoceras? canadense and stated that this species differs from L. regulare "in being a little less curved in the adult region and in its more rapid enlargement".

Comparisons of the three holotypes suggest them to be conspecific; L. paquettense a smaller fragment with the same dimensions



Comparison of Specimens of Loganoceras

Figure 7

as a section of L. regulare, and L.? canadense a fragment further from the apex than L. regulare (fig. 7).

Actinoceras cf. aequale Flower

Plate VIII, figure 12

1957 Actinoceras aequale FLOWER, p. 35, Pl. 3, fig. 1-5, text fig. 3F.

1961 Actinoceras aequale Flower, WILSON, p. 48, Pl. XV, fig. 1-3.

Material

3 fragments of phragmacones.

Hypotype C 1: (Pl. VIII, fig. 12), polished section.

Description

Large, smooth shell, compressed dorsal-ventrally. Sutures transverse except for a broad, shallow lobe on the venter. Dorsal-ventral diameter increasing from 40 mm to 50 mm in length of 50 mm. Distance between septa about 11 mm. Therefore, length-width ratio of camerae about 1/4. Siphuncle situated close to the venter with distance from the ventral wall increasing orad. Septal necks long, brims short, connecting rings strongly curved. Width of the siphuncle 8-15 mm at the septal neck; expanding to 18-22 mm at the widest part of the connecting ring. Cameral deposits and siphuncle deposits lacking. Thin secondary deposits of calcite present on the septal necks and connecting rings of all specimens.

Discussion

The present specimens closely resemble A. aequale Flower, originally described from Lowville beds near Ottawa. Compared with the

holotype as described by Flower, the present specimens are incomplete and do not show ratio variation with growth. Siphuncle deposits, typical of the species (Flower, 1957, p. 36) are absent here.

Ormoceras sp.

Plate VIII, figure 11

Material

Two small phragmacone pieces of one specimen, Hypotype C 2.

Description

Shell medium size and smooth with circular cross-section. Width of shell increasing from 20 mm to 30 mm in length of 95 mm. Therefore, angle of increase about 6° . Distance between septae at greatest width about 6 mm. Therefore, length/width ratio of camerae about 1/5. Siphuncle close to the ventral wall. Septal necks and brims short, connecting rings strongly curved giving each segment a globular appearance. Width at the septal neck about 4 mm; expanding to about 9 mm at the widest part of the connecting ring. Most of this specimen recrystallized.

Discussion

Comparison with previously described species is difficult as many species are based on external features. Present material is scanty and poorly preserved, so that identification is possible only to generic level.

Michelinoceras sp. 1

Plate VIII, figures 9, 10

Material

5 fragments of phragmacones.

Hypotypes: C 3 (Pl. VIII, fig. 9), polished section.

C 4 (Pl. VIII, fig. 10), etched silicified specimen.

Description

Shell smooth and slender with an apical angle about 4° . Distance between septae 2+ mm at shell width 9 mm. Therefore, length/width ratio of septa about 1/4. Siphuncle small, straight and centrally situated. Septal necks and brims short; connecting rings straight or slightly curved. Siphuncle length 2+ mm and width 1.5 mm at cameral width 9 mm.

Discussion

Comparison with previously described species is difficult as many species are based on external features alone. Present specimens are few and poorly preserved. Thus identification is possible only to generic level.

Michelinoceras sp. 2

Plate VIII, figure 8

Material

4 fragments of phragmacones.

Hypotype C 5: (Pl. VIII, fig. 8), polished section.

Description

Shell smooth and slender with an apical angle about 2° . Distance between septae 3+ mm at shell width 10 mm. Therefore, length/width ratio of septa about 1/3. Siphuncle small, straight, centrally situated and poorly preserved. Siphuncle necks short and connecting rings straight or slightly curved.

Discussion

As with M. sp. 1, comparison with previously described species is difficult and specific identification is not possible.

Michelinoceras sp. 3

Plate VIII, figures 6, 7

Material

3 fragments of phragmacones.

Hypotype C 6: (Pl. VIII, fig. 6, 7), etched specimen.

Description

Shell smooth and slender with an apical angle less than 2°. Distance between septa 2.5 mm at shell width 5 mm. Therefore, length/width ratio of septae about 1/2. Siphuncle small and centrally situated; siphuncle necks and connecting rings not preserved.

Discussion

The present specimens and M. beltrami (Clarke) have slender phragmacones and similar cameral ratios. However, comparison with M. beltrami is not possible as the siphuncle is known in neither specimen.

Spyroceras (general note)

Hyatt erected the genus Spyroceras for specimens having annulated shells with longitudinal markings (see Flower, 1946, p. 213). Shimizu and Obata later introduced many new generic names for cephalopods with Spyroceras-type external markings. Two of these genera, Anaspyroceras and Gorbyoceras have been recognized by Flower (1946, p. 214). Anaspyroceras has an orthochoanitic siphuncle and Gorbyoceras a cyrtochoanitic siphuncle. Spyroceras is a Middle Devonian form with a crytochoanitic siphuncle bearing organic (sic) deposits which grow orad along the connecting ring in each segment of the siphuncle and finally fuse and form a continuous lining (Flower, 1946, p. 218).

Because Ordovician specimens have been previously assigned to Spyroceras without sufficient information regarding internal structures, Flower continues to use the generic name until further study indicates proper generic position (Flower, 1946, p. 215). "Spyroceras" is used here because of lack of information concerning internal structure.

"Spyroceras" sp.

Plate IX, figures 1-3

Material

Two small silicified fragments.

Hypotypes: C 9 (Pl. IX, fig. 1, 2).

C 10 (Pl. IX, fig. 3)

Description

Small annulated shell with prominent longitudinal striae. Circular cross-section with diameter of the largest fragment increasing from 2 mm to 7.5 mm in 50 mm length. Therefore, angle of increase about 7° . Annulations distinct but low and broad, almost transverse; 5 occurring in 10 mm. 32 primary longitudinal ribs about circumference of the small fragment; secondary ribs faintly indicated in several grooves. Septa transverse but cameral length indeterminable. Siphuncle centrally situated but not preserved.

Discussion

No previously described species appears to be similar. However, the present material is inadequate to designate a new species.

Monomuchites ? decrescens (Billings) sensu Wilson

Plate IX, figures 7, 8

1857 Orthoceras decrescens BILLINGS, p. 337.

1932 Cycloceras decrescens (Billings), FOERSTE, p. 84, Pl. 12, fig. 1a-c.

1961 Monomuchites decrescens (Billings), WILSON, p. 25, Pl. V, fig. 7, 8.

Material

Fragments of two specimens; both with phragmacone and living chamber. Hypotype C 7: (Pl. IX, fig. 7, 8), polished section.

Description

Shell medium size, having annulations but no longitudinal ornamentation. Cross-section sub-circular. Septa concave with concavity about 4 mm; 3 mm apart at diameter 22 mm. Angle of taper and shape of the sutures indeterminable. Siphuncle sub-central, having short septal necks and slightly curved connecting rings. Siphuncle width at the septal neck about 2 mm; indeterminable at the connecting ring. About 7 annulations occurring in a length equal to the diameter of the shell.

Discussion

The name Cycloceras has been widely used for all specimens having an annulated exterior with no longitudinal ornamentation. Teichert (in Moore, 1964, p. 259) recommends application of the generic name Cycloceras to the type specimen only, as the "type specimen is based on an internal mold of a body chamber on which even position of siphuncle is indiscernable". Wilson (1961, p. 24) defined a new genus Monomuchites to include specimens similar to Cycloceras but having only one suture between two annular rings, for according to her, McCoy's original description of Cycloceras stated that two chambers occurred between two annular rings. Flower (1962, p. 32) stated that "relative spacing of septa and annuli fails to differentiate obviously valid species, groups or genera". However, he stated that in the genus Monomuchites segments of the siphuncle, broadly expanded in the young and slender in adult, are occupied by annuli. These siphuncular features are not evident in the holotype of M. costalis, the type species. Until further revision however, the generic name Monomuchites is used.

"Cycloceras" cylindratum (Foerste)

Plate IX, figures 4-6

1847 Orthoceras arcuoliratum HALL, p. 198, Pl. 42, fig. 7b, c (not 7a).

1932 Spyroceras cylindratum FOERSTE, p. 97, Pl. 11, fig. 6A, B, 7A, C.

1961 "Spyroceras" cylindratum Foerste, WILSON, p. 35, Pl. IX, fig. 1-5.
"Spyroceras" arcuoliratum (Hall), WILSON, p. 35, Pl. VIII, fig. 2, 3.

Material

Four small fragments of phragmacones.

Hypotype C 8: (Pl. IX, fig. 4-6).

Description

Small, annulated shell with no longitudinal ornamentation. Cross-section circular. Diameter of largest fragment increasing from 5 mm to 5.5 mm in 20 mm length. Therefore, angle of increase about 2° . Five annulations occurring in length equal to diameter of the shell. Annulations slightly undulating on about two-thirds of the shell but on remaining third rising abruptly into rounded arches with heights slightly more than one annulation above their lower limit. Septa concave but seldom preserved. Sutures transverse, about 3 mm apart, so that less than two camerae occur in length equal to diameter of the shell. Siphuncle centrally situated.

Discussion

Foerste (1932, p. 97) erected the species S. cylindratum on specimens from both Watertown and Paquette Rapids and chose the

specimen from Watertown as the holotype. As the Watertown specimen figured by Hall (1847, Pl. 42, fig. 7b, c) is an interior cast, comparison with silicified material from Paquette Rapids is not possible and different species or genera may be present in each case.

Foerste (1932, p. 98) assigned this species to the genus Spyroceras claiming that in cross-illumination one specimen from Paquette Rapids "appears distinctly striated vertically". He felt that coarse silicification had obliterated the striae in other specimens. However, neither the paratype nor other specimens present in the collection of the Geological Survey of Canada appear to have had longitudinal striations. The Braeside specimens are similar to those from Paquette Rapids and also appear never to have had longitudinal ornamentation. A genus other than Spyroceras is here therefore, suggested. The species is here assigned to the genus "Cycloceras" until further study indicates proper generic position.

Wilson (1961, p. 35) recorded "S". arcuoliratum (Hall) from Paquette Rapids. This specimen, however, does not appear to have a larger apical angle as suggested by Wilson and therefore, belongs to the species "C". cylindratum (Foerste).

Colour Markings on Cephalopods

Longitudinal colour markings are present on 5 specimens. The smooth exteriors and diameter sizes of these specimens suggest Actinoceras although exact affinities are indeterminable as

sectioning in a dorsal-ventral direction would destroy the colour markings.

The markings are longitudinal bands confined to one side of the specimen. The lines, dark brown on a light brown or grey background of the rest of the shell, vary in width with the specimen and appear to become narrower and more widely separated at the lateral regions of the colour-marked area (Pl. IX, fig. 10). Deeper weathering of the colour bands on two specimens suggests a dissimilarity between the bands and the rest of the shell (Pl. IX, fig. 9). Ruedemann (1921, p. 84) also records differential weathering between the colour markings and the rest of the shell but on his specimens the colour bands show greater resistance than the rest of the shell.

Measurements:

Diameter of shell in mm	Width of colour band in mm	Distance apart from mid-point of colour band in mm
60+	4	9-10
34	2	5
37	$\frac{3}{4}$ (on lateral edge of marked area)	$2\frac{1}{2}$
32+	1	$3\frac{1}{2}$
24	$1\frac{1}{2}$	3

Teichert (in Moore, 1964, p. K24) stated that the "colour markings of fossil shells are in fact patterns of pigmentation ... indicating presence of former colour markings". Foerste (1930, p. 145) suggested that the prismatic layer, which carries the colour markings is covered by the mantle or a horny layer during the life of the animal. This mantle or horny layer may show colours but the colours are not retained by the shell in fossil form. However, he suggested that there is a relation between the colour markings of the fossils

and the affect of light on the living animal. Distinct colour markings are found today primarily on the shells of animals living in shallow seas. If these marks are confined to one side it is assumed that the animal lived in a horizontal position with the colour markings on the dorsal side of the shell (Ruedemann, 1921, p. 84).

Conclusions

Specimens from Braeside are sufficiently common to permit assessment of morphological variations in numerous species and the present material suggests that many previously erected species may be conspecific. Study of specimens of Cyrtodonta (p. 13), Vanuxemia (p. 26) and Lophospira (p. 42) in the type collection of the Geological Survey of Canada illustrates this point. Fine textured silicification has resulted in perfect replacement of delicate internal and external features. Many of these characteristics, often not preserved in fossils from other localities, are necessary for generic and specific identification. Certain taxonomic details have here been reported for the first time.

Stratigraphical Affinities

Important similarities and differences occur among the molluscan faunas of Braeside, Fourth Chute and Paquette Rapids.

The following genera and species of mollusca recorded by Wilson (1951, 1956, 1961) from Paquette Rapids are also found at Braeside:

Pelecypoda	Ctenodonta nasuta (Hall)
	Tancrediopsis abrupta (Billings)
	Tancrediopsis contracta (Salter)
	Cyrtodonta
	Modiolopsis
	Vanuxemia

Gastropoda	Helicotoma planulata Salter
	Hormotoma salteri canadensis Ulrich & Scofield
	Lophospira milleri (Miller)
	Lophospira serrulata (Salter)
	Pterotheca expansa (Emmons) sensu Wilson
	Subulites regularis Ulrich and Scofield
	Holopea
	Raphistomina
	Tetranota
	Trochonema
Cephalopoda	Loganoceras regulare Billings
	Monomuchites decrescens (Billings)
	Actinoceras
	"Cycloceras"
	Michelinoceras
	"Spyroceras"
	Ormoceras

The following genera and species recorded by Wilson (1951, 1956, 1961) from Fourth Chute are also found at Braeside:

Pelecypoda	Ctenodonta nasuta (Hall) sensu Salter
	Vanuxemia inconstans Billings
	Cyrtodonta
Gastropoda	Hormotoma salteri canadensis Ulrich and Scofield

The fauna from Paquette Rapids is better known than that from Fourth Chute.

The following new species are found at Braeside:

Pelecypoda	Cyrtodonta ripana
	Cyrtodonta ? perplexa
	Whitella ottawana
	Clionychia naba
Gastropoda	Trochonema wilsonae
	Raphistomina fissurata

Although the beds near Braeside have fossils similar to those at Paquette Rapids and Fourth Chute, important differences are seen. Maclurites is common at Paquette Rapids and at the top of the gorge at Fourth Chute. This genus is not found in the sampled beds at Braeside but is seen higher in the face of the quarry. Clathrospira, common at Braeside is unrecorded from Paquette Rapids and the top of the gorge at Fourth Chute. However, one specimen is known from beds in the gorge. These differences suggest that the sampled beds at Braeside are slightly lower stratigraphically than those at Paquette Rapids and at the top of the Fourth Chute gorge. Beds lower in the gorge at Fourth Chute are probably stratigraphically equivalent to those at Braeside.

Palaeoecology

Some information on the habitat of these organisms can be deduced from preservation of the fossils. Large branching bryozoa encrusting the bivalves, delicately ornamented unbroken shells, and articulated pelecypod valves suggest a quiet water environment,

probably too inactive for post-mortem shell transportation. Colour markings on cephalopods may be indicative of clear, shallow water in the photic zone. Large branching bryozoa, adhering to the exterior surfaces of pelecypod shells suggest a slow rate of sedimentation. Worm tubes are found on the inside of several pelecypod and gastropod shells. There are however, no holes in the shells to indicate boring parasites.

The resulting picture is of a shallow, quiet water, marine environment supporting a diverse molluscan fauna.

Selected Bibliography

Bassler, R.S.,

1915: Bibliographic Index of American Ordovician and Silurian Fossils; U.S. National Mus. Bull. 92.

Billings, E.,

1857: Geol. Surv. Can., Rept. Prog., 1853-54-55-56, pp. 314, 337.

1858: New Genera and Species of Fossils from the Silurian and Devonian formations of Canada; Can. Naturalist and Geol., vol. 3, pp. 419-444.

1862: On some new or little-known species of Lower Silurian Fossils from the Potsdam Group (Primordial Zone); Geol. Surv. Can., Palaeozoic Fossils, vol. 1.

1863: in Logan, W.E., Geology of Canada, Geol. Surv. Can., Rept. Prog., pp. 136-198.

1865: Geol. Surv. Can., Palaeozoic Fossils, vol. 1.

Emmons, E.,

1842: Natural History of New York, Geology of New-York, vol. II, p. 397.

Flower, R.H.,

1946: Ordovician Cephalopoda of the Cincinnati Region: Bull. Amer. Pal., No. 116.

Flower, R.H.,

1957: Studies of the Actinoceratida; State Bur. Mines Mineral Resources, New Mexico Inst. Mining Technology, Mem. 2.

1962: Part II. Notes on Michelinoceratida; State Bur. Mines Mineral Resources, New Mexico Inst. Mining Technology, Mem. 10.

1964: Nautiloid Shell Morphology; State Bur. Mines Mineral Resources, New Mexico Inst. Mining Technology, Mem. 13.

Foerste, A.F.,

1930: The Colour Patterns of Fossil Cephalopods and and Brachiopods with Notes on Gastropods and Pelecypods; Mich. Univ., Contr. Mus. Pal., vol. III, No. 6, pp. 109-150.

1932: Black River and Other Cephalopods from Minnesota, Wisconsin, Michigan and Ontario (Part I); Denison Univ. Bull., J. Sci. Lab., vol. 27, pp. 47-136.

1933: Black River and Other Cephalopods from Minnesota, Wisconsin, Michigan and Ontario (Part II): Denison Univ. Bull., J. Sci. Lab., vol. 28, pp. 1-151.

Foerste, A.F., Teichert, C.,

1930: The Actinoceroids of East-Central North America; Denison Univ. Bull. J. Sci. Lab., vol. 25, pp. 201-296.

Goudge, M.F.,

1938: Limestones of Canada, Their Occurrence and Characteristics, Part IV, Ontario; Canada Dept. Mines Resources.

Hall, J.,

1847: Natural History of New York, Palaeontology, vol. 1.

1856: On the Genus Tellinomya and Allied Genera; Can. Naturalist J. of Sci., vol. 1, pp. 391-395.

1861: Geol. Surv. Wisconsin, Rept. Supt.

Knight, J.B.,

1941: Palaeozoic Gastropod Genotypes; Geol. Soc. Amer., Sp. Paper 32.

Marek, L.,

1963: New Knowledge on the Morphology of Hyolithes; Sbor. Geol. Ved., Pal., pp. 53-73.

McAlester, A.L.

1963: Revision of the Type Species of the Ordovician Nuculoid Pelecypod Genus Tancrediopsis; Postilla, Yale Peabody Mus. Natural Hist., No. 74.

Moore, R.C., (Editor)

1960: Treatise on Invertebrate Palaeontology; Pt. I, Mollusca 1.

1962: Treatise on Invertebrate Palaeontology; pt. W, Miscellaneous.

Moore, R.C., (Editor)

1964: Treatise on Invertebrate Palaeontology; pt. K, Mollusca 3.

Ruedemann, R.,

1921: Paleontologic Contributions from the New York State Museum, pt. 4, On Colour Bands in Orthoceras; Bull. N.Y. State Mus., No. 227, 228, pp. 79-88.

Salter, J.W.,

1859: Figures and Descriptions of Canadian Organic Remains, Decade I; Geol. Surv. Can.

Sardeson, F.W.,

1939a: Early Pelecypod Vanuxemia in Minnesota; Pan-Am. Geol., vol. LXXI, pp. 283-293.

1939b: Early Pelecypod Cyrtodonta in Minnesota; Pan-Am. Geol., vol. LXXI, pp. 337-346.

Shimer, H.W., Shrock, R.R.,

1949: Index Fossils of North America, fourth printing; Wiley and Sons, New York.

Ulrich, E.O.,

1892: New Lamellibranchiata; Amer. Geol., vol. X, pp. 96-104.

1893: New and Little Known Lamellibranchiata from the Lower Silurian Rocks of Ohio and Adjacent States; Geol. Surv. Ohio, Geology, vol. 7, pp. 625-693.

Ulrich, E.O.

1894: The Lower Silurian Lamellibranchiata of Minnesota; Geol. Natural Hist. Surv. Minnesota, vol. III, pt. II, pp. 475-628

1924: in Foerste, A.F., Modiodesma n. gen. Ulrich and the genotype of Modiolopsis Hall; Upper Ordovician Faunas of Ontario and Quebec, Geol. Surv. Can., Mem. 138, pp. 183-190.

Ulrich, E.O., Scofield, R.R.,

1897: The Lower Silurian Gastropoda of Minnesota; Geol. Natural Hist. Surv. Minnesota, vol. III, pt. II, pp. 813-1081.

Whitfield, R.R.,

1877: Preliminary Descriptions of New Species of Fossils from the Lower Geological Formations of Wisconsin; Rept. Geol. Surv. Wisconsin, pp. 50-90.

1882: Specics from the Trenton Limestone, Pteropoda; Geology of Wisconsin, Survey of 1873-1879, vol. IV, p. 225.

1895: Mem. Am. Mus. Natural Hist., vol. I, pt. II, pp. 39-74.

Wilson, A.E.,

1951: Gastropoda and Conularida of the Ottawa Formation of the Ottawa-St. Lawrence Lowland; Geol. Surv. Can., Bull. 17.

Wilson, A.E.,

1956: Pelecypoda of the Ottawa Formation of the Ottawa-St. Lawrence Lowland; Geol. Surv. Can., Bull. 28.

1961: Cephalopoda of the Ottawa Formation of the Ottawa-St. Lawrence Lowland; Geol. Surv. Can., Bull. 67.

PLATE I

Plate I

(all figures x 2)

Figures 1-8. Cyrtodonta ripana n. sp. (page 9)

1, 2 Left valve (fig. 1); right valve (fig. 2); interior views showing shell outline, straight hinge line, position of beak, anterior and posterior teeth, anterior adductor scar. Holotype P 1.

3, 4 Left valve (fig. 3); right valve (fig. 4); exterior views showing outline of shell, tumidity, growth lines. Holotype P 1.

5, 6 Left valve (fig. 5); right valve (fig. 6); interior views showing thick shell, anterior and posterior teeth, pronounced anterior sinus, prominent depression parallel to anterior margin of shell. Paratype P 2.

7, 8 Left valve (fig. 7); right valve (fig. 8); exterior view showing tumidity and growth lines. Paratype P 2.

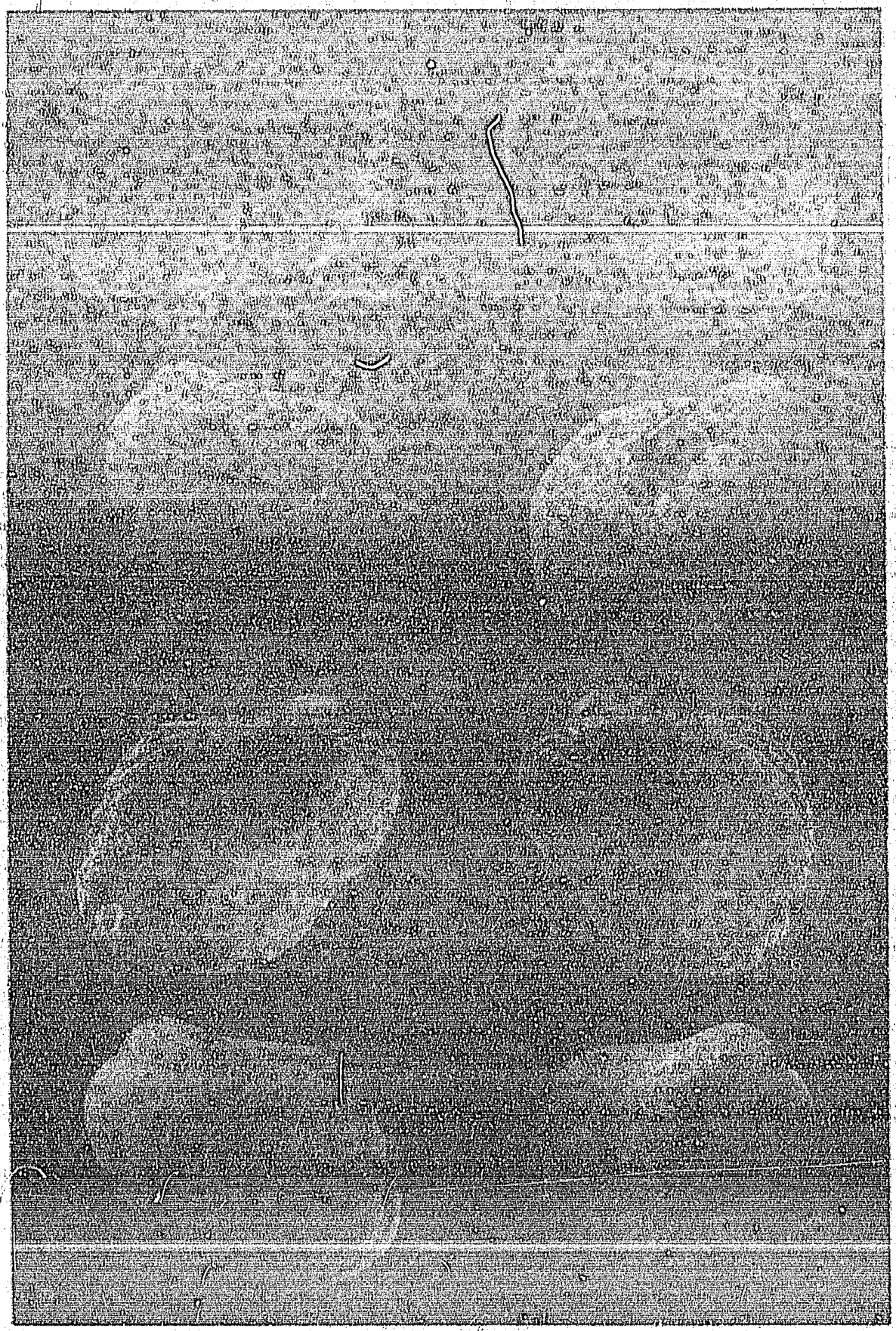


Plate I

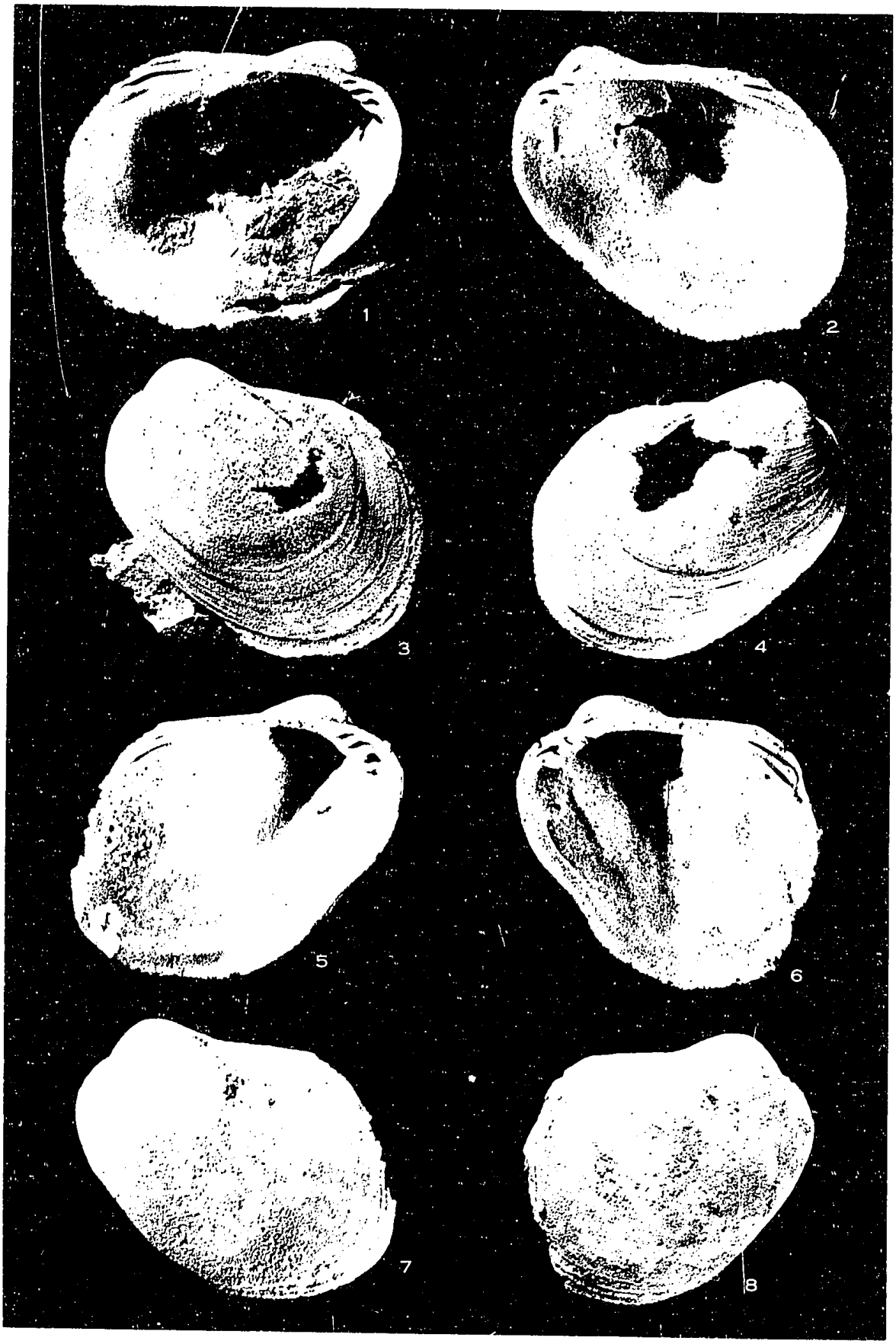

1
2
3
4
5
6
7
8

PLATE II

Plate II

(all figures x 2)

Figures 1-5 — Cyrtodonta ripana n. sp. (page 9)

1 — Right valve; internal view showing large anterior angle. Paratype P 4.

2 — Right valve; external view showing attached bryozoa. Paratype P 8.

3 — Attached valves showing tumidity, growth lines, hinge line with external ligamental area, no lunule or escutcheon. Paratype P 7.

4 — Left valve; hinge line showing anterior teeth. Paratype P 10.

5 — Left valve; hinge line showing anterior and posterior teeth. Paratype P 11.

Figures 6-9 — Cyrtodonta ? perplexa n. sp. (page 19)

6, 7 — Left valve (fig. 6); right valve (fig. 7); exterior views showing tumidity, growth lines. Holotype P 16.

8, 9 — Left valve (fig. 8); right valve (fig. 9); interior views showing thickness and outline of shell, anterior position of beak, anterior adductor scar, depressions on floor of valve, coarse anterior and posterior teeth. Holotype P 16.

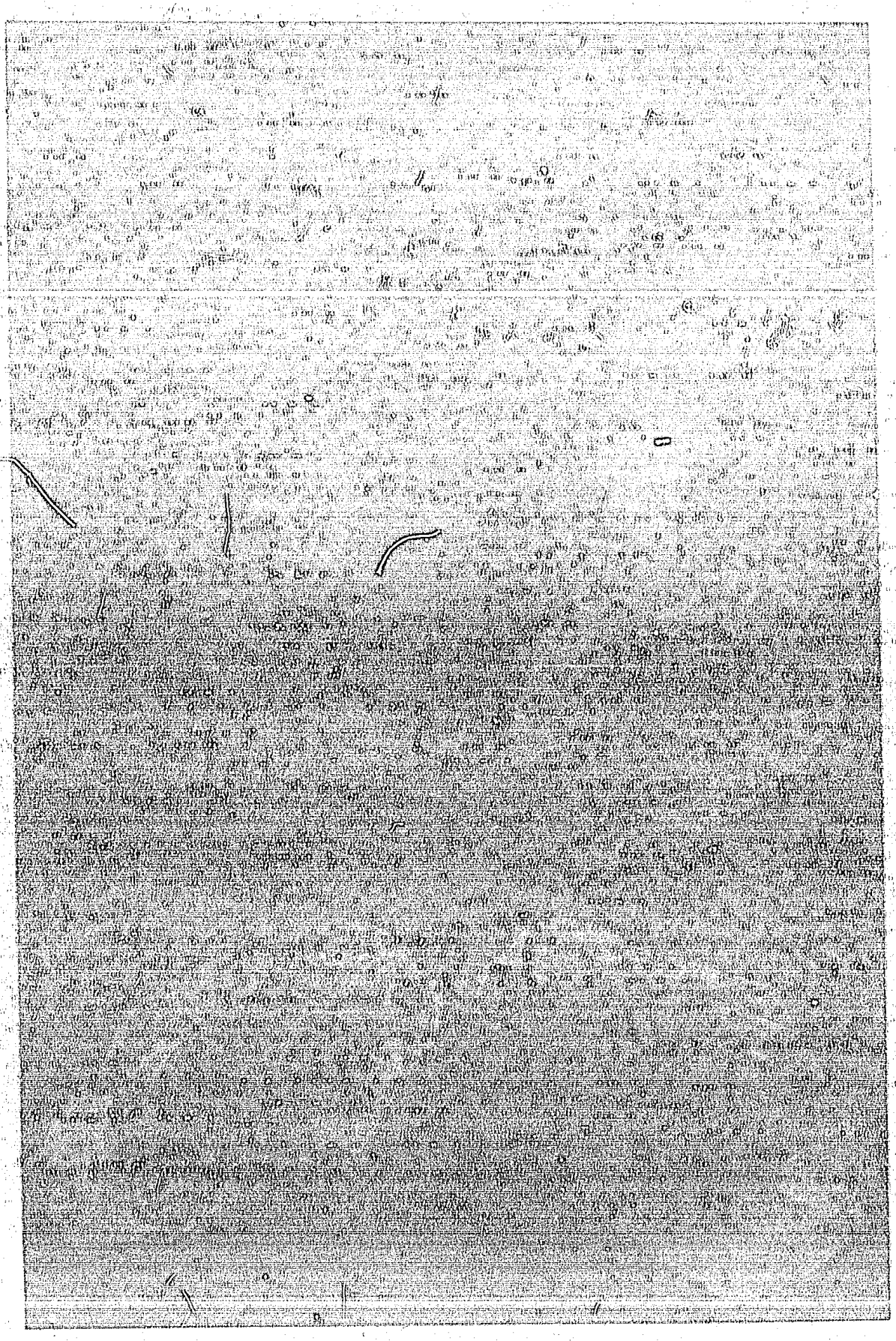


Plate II

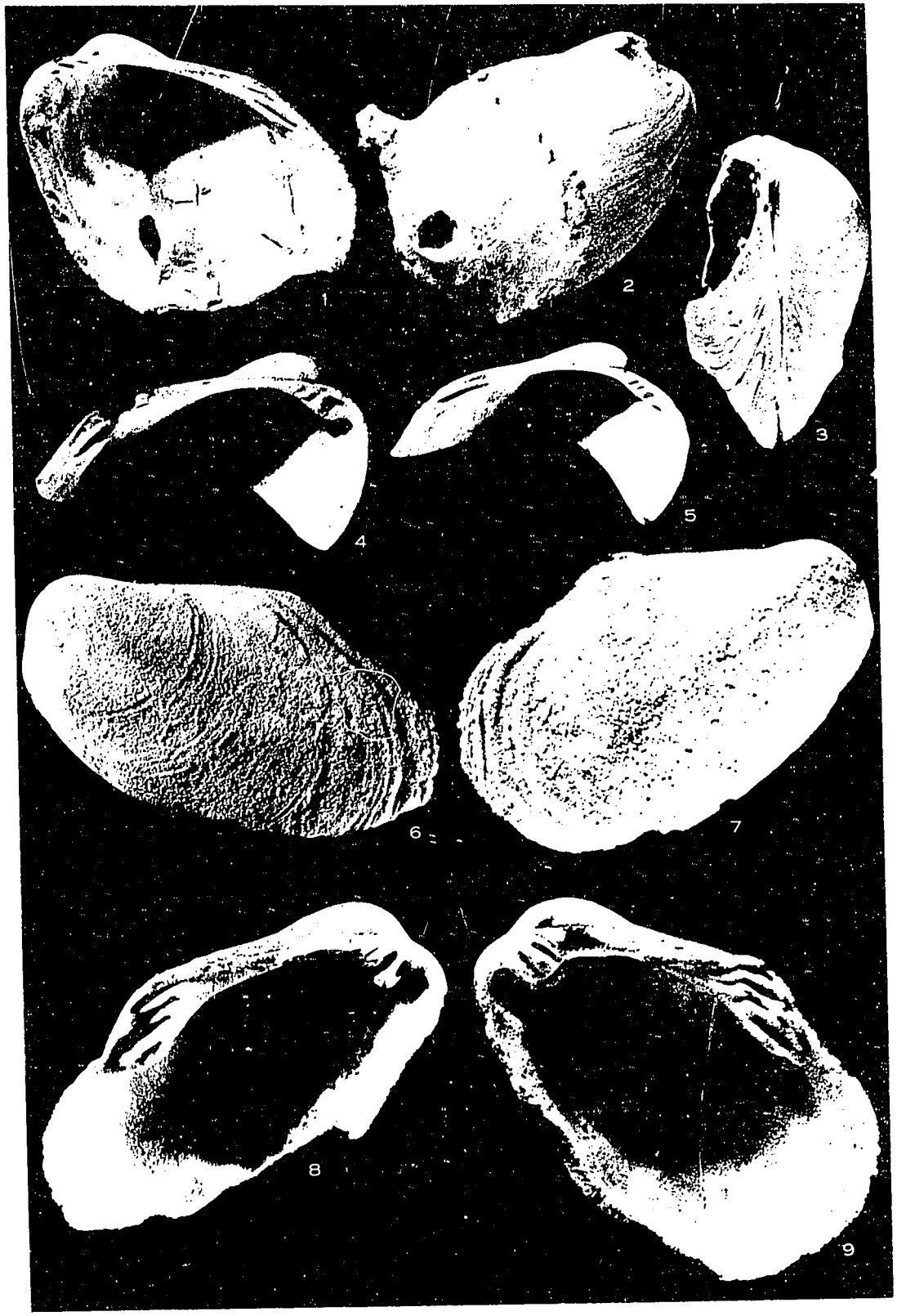

1
2
3
4
5
6
7
8
9

PLATE III

Plate III

(all figures x 2 except where otherwise stated)

Figures 1-14 *Vanuxemia inconstans* Billings (page 21)

1 Right valve; exterior view showing sub-rounded outline. Hypotype P 17.

2 Right valve; interior view showing sub-rounded outline with anterior region projecting forward beyond the hinge line, anterior adductor scar on floor of valve. Hypotype P 17.

3 Right valve; interior view showing sub-rounded outline with anterior region projecting forward beyond the hinge line, anterior adductor scar on floor of valve. Hypotype P 18.

4 Right valve; exterior view showing sub-rounded outline. Hypotype P 18.

5 Right valve; interior view showing sub-rounded to sub-ovate outline with beak close to anterior extremity of hinge line, anterior adductor scar on floor of valve. Hypotype P 19.

Plate III (continued)

6 Right valve; exterior view showing sub-rounded to sub-ovate outline. Hypotype P 19.

7 Left valve; interior view showing sub-rounded outline, anterior adductor scar embedded in hinge plate, striated anterior and posterior teeth. Hypotype P 20.

8 Right valve; interior view showing sub-ovate outline with beak very close to anterior end of hinge line, hinge line curved over anterior teeth, striated external ligamental area, anterior adductor scar embedded partially in the hinge plate and partially on the floor of the valve. Hypotype P 21.

9 Right valve; exterior view showing sub-ovate outline, growth lines. Hypotype P 21.

10 Right valve; exterior view showing anterior ear. Hypotype P 21.

11 Left valve; interior view showing sub-ovate outline with beak at anterior end of hinge line, anterior adductor scar embedded in hinge plate. Hypotype P 22.

Plate III (continued)

12 Left valve; exterior view showing sub-ovate outline, concentric growth lines. Hypotype P 22.

13 Right valve; interior view showing sub-ovate outline with beak at anterior end of hinge line, striated external ligamental area, striated anterior teeth, anterior adductor scar embedded in hinge plate. Hypotype P 23.

14 x1. Right valve; exterior view showing attached bryozoa. Hypotype P 24.

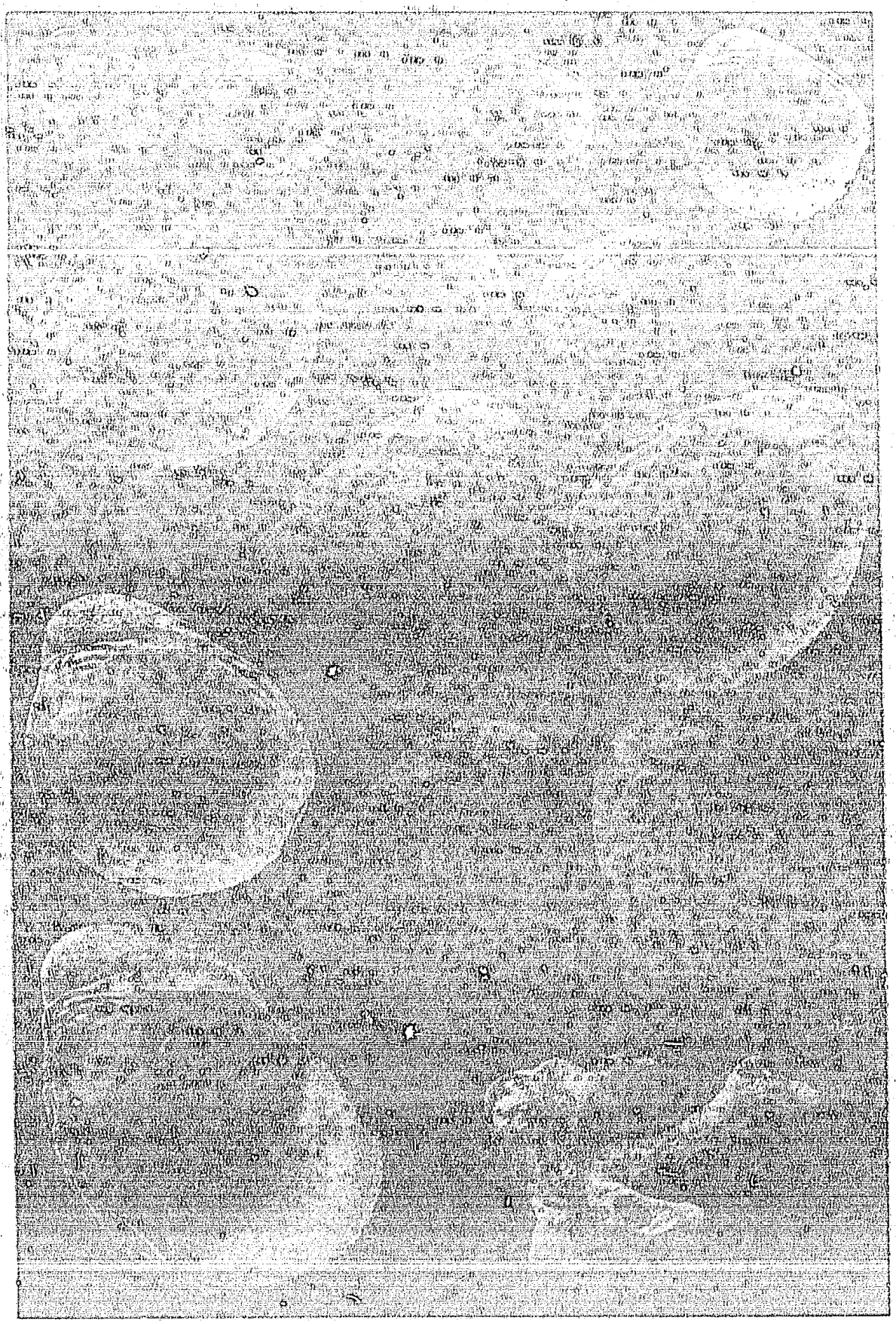


Plate III

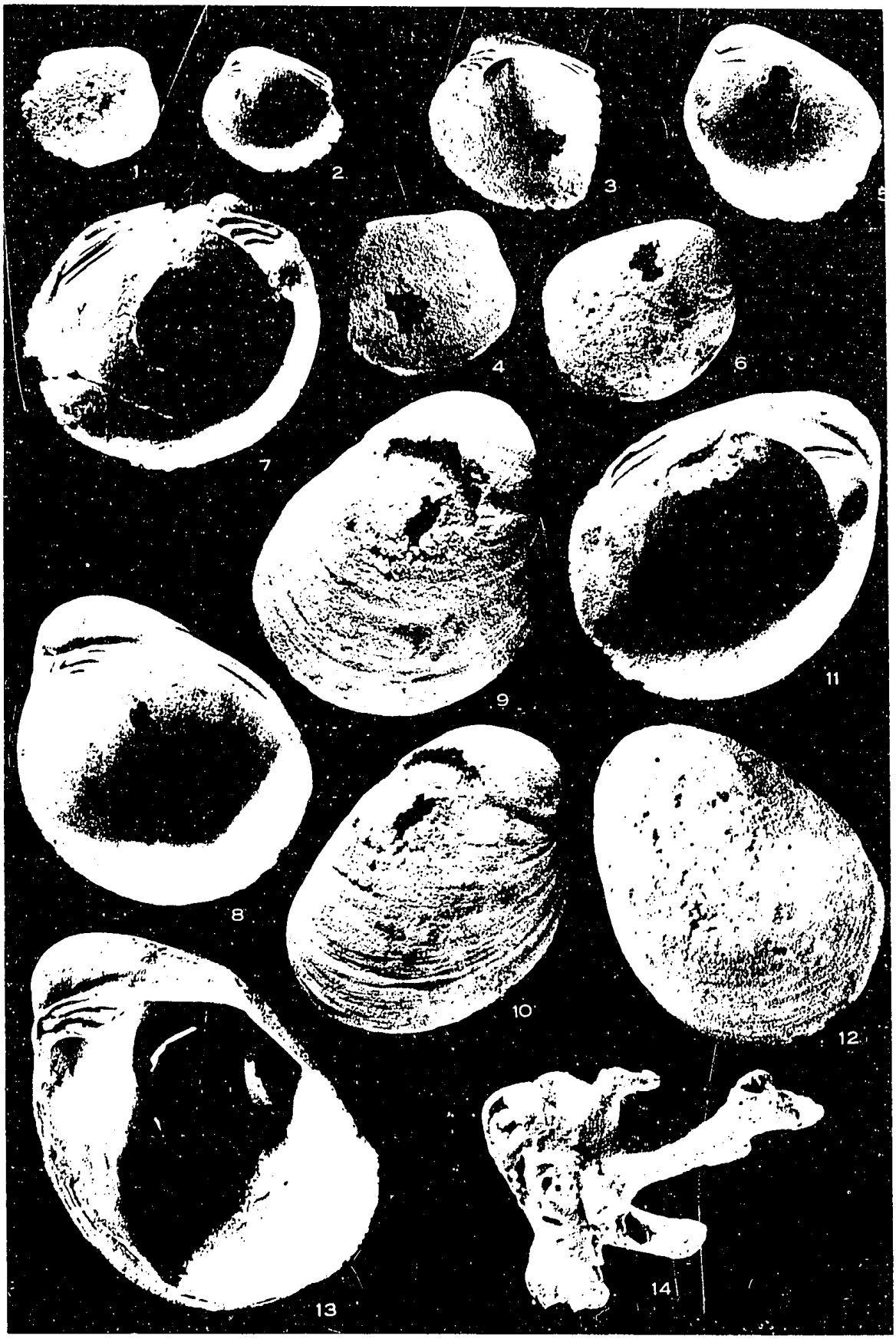

1
2
3
4
6
7
9
11
8
10
12
13
14

PLATE IV

Plate IV

(all figures x 2)

Figures 1, 2 — Ctenodonta nasuta (Hall) sensu Salter (page 34)

1 — Left valve; interior view showing shell outline, continuous series of teeth along hinge line, muscle impressions under hinge plate. Hypotype P 40.

2 — Left valve; interior view under hinge plate showing muscle impressions. Hypotype P 40.

Figures 3-6 — Whitella ottawana n. sp. (page 27)

3, 4 — Right valve (fig. 3); left valve (fig. 4); exterior views showing shell outline, steeply sloping surface from umbonal ridge to anterior margin and gently sloping to posterior margin, pronounced sinus in anterior margin, strong concentric growth lines. Holotype P 36.

5, 6 — Right valve (fig. 5); left valve (fig. 6); interior views showing narrow hinge plate, two small anterior teeth, faint ridge at posterior end of hinge line, anterior adductor scar. Holotype P 36.

Plate IV (continued)

(all figures x 2)

Figures 7, 8 — Tancrediopsis contracta (Salter) (page 36)

7 — Right valve; interior view showing shell outline, taxodont dentition, subcentral beak, strong adductor scars. Hypotype P 41.

8 — Right valve; exterior view showing shell outline, sub-central umbo. Hypotype P 41.

Figures 9, 10 — Tancrediopsis "abrupta" (Billings) (page 37)

9 — Right valve; interior view showing shell outline, taxodont dentition, posteriorly situated beak, strong adductor scars. Hypotype P 42.

10 — Right valve; exterior view showing shell outline, posteriorly situated umbo. Hypotype P 41.

Plate IV

Fig. IV

PLATE V

Plate V

(all figures x 2 unless otherwise stated)

Figures 1-4 Clionychia naba n. sp. (page 29)

1 x 1. Left valve; interior view showing outline of shell. Hypotype P 37.

2 x 1. Left valve; exterior view showing outline of shell. Hypotype P 37.

3 Left valve; interior view showing straight hinge line, beak, depression behind beak, growth lines in depression and along anterior margin. Hypotype P 37.

4 Left valve; exterior front view showing growth lines meeting beneath the beak.

Figures 5, 6 Modiolopsis sp. (page 32)

5 Left valve; interior view showing outline of shell, hinge plate with two small anterior teeth and two well-defined posterior teeth. Hypotype P 38.

6 Left valve; exterior view showing outline of shell. Hypotype P 38.

Plate V (continued)

Figure 7 — Pterotheca expansa (Emmons) sensu Wilson (page 56). Dorsal view showing outline of shell, incurved apex, median crest, narrow sinus, interior platform. Hypotype G 39.

Figure 8 — Hormotoma salteri canadensis Ulrich and Scofield. (page 57). Side view showing peripheral band, growth lines. Hypotype G 41.

Figures 9, 10 — Helicotoma planulata Salter (page 58)

9 — Top view showing step-like appearance of whorls. Hypotype G 46.

10 — Bottom view showing umbilicus. Hypotype G 46.

Figure 11 — Subulites regularis Ulrich and Scofield sensu Wilson. (page 59) Side view showing high spire, shallow sutures. Hypotype G 47.

Figures 12-17 — Hyolithes baconi Whitfield (page 60)

12-14 — x 4. Views of flatter side showing conical shape of missing region. Hypotypes: G 50 (fig. 12), G 51 (fig. 13), G 52 (fig. 14).

15 — x 4. View of flatter side showing partial dissolution in conical shape. Hypotype G 53.

Plate V (continued)

16 x 4. View of convex side showing rounded median ridge flanked on each side by concave area, fine transverse growth lines with slight upward curve, finer vertical striae. Hypotype G 48.

17 x 4. View of flatter side showing fine transverse growth lines with stronger upward curve than on convex side, finer vertical striae. Hypotype G 49.

Plate V


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

PLATE VI

Plate VI

(all figures x 2)

Figures 1-6 *Lophospira milleri* (Miller) (page 39)

1 Apertural view showing broad notch, inner lip reflexed about umbilicus. Hypotype G 1.

2 Side view showing growth lines, trilineate peripheral keel, sharply defined upper and lower carinae. Hypotype G 2.

3 Side view showing trilineate peripheral keel, broadly rounded upper carina and very faint lower carina. Hypotype G 3.

4 Side view showing growth lines, rounded peripheral keel, sharply defined upper carina and slight ridge for lower carina. Hypotype G 4.

5 Side view showing rounded peripheral keel, broadly rounded upper carina, very faint lower carina. Hypotype G 5.

6 Side view showing rounded peripheral carina, very faint upper and lower carina. Hypotype G 6.

Plate VI (continued)

Figures 7-11 — Lophospira serrulata (Salter) (page 41)

7 — Side view showing growth lines and peripheral slit, strong carinae, uncoiling body whorl. Hypotype G 11.

8 — Side view showing growth lines, aperture with peripheral slit, four strong carinae, trilineate peripheral keel. Hypotype G 11.

9 — Side view tilted further back than in fig. 8; showing same features as in fig. 8.

10 — Side view showing growth lines, four strong carinae, trilineate peripheral keel with serrated edge. Hypotype G 12.

11 — Side view showing growth lines and peripheral slit, three strong carinae, rounded peripheral keel on bottom whorl, trilineate keel with serrated edge on top whorl. Hypotype G 13.

Figures 12-15 — Trochonema wilsonae n. sp. (page 47)

12 — Side view showing growth lines, first, second, third carinae. Holotype G 25.

13 — Top view showing outline of shell Holotype G25.

Plate VI (continued)

14 Side view showing aperture, four strong carinae separated by concave areas, growth lines. Holotype G 25.

15 Bottom view showing wide, open umbilicus, fourth and fifth carinae, aperture with inner lip slightly reflexed about umbilicus. Paratype G 26.

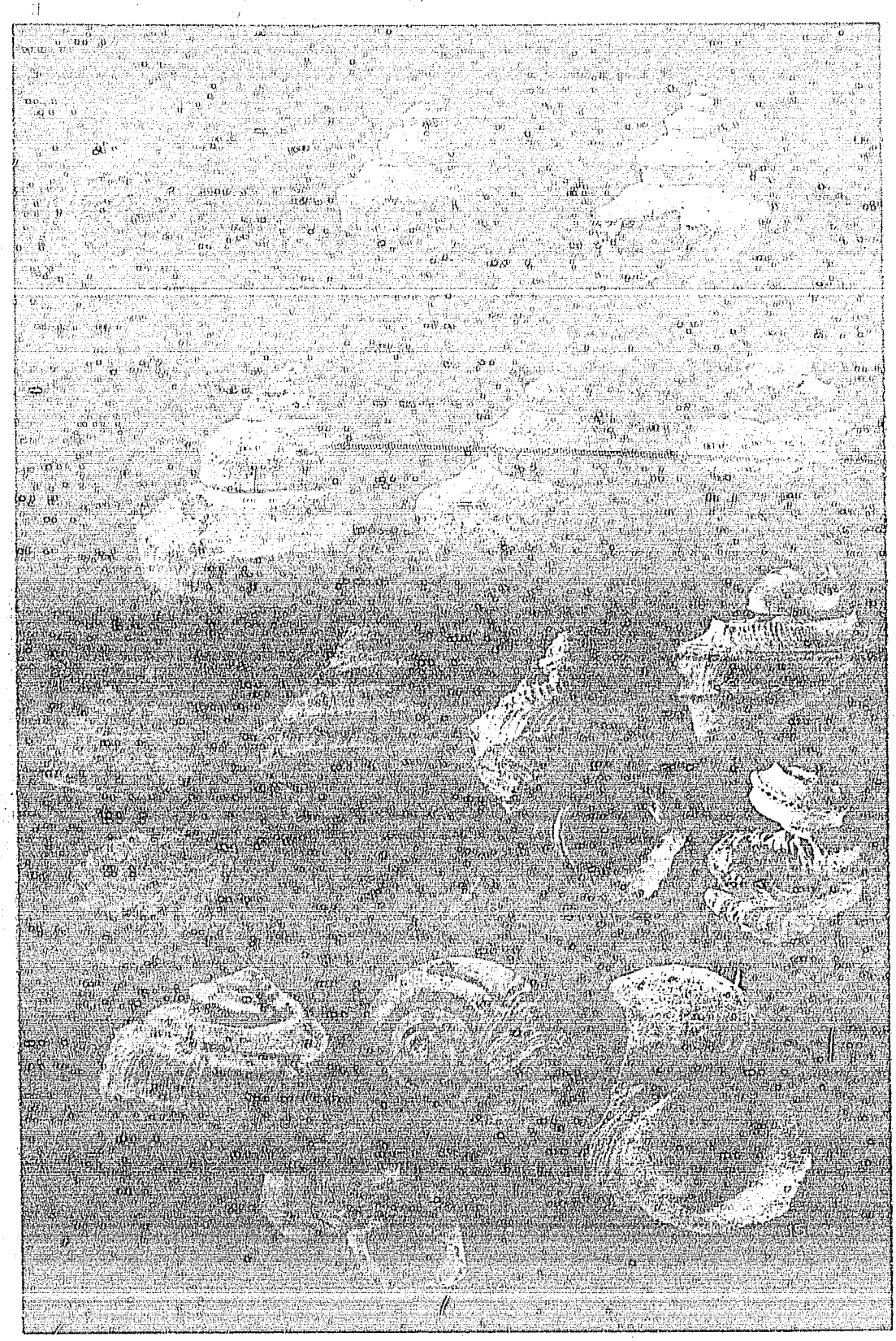


Plate VI

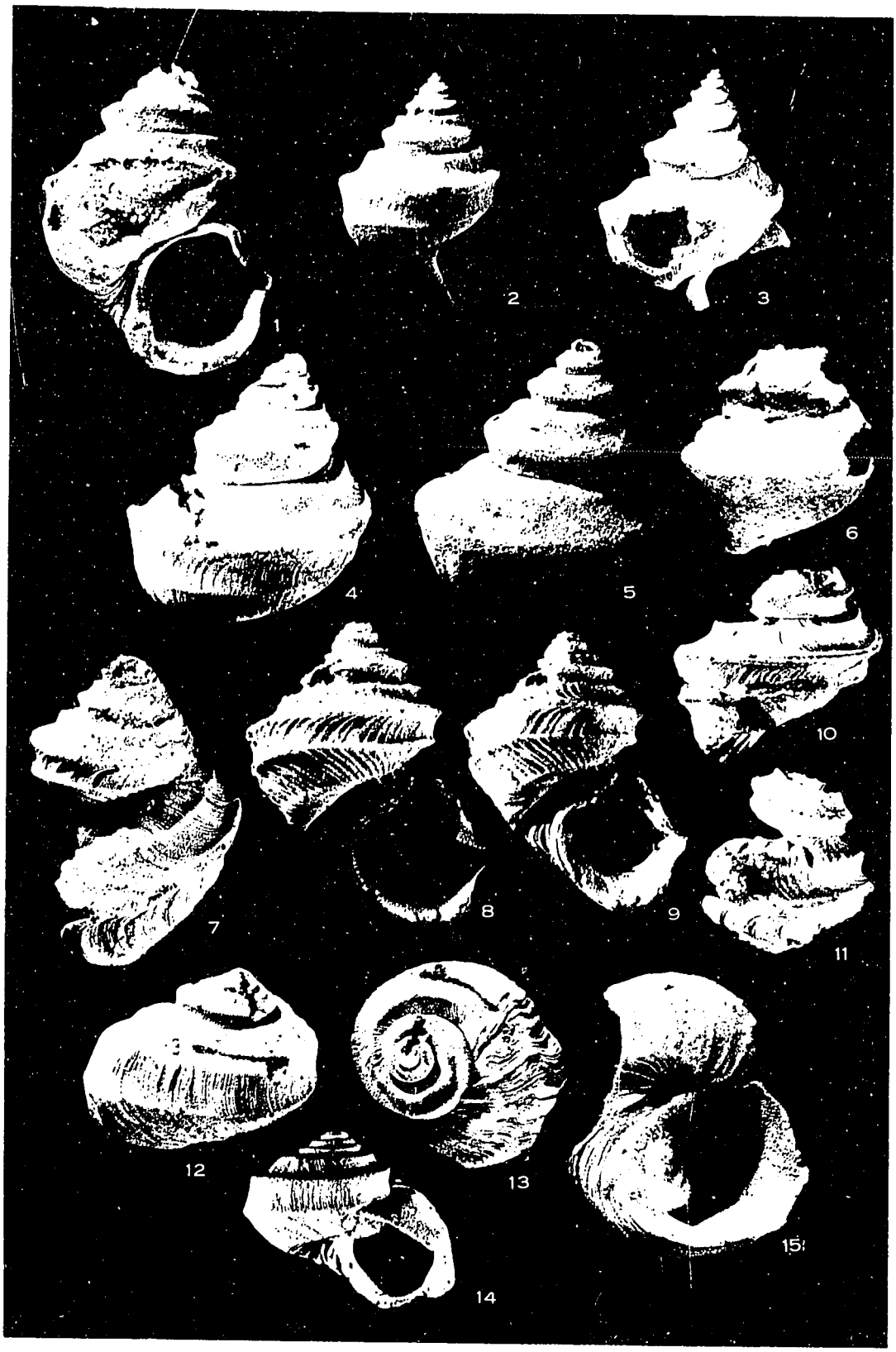

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

PLATE VII

Plate VII

(all figures x 2 unless otherwise stated)

Figures 1, 2 — Tetranota sp. (page 54)

1 — x 4. Dorsal view showing ridges, selenizone, concave areas. Hypotype G 36.

2 — x 4. Side view showing umbilicus. Hypotype G 36.

Figures 3, 4 — Phragmolites ? sp. (page 55)

3 — x 4. Side view showing loosely coiled whorls. Hypotype G 37.

4 — x 4. Dorsal view showing conspicuous keel. Hypotype G 37.

Figure 5 — Phragmolites sp. (page 56). Side view showing surface ornamentation. Hypotype G 38.

Figure 6 — Tetranota cf. bidorsata (Hall) (page 52)

Dorsal view showing flared outer lip. Hypotype G 35.

Figures 7-10 — Raphistomina fissurata n. sp. (page 48)

7 — Side view showing outline of specimen, smoothly sloping spire, peripheral keel, position of aperture. Holotype G 28.

Plate VII (continued)

8 Side view showing outline of specimen, peripheral keel with selenizone near aperture, growth lines, position of body whorl compared with position of preceeding whorl. Holotype G 28.

9 Top view showing growth lines, injury and subsequent growth on body whorl. Holotype G 28.

10 Bottom view showing growth lines, thickened inner lip slightly reflexed about umbilicus. Holotype G 28.

Figures 11, 12 Clathrospira subconica (Hall) (page 51)

11 Side view showing outline of shell, ornamentation, prominent selenizone. Hypotype G 29.

12 x 3. Side view showing selenizone, growth lines and transverse lines. Hypotype G 29.

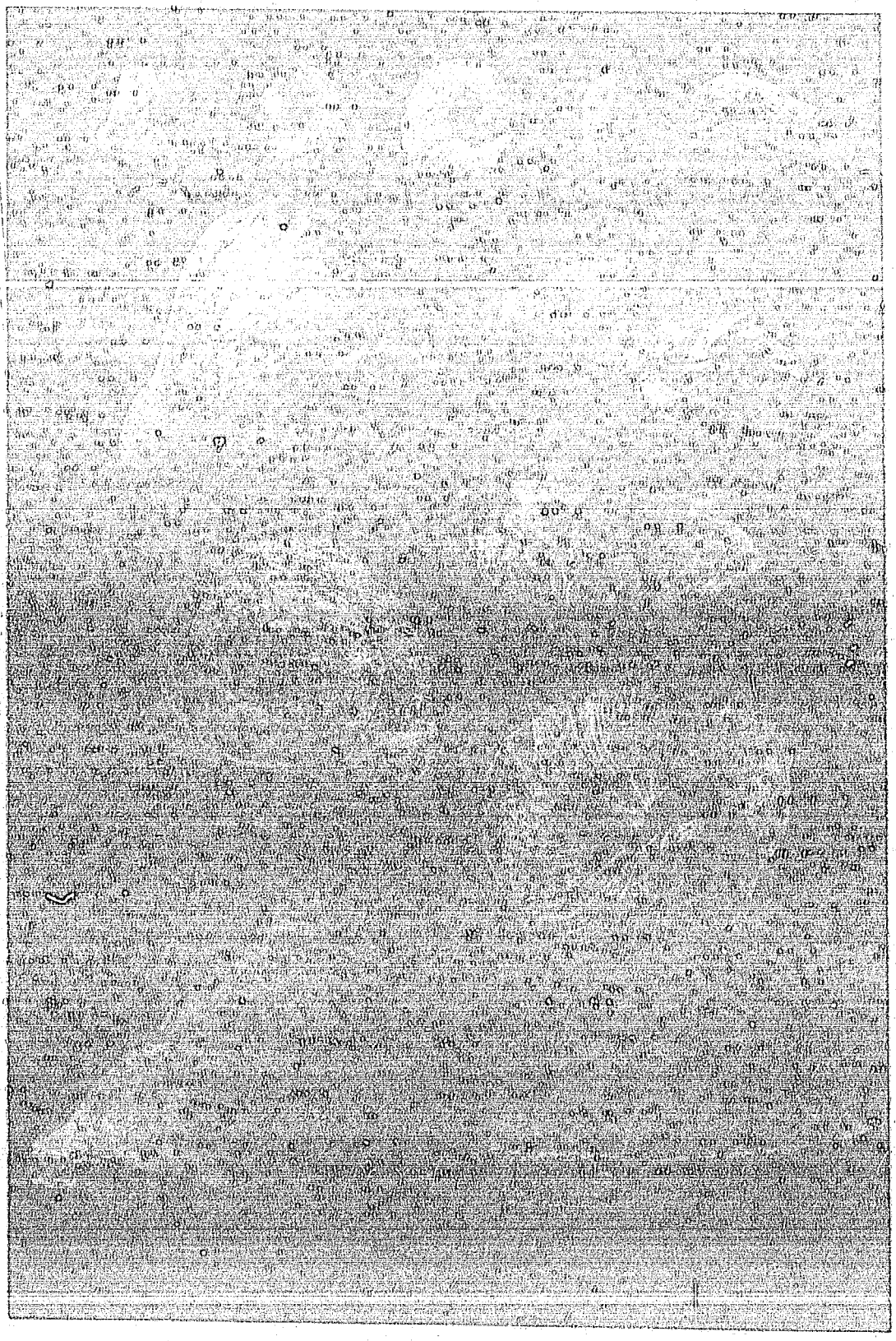


Plate VII

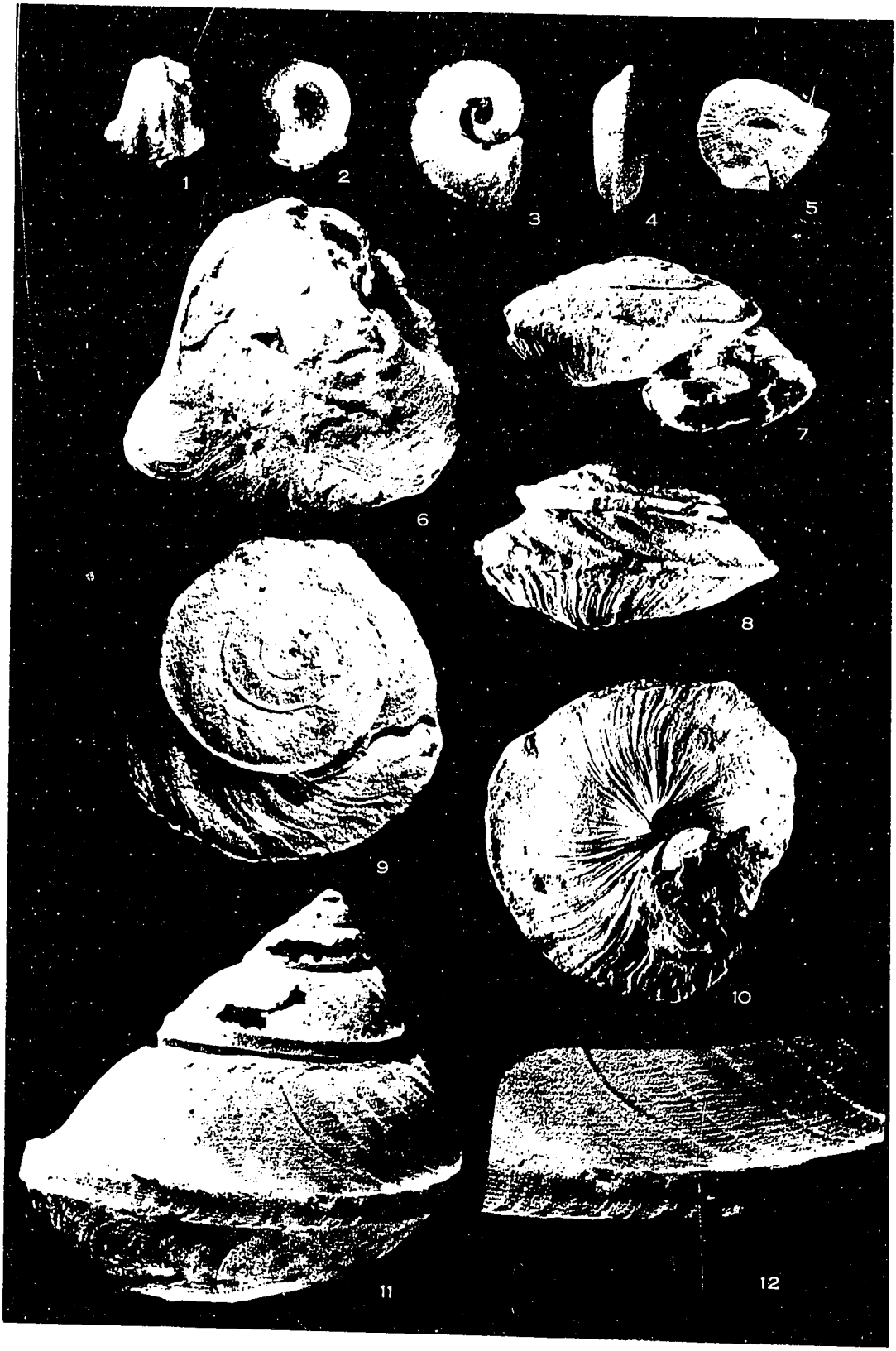

1
2
3
4
5
6
7
8
9
10
11
12

PLATE VIII

Plate VIII

(all figures x 2 except where otherwise stated)

Figures 1-5 Loganoceras regulare (Billings) (page 62)

1 View of septum showing circular outline, position of siphuncle. Hypotype C 11.

2 Ventral view showing downward bend of growth lines at position of hyponomic sinus. Hypotype C 11.

3 Lateral view showing transverse growth lines. Hypotype C 11.

4 View of septum showing position of siphuncle, stepped nature of septum. Hypotype C 12.

5 Lateral view showing irregular bumpy growth on surface. Hypotype C 12.

Figures 6, 7 Michelinoceras sp. 3 (page 68)

6 View of interior showing separation of septa. Hypotype C 6.

7 View of exterior. Hypotype C 6.

Figure 8 Michelinoceras sp. 2 (page 67). Polished section showing siphuncle, separation of septa. Hypotype C 5.

Plate VIII (continued)

Figures 9, 10 — Michelinoceras sp. 1 (page 67)

9 — Polished section showing siphuncle with septal necks, separation of septa. Hypotype C 3.

10 — View of interior showing separation of septa. Hypotype C 4.

Figure 11 — Ormoceras sp. (page 66). Polished section showing siphuncle with septal necks, brims and connecting rings, separation of septa. Hypotype C 2.

Figure 12 — Actinoceras cf. aequale Flower (page 65) x 1. Polished section showing siphuncle with septal necks, brims and connecting rings, separation of septa. Hypotype C 1.

Plate VIII

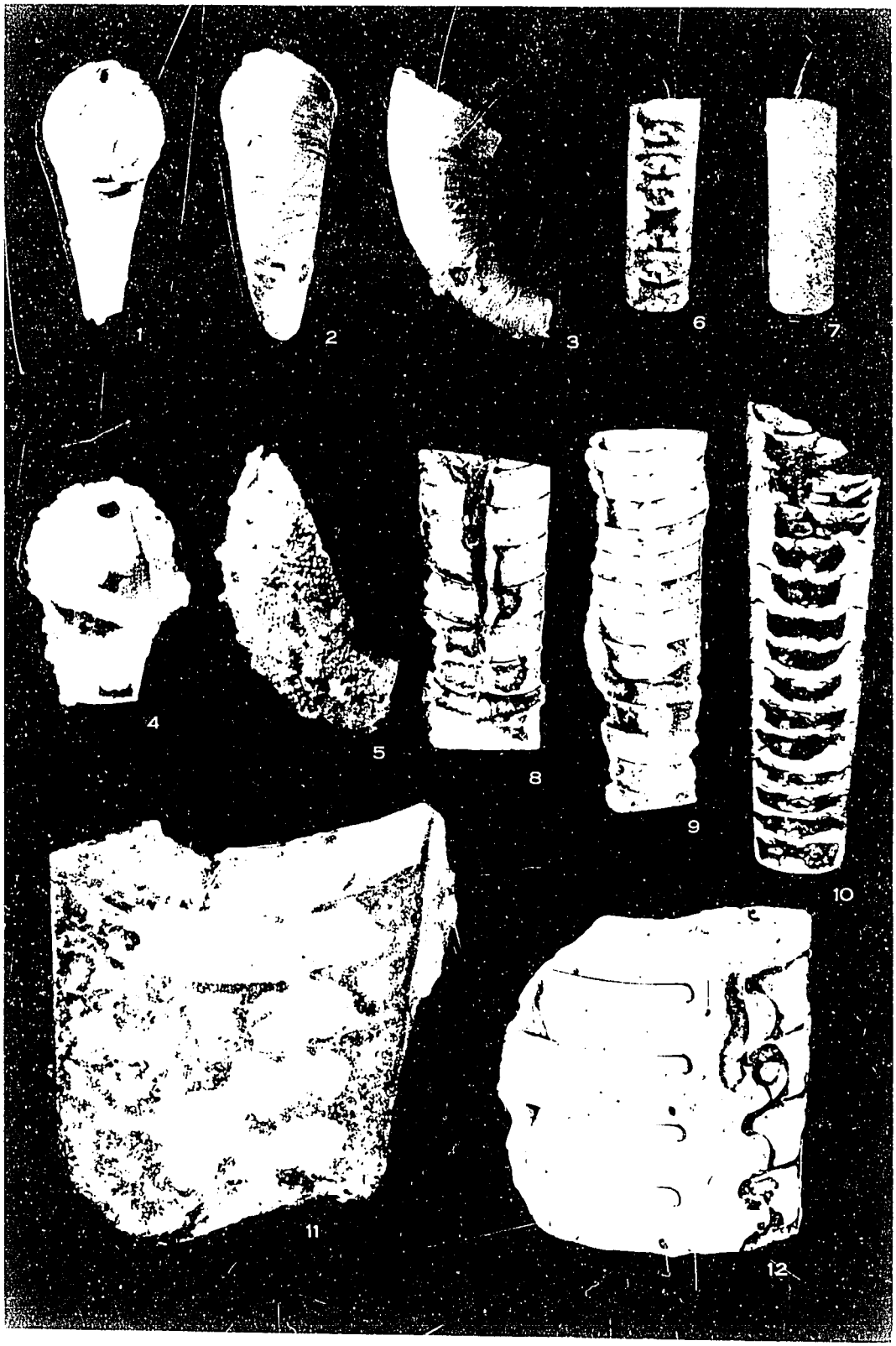

1
2
3
6
7
4
5
8
9
10
11
12

PLATE IX

Plate IX (continued)

10 x 1. Colour bands narrower at lateral regions of shell.

11 x 1. Wide colour bands.

Plate IX

(all figures x 2 unless otherwise stated)

Figures 1-3 "Spyrocera "sp. (page 69)

1 Side view showing annuli, primary and secondary longitudinal ribs. Hypotype C 9.

2 View of septum. Hypotype C 9.

3 Side view showing annuli, primary, longitudinal ribs. Hypotype C 10.

Figures 4-6 "Cycloceras" cylindratum Foerste (page)

4-6 Side views showing undulating annulations, separation of sutures. Hypotype C 8.

Figures 7, 8 Nonomuchites decrescens (Billings) sensu Foerste (page 70)

7 x 1. Polished section showing body chamber, siphuncle with septal necks, separation of septa. Hypotype C 7.

8 x 1. View of exterior showing annuli. Hypotype C 7.

Figures 9-11 Cephalopods showing colour markings.

9 Etched specimen with more deeply weathered colour bands than remainder of shell.

Plate IX

Plate IX