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MINES AND GEOLOGY BRANCH

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GEOLOGICAL SURVEY BULLETIN

No. 8

BRACHIOPODA OF THE OTTAWA FORMATION  
OF THE OTTAWA-ST. LAWRENCE LOWLAND

BY

Alice E. Wilson



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OTTAWA  
EDMOND CLOUTIER  
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY  
1946

*Price, 50 cents*

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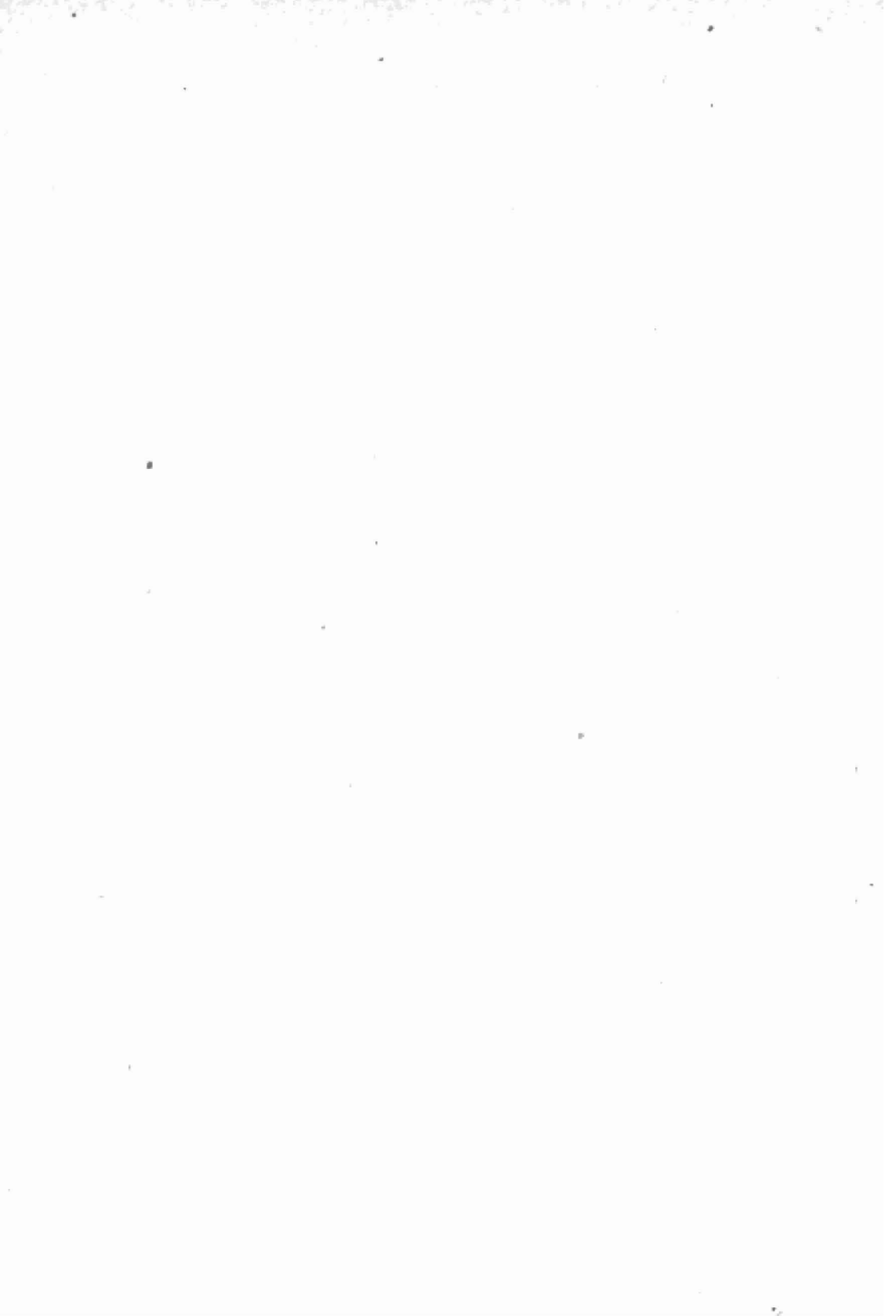
## PREFACE

This report is the second of a series of planned reference texts on the palæontology of the Palæozoic strata of the Ottawa-St. Lawrence Lowland. The series commences with studies of the fauna of the Ottawa formation, the initial contribution, Geological Survey Bulletin No. 4, dealing with the Echinodermata. The Ottawa formation itself is of late Middle Ordovician age, and its lithology and stratigraphic position with relation to other Palæozoic formations are fully discussed in a recent report by the same author, Memoir 241, on the "Geology of the Ottawa-St. Lawrence Lowland".

Brachiopods constitute the most important group of fossils in the Ottawa formation, both in respect to numbers of genera and species and numbers of specimens. The following exhaustive study of the numerous forms will, it is hoped, supply a useful guide to the correlation of Ordovician formations in the various parts of Canada where marine strata of this period are represented.

GEORGE HANSON,  
*Chief Geologist, Geological Survey*

OTTAWA, April 2, 1946



# BRACHIOPODA OF THE OTTAWA FORMATION OF THE OTTAWA-ST. LAWRENCE LOWLAND

## INTRODUCTION

### GENERAL STATEMENT

The Ottawa-St. Lawrence Lowland is the early Palæozoic basin drained by Ottawa and St. Lawrence Rivers. It is bounded on the north and south by the Canadian Shield and Adirondack Mountains respectively, on the southwest by the Frontenac axis, which connects the Shield with the western Adirondacks, and on the east by the Beauharnois anticline, a lesser axis partly concealed by the earliest Palæozoic sediments and extending from St. Jerome, Quebec, to the eastern Adirondacks.

Within this basin the Precambrian floor is overlain by about 2,300 feet of Lower, Middle, and Upper Ordovician sediments. The Ottawa formation occurs at the top of the Middle Ordovician and is of Black River-Trenton age. It overlies deposits of Chazy age and underlies the shales of Collingwood-Gloucester age. The formation has a thickness of 690 feet. It is composed mainly of thick beds of limestone—though some shale and sandstone is interbedded at the base. The lower beds, consisting of about 75 feet of limestone and dolomitic limestone interbedded at the base with some sandstone and shale, were originally considered to be of Chazy age, and were mapped as such. The remaining 615 feet of limestone were designated the Black River-Trenton group by early geologists. Both are included in the Ottawa formation because there was no interruption in the deposition of the sediments and no significant change in lithology, and because fossils found in the lower beds show that they, too, are of Black River age. The more recent New York term 'Mohawkian' cannot be applied here because it does not include the lower beds.

The 690 feet of Black River-Trenton sediments have been split into seven divisions, variously called 'members' or 'formations'. These several divisions are here considered to be beds of faunal associations. They are not sharply differentiated either in lithology, or, except in a very few cases, in the occurrence of fossils. A change in fauna would occur inevitably during the length of time required to deposit 690 feet of sediments, and such a change does occur, but it is gradual. Certain groupings of fossils can be recognized, but passing upward first one and then another species or genus of each group gives place to other species or genera so that the grouping changes gradually with an overlapping of species and without a definite line of demarcation. These groupings or associations of fossils are not faunal zones, because most of the species range irregularly through two or more groupings. For these reasons, then, the grouping of fossils within certain beds are faunal associations rather than faunal zones, or, rather than 'members' or 'formations' as previously defined. The original names of the so-called 'members' or 'formations', however, are retained here, in conjunction with the more elastic term 'beds,' to designate the general level at which each fossil species occurs and to show its range.

The Ottawa formation carries the most prolific fauna of the Ordovician formations of the region. All the formation within the basin lies north of the International Boundary, and its best exposures are found in the vicinity of the city of Ottawa and below the city in the valley of Ottawa River, from which area its name is taken.

### OCCURRENCE OF BRACHIOPODA

The Brachiopoda constitute the most important group of fossils found in the Ottawa formation, and are the most prolific in genera and species and in number of specimens. They are classified here according to the pedicle opening and the structure of the animal as reflected upon the interior of the valves, rather than upon the punctæ system of the shell as adopted by G. A. Cooper<sup>1</sup>.

<sup>1</sup> Cooper, G. A.: Index Fossils of North America, 1944, p. 283.



## ANALYSIS OF RANGE

One hundred and eighty-four species of brachiopods have been found in the Ottawa limestone.

7	first appear in the Pamela or Pamela-Lowville beds
19	in the Lowville or Lowville-Leray beds
62	in the Leray or Leray-Rockland beds
15	in the Rockland or Rockland-Hull beds
14	in the Hull or Hull-Sherman Fall beds
25	in the Sherman Fall or Sherman Fall-Cobourg beds
42	in the Cobourg beds

184 total

Table I shows the range of each of the brachiopods within these beds. Of the 184 species only 32 (those in brackets) are confined to the beds in which they occur, and 18 of these 32 occur within the doubtful beds that some authors call Leray and others Rockland. There are, then, only 15 definitely limited species, except the 42 species that do not appear until the deposition of the Cobourg beds, and it must be remembered that the Cobourg beds comprise the upper half or more of the formation.

TABLE I  
*Range of Brachiopod Groups*

Pamelia or Pamelia-Lowville	Lowville or Lowville-Leray	Leray or Leray-Rockland	Rockland or Rockland-Hull	Hull or Hull-Sherman Fall	Sherman Fall	Cobourg
7	19(3)	3 5 62(24)	2 2 25 15(2)	1 1 2 14(1)	1 10 2 3 25(2)	1 8 21 6 11 23 42

TABLE II  
Range of Species

Species	OTTAWA FORMATION FAUNAL BEDS <sup>1</sup>						
	Pamella	Lowville	Leroy	Rockland	Hull	Sherman Fall	Cobourg
<i>Dinobolus canadensis</i> (Billings)				x			
<i>D. erectus</i> n.sp.				x			
<i>D. magnificus</i> (Billings)				x			
<i>Langula brisets</i> Billings						x	x
<i>L. cobourgensis</i> Billings						x	x
<i>L. curta</i> Conrad						x	x
<i>L. elongata</i> Hall						x	x
<i>L. hullensis</i> n.sp.		x					
<i>L. huronensis</i> Billings							
<i>L. narrawayi</i> Wilson	x						
<i>L. obtusa</i> Hall							
<i>L. philomela</i> Billings						x	x
<i>L. rectilateralis</i> Emmons						x	
<i>L. riciniiformis</i> Hall						x	x
<i>L. sinclairi</i> h.sp.							
<i>L. trenlonensis</i> Conrad						x	
<i>Langulasma eoa</i> (Billings)							
<i>Corruwallia minuta</i> Wilson ?							
<i>Trematis otawaensis</i> Billings							
<i>T. terminalis</i> (Emmons)						x	x
<i>Schizocrania filosa</i> Hall		x					
<i>S. minuscula</i> n.sp.						x	x
<i>Orbiculoides lamellosa</i> d'Orbigny							
<i>Schizotreta canadensis</i> n.sp.							
<i>S. pelopea</i> (Billings)							
<i>Crania setigera</i> Hall							
<i>C. trenlonensis</i> Hall							
<i>Pholidops trenlonensis</i> Hall							
<i>Plectrothis neglecta</i> (James)							
<i>P. otawaensis</i> n.sp.							
<i>P. plicatella laurentina</i> n. var.							





OTTAWA FORMATION  
FAUNAL BEDS

Species	OTTAWA FORMATION FAUNAL BEDS						
	Pamella	Lowville	Leray	Rookland	Hull	Sherman Fall	Cobourg
<i>D. pectinella</i> (Emmons)				x x		x	
<i>D. pectinella</i> cf. <i>sweeneyi</i> (N. H. Winchell)				x		x	
<i>D. regularis</i> n.sp.				x		x	
<i>D. strahmorria</i> Wilson					x		x
<i>D. subquadrata</i> (Hall)					x	x	
<i>D. subquadrata alternata</i> n.var.					x	x	x
<i>Doleroides gibbosus</i> (Billings)					x	x	x
<i>D. perretus ottawanus</i> Wilson				x	x		
<i>Sowerbyella</i> ? <i>minuta</i> n.sp.				xx			
<i>S. punctostriata</i> Mather				x			x
<i>S. sericea</i> (Sowerby)				xx	x	x	x
<i>S. subovatis</i> Wilson				x	x	x	x
<i>Leptaena affinis</i> n.sp.							x
<i>L. ? diminuta</i> n.sp.							x
<i>L. trentonensis</i> Wilson							x
Low convexity							
<i>Rafinesquina alternata</i> (Conrad)				x	x	x	x
<i>R. alternata elata</i> Wilson				x			
<i>R. alternata intermedia</i> Wilson				x	x	x	x
<i>R. alternata plana</i> Wilson				x	x	x	x
<i>R. alternata platys</i> Wilson				x			
<i>R. alternata pola</i> Wilson						x	x
<i>R. alternata quadrata</i> Wilson					x	x	x
<i>R. alternata semiquadrata</i> Wilson				x	x		
<i>R. alternata transversa</i> Wilson				x	x		
<i>R. carlottina</i> Wilson					x	x	x
<i>R. lenocensis</i> Salmon				x			
High convexity							
<i>R. apicalis</i> Wilson							x
<i>R. calderi</i> Wilson						x	x





OTTAWA FORMATION  
FAUNAL BEDS

Species

Species	OTTAWA FORMATION FAUNAL BEDS						
	Pamella	Lowville	Leray	Rockland	Hull	Sherman Fall	Cobourg
<i>O. plicata</i> Wilson.....						x	
<i>O. auriculata</i> Wilson.....							x
<i>O. gloucesterensis</i> Wilson.....							
<i>O. hemispherica</i> Wilson.....							
<i>O. inaquassa</i> (Sardeson).....							
<i>O. ovalis</i> Wilson.....							
<i>O. platys</i> Wilson.....							
<i>O. rugosa</i> (Wilson).....						?	
<i>O. f rugosa arida</i> (Wilson).....							
<i>O. septata borealis</i> Wilson.....							
<i>O. stictari</i> Wilson.....							
<i>O. subtriangularis</i> Wilson.....							
<i>O. transitionalis</i> (Okulitch).....							
<i>O. tumida</i> Wilson.....							
<i>O. wagneri</i> (Okulitch) ?.....							
<i>O. wagneri robusta</i> Wilson.....							
<i>O. williamsi</i> (Okulitch).....							
<i>O. pibinella affinis</i> Wilson.....							
<i>O. salmoni</i> Wilson.....							
<i>Strophomena bilingsi</i> W. and S.....							
<i>S. delicatula</i> Fenton.....							
<i>S. cf. dignata</i> Fenton.....							
<i>S. extensa</i> Wilson.....							
<i>S. flitceata</i> Hall.....							
<i>S. flitceata crenulata</i> Wilson.....							
<i>S. flitceata obesa</i> Wilson.....							
<i>S. irregularis</i> Wilson.....							
<i>S. magna</i> Wilson.....							
<i>S. f millioenenensis affinis</i> n. var.....							
<i>S. minuta</i> Wilson.....							
<i>S. mollis</i> Wilson.....							



## FOSSIL LOCALITIES

1. Westport, Ontario
2. Lot 10, con. VIII, North Crosby tp., Ontario
3. Lake Clear, Ontario
4. West side of Lake Clear, Ontario
5. North side of Lake Clear, 3 miles east of west end, Ontario
6. One mile west of Esmonde, Opeongo road, Ontario
7. Paquette Rapids, Ontario
8. La Rhône snye at foot of Paquette Rapids, Quebec
9. Pointe Sèche, Quebec
10. Eganville, Ontario
11. Bonnechère River below Eganville, Ontario
12. North shore, opposite limekiln, Bonnechère River below fault, near Eganville, Ontario
13. Jessop Rapids, Bonnechère River, Ontario
14. Four miles west of the 4th Chûte, Bonnechère River, Ontario
15. 4th Chûte, Bonnechère River, Renfrew county, Ontario
16. Cobden road, northeast of Douglas ?, Ontario
17. One mile south of Douglas, Ontario
18. Lot ?, con. ?, McNab tp., Ontario
19. Hill above Sand Point, Ontario
20. Pakenham, Ontario
21. Quarry east of Pakenham, Ontario
22. First corner east of Panmure, Ontario
23. One-half block north of Panmure, Ontario
24. Lot 1, con. IV, Fitzroy tp., Ontario
25. Lot 23, con. XII, Fitzroy tp., Ontario
26. Lot 25, con. I, Torbolton tp., Ontario
27. Lot 27, con. I, Torbolton tp., Ontario
28. Lots 22 and 23, con. III, Torbolton tp., Ontario
29. Large, flat, plateau-like area, Torbolton tp., Ontario
30. MacLaren Landing, Ontario
31. Lot 20, con. V, Hull tp., Quebec
32. North from Aylmer, Quebec
33. Two miles north of Aylmer, Quebec
34. Broad street, Aylmer, Quebec
35. Creek crossing road west of Fairy Lake, west of Hull, Quebec
36. East side of Fairy Lake, Quebec
37. Back of schoolhouse north of Fairy Lake, Quebec
38. Val Tetreau, Quebec
39. East of Val Tetreau, Quebec
40. Between Hull and Val Tetreau, Quebec
41. La petite Chaudière, Val Tetreau, Quebec
42. C.P.R. cut south of Aylmer road crossing, Hull, Quebec
43. Philemon Island, Hull, Quebec
44. Cache Bay, Hull, Quebec
45. Beaver meadow, Hull, Quebec
46. Table rock, Chaudière Falls, Hull, Quebec
47. Booth Mills, Ottawa, Ontario
48. Small island at foot of 'slide', Hull, Quebec
49. East of creek through Eddy's property, Hull, Quebec
50. Cliff behind Eddy's match factory, Hull, Quebec
51. Armouries, Hull, Quebec
52. Between C.P.R. tracks and Front street, Hull, Quebec
53. Wright quarry, Hull, Quebec
54. Top of Wright quarry, Hull, Quebec
55. Opposite Canadian Packing factory, Hull, Quebec
56. Behind axe factory, Hull, Quebec
57. Brewery Creek, Hull, Quebec
58. Brigham Quarry, Hull, Quebec
59. Brigham (Leamy?) Lake, Hull, Quebec
60. Cement quarry, Hull, Quebec
61. West of Lake Flora, Hull, Quebec
62. R.R. track, one mile east of Stittsville, Ontario
63. Quarry east of turn to Stittsville, Ontario
64. Lot 13, con. XII, Goulbourn tp., Ontario
65. Lot 18, con. XI, Goulbourn tp., Ontario
66. Lot 8, con. IX, Goulbourn tp., Ontario

67. Lots 22 and 23, cons. II and III, Nepean tp., near Fallowfield, Ontario
68. South of C.P.R. track, south of Eagleson Corners, Ontario
69. East end of road between G. and H., con. C, Nepean tp., Ont.
70. Lot 14, con. C, R.F., Nepean tp., Ontario
71. Lot 35, R.F., Nepean tp., Ontario
72. Lot C, R.F., Nepean tp., Ontario
73. Duntile quarry, Carlington, Ontario
74. City View, southwest of Ottawa, Ontario
75. Hillside opposite church, City View, Ontario
76. Base line, City View, Ontario
77. Merivale road, south of Carlington, Ontario
78. Foster's quarry, Merivale road, Ontario
79. Hogsback, south of Ottawa, Ontario
80. Hogsback, right bank below bridge, Ontario
81. Quarry east of Hogsback, Ontario
82. Hogsback, quarry east side of river above bridge, Ontario
83. South of Walkley road, con. III, Gloucester tp., Ontario
84. DeLury Farm ?, Ottawa, Ontario
85. Corner Fifth ave. and Percy street, Ottawa, Ontario
86. West end of Fifth ave., Ottawa, Ontario
87. Corner Fifth ave. and Bronson ave., Ottawa, Ontario
88. Fourth ave., Ottawa, Ont.
89. Lakeside Park, Ottawa, Ontario
90. Booth (Division) street, Ottawa, Ontario
91. South end of LeBreton street, Ottawa, Ontario
92. West side of Dow Lake, Ottawa, Ontario
93. Northeast of Dow Lake, Ottawa, Ontario
94. Ruskin ave., west of Holland ave., Ottawa, Ontario
95. Corner of Rochester and Lydia streets, Ottawa, Ontario
96. Bureau of Mines excavation, Booth street, Ottawa, Ontario
97. Between Lyon and Bay streets, Ottawa, Ontario
98. Between Rochester street and Mount Sherwood, Ottawa, Ontario
99. Mount Sherwood, Ottawa, Ontario
100. Old limekiln, Ottawa, Ontario
101. C.N.R. tracks, just west of Bronson ave., Ottawa, Ontario
102. Cliff at west end of Sparks street, Ottawa, Ontario
103. Corner Booth and Elm streets, Ottawa, Ontario
104. Corner Lorne ave. and Maple street, Ottawa, Ontario
105. Corner Somerset street and Spadina ave., Ottawa, Ontario
106. West side of Parkdale ave., north of C.P.R. tracks, Ottawa, Ontario
107. Bridge to Lemieux Island, Ottawa, Ontario
108. North and east side of Lemieux Island, Ottawa, Ontario
109. Mechanicsville, Ottawa, Ontario
110. Victoria Island, Ottawa, Ontario
111. Canal basin, Ottawa, Ontario
112. La Salle College excavation, Ottawa, Ontario
113. Russell ave. ?, Ottawa, Ontario
114. Parliament Hill, Ottawa, Ontario
115. Lady Grey Drive, Ottawa, Ontario
116. Nepean Point, Ottawa, Ontario
117. Between Nepean Point and Queens Wharf, Ottawa, Ontario
118. Foot of Sussex street, Ottawa, Ontario
119. Steamboat landing, Sussex street, Ottawa, Ontario
120. East of steamboat landing, Sussex street, Ottawa, Ontario
121. Research Council Laboratories excavation, Ottawa, Ontario
122. MacLaren Mills (Edwards Mills?), Ottawa, Ontario
123. New Edinburgh, Ottawa, Ontario
124. Crichton street, New Edinburgh, Ottawa, Ontario
125. McKay street, Ottawa, Ontario
126. Corner of McKay and Thomas streets, Ottawa, Ontario
127. Loose on shore, McKay street, Ottawa, Ontario
128. West side of Governor Bay, Ottawa, Ontario
129. Governor Bay, Ottawa, Ontario
130. Near Rideau Hall gate, Ottawa, Ontario
131. Rideau Hall, Ottawa, Ontario
132. Beechwood cemetery, Ottawa, Ontario
133. From an unspecified locality, Ottawa, Ontario
134. East of Notre Dame cemetery, Eastview, east of Ottawa, Ontario
135. Road north of Notre Dame cemetery, Eastview, Ontario

136. Crest of hill, Rockcliffe Aerodrome road, east of Ottawa, Ontario
137. Powder Magazine quarry, Montreal road, east of Ottawa, Ontario
138. Robillard quarry, Montreal road, east of Ottawa, Ontario
139. Skead road, 3 miles east of Ottawa, Ontario
140. Field east of Skead road and north of Montreal road, east of Ottawa, Ontario
141. Montreal road, west of Green Creek crossing, Ontario
142. East of Green Creek, about 5 miles east of Ottawa, Ontario
143. One-half mile southeast of Green Creek crossing, Ontario
144. Top of scarp, east of tank proving ground, 6 miles east of Ottawa, Ontario
145. Lot 23, R.F., Gloucester tp., Ontario
146. Near corner Navan road and Montreal road, Ontario
147. Lots 3 and 4, con. III, R.F., Gloucester tp., Ontario
148. North of Orleans, Ontario
149. Fault line, north of Orleans, Ontario
150. Near Daniston, Ontario
151. Squiggley Hill, west of Cumberland, Ontario
152. Southeast of Cumberland, Ontario
153. Creek bed, 1 mile southeast of Cumberland, Ontario
154. Lot 35, con. F, Cumberland tp., Ontario
155. Lot B, con. IV, Cumberland tp., Ontario
156. Stewart quarry, 1 mile south of Rockland, Ontario
157. Upper 10 feet of Stewart quarry, south of Rockland, Ontario
158. Quarry south of Stewart quarry, south of Rockland, Ontario
159. Lot 21, Front con., Clarence tp., Ontario
160. Creek bed, old highway, east of Rockland, Ontario
161. Fox Creek, Clarence tp., Ontario
162. Lots 13 and 14, con. III, North Plantagenet tp., Ontario
163. One mile northeast of Orient, Ontario
164. Jessop Rapids, Nation River, Ontario
165. East side of Nation river, above Jessop Rapids, Ontario
166. Plantagenet near the bridge, Ontario
167. Plantagenet below the bridge, Ontario
168. Lot 10, con. VI, North Plantagenet tp., Ontario
169. Bridge south of Plantagenet, Ontario
170. Lot 7, con. IX, Cumberland tp., Ontario
171. Lot G, con. VII, Cumberland tp., Ontario
172. Lot A, con. VII, Cumberland tp., Ontario
173. Ridge crossing lot A, con. VII, Cumberland tp., Ontario
174. Lot 2, con. IV, Cumberland tp., Ontario
175. North of Navan, Ontario
176. Hill crossing Navan road 4,130 feet north of junction with Blackburn road, Ontario
177. Escarpment on Navan-Sarsfield road, Ontario
178. Lot 31 ?, con. I, Cumberland tp., Ontario
179. Two and one-half miles east of Leonard, Ontario
180. Cons. IX and X, Clarence tp., Sarsfield road, Ontario
181. Lots 11 and 12, cons. X and XI, Clarence tp., Ontario
182. Farthest east of three quarries, south from Clarence Creek, Ontario
183. One mile south and 2 miles east of Clarence Creek, Ontario
184. Southwest of Bourget, Ontario
185. Lot 19, con. XVI, South Plantagenet, Ontario
186. Castor River below Embrun, Ontario
187. Three-quarters mile south of Embrun, Ontario
188. Lot 9 ?, con. X, Russell tp., Ontario
189. Casselman, Ontario
190. One and three-quarter miles east of St. Albert, Ontario
191. Lots 13 and 14, cons. IX and X, Cambridge tp. (loose on road), Ontario
192. Lot 22, con. V, Winchester tp., Ontario
193. Lot 25, con. X, Cambridge tp., Ontario
194. Lot 24, con. IX, Finch tp., Ontario
195. River bed, Crysler, Ontario
196. Lot 13, con. VII, Finch tp., Ontario
197. Near Berwick, Ontario
198. Payne River, south of bridge, cons. IV and V, Finch tp., 2 miles north of Finch, Ontario
199. Payne River, Finch, Ontario
200. One mile west of Finch, Ontario
201. East of Goldfield, Ontario
202. Southeast of Goldfield, Ontario
203. Lots 25-27, con. V, Osnabruck tp., Ontario
204. North of Alfred Centre, Ontario

205. East of Alfred Centre, Ontario
206. Alfred Centre, Ontario
207. Lot 14, con. V, Alfred tp., Ontario
208. Industrial School, Alfred, Ontario
209. Quarry, con. V, east side of first north-south road east of Alfred, Ontario
210. Ange gardien road, 4 miles west of L'Original, Ontario
211. North of cheese factory, Ange gardien road, Ontario
212. North of west red brick house, Ange gardien road, Ontario
213. Quarry on south side of Ange gardien road, Ontario
214. Quarry west of L'Original, Ontario
215. Murray's quarry, L'Original ?, Ontario
216. L'Original—not specified, Ontario
217. North of Cassburn, Ontario
218. Creek, 1½ miles west of Cassburn, Ontario
219. School west of Cassburn, Ontario
220. Stepney Hill, north of Vankleek Hill, Ontario
221. Lot 10, con. III, West Hawkesbury tp., Ontario
222. Quarry on con. IV, West Hawkesbury tp., Ontario
223. McAlpine, Ontario
224. West of McAlpine, Ontario
225. Two and one-half miles west of McAlpine, Ontario
226. Curran ? (loose?), Ontario
227. Southwest of Skye, con. XI, Caledonia tp., Ontario
228. West of Dunvegan, a loose block, Ontario
229. One mile east of a little south of Dunvegan, Ontario
230. Lot 12, con. VIII, Kenyon tp., Ontario
231. Lot 28, con. VI, Kenyon tp., Ontario
232. Lot 22, con. IV, Kenyon tp., southeast of Greenfield, Ontario
233. Lot 32, con. III, Kenyon tp., Ontario
234. Lots 30 and 31, con. I, Lochiel tp., Ontario
235. Mill dam, Loch Gerry, Ontario
236. Lots 22 and 23, con. VII, Roxborough tp., Ontario
237. Lot 33, con. III, Kenyon tp., Ontario
238. Lot 6, Indian Lands, con. III, Kenyon tp., north of cheese factory on Apple Hill-Maxville road, Ontario
239. Lots 24 and 25, con. VI, Roxborough tp., Ontario
240. Lot 9, con. IV, Roxborough tp., east of Gravel Hill, Ontario
241. Lot 22, con. III, Roxborough tp., Ontario
242. Lots 13-15, con. III, Roxborough tp., Ontario
243. Lots 10-12, con. III, Roxborough tp., Ontario
244. Lot 15, con. II, Roxborough tp., Ontario
245. Lot 3, con. I, Roxborough tp., Ontario
246. Back of cheese factory, Strathmore, Ontario
247. Where stream crosses road, 1 mile east of Strathmore, con. I, Roxborough tp., Ontario
248. Road intersecting Indian Lands and con. IX, Charlottenburgh tp., 2 miles southeast of Strathmore, Ontario
249. Indian Lands, cons. VIII and IX, Charlottenburgh tp., Ontario
250. Corner, road between cons. VII and VIII, Charlottenburgh and first north-south road east of Cornwall tp. boundary, Ontario
251. Second north-south road east of Sandfield Mills, Ontario
252. Lots 34 and 35, con. IX, Charlottenburgh tp., southeast of Apple Hill, Ontario
253. Munroe Mills, Ontario
254. One mile southwest of St. Raphael, Ontario
255. In creek south of Martintown, Ontario
256. One mile east of McGillivray bridge, Aux Raisins River, Ontario
257. Lot 21, con. VIII, Cornwall tp., Ontario

258. Lot 1, con. VIII, Cornwall tp., Ontario
259. Bonville, Ontario
260. Aux Raisins River,  $\frac{1}{4}$  mile west of North Lunenburg, con. V, Cornwall tp., Ontario
261. Cut in stream crossing road between Lunenburg and North Lunenburg, Ontario
262. South of where Hoople Creek crosses road between cons. I and II, Osnabruock tp., Ontario
263. Aux Raisins River near Black River Station, Ontario
264. Mille Roches quarries, Ontario
265. Southeast of St. Andrews, Ontario
266. Ridge northwest of Grants Corners, con. IV, Cornwall tp., Ontario
267. Lots 13-15, con. III, Cornwall tp., Ontario
268. Loose at lot 22, con. IV, Gratton tp., Ontario
269. Lot 24, con. IV, Admaston tp., Ontario
270. Lot 10, con. VIII, N. Crosby tp., Ontario
271. Loose, Huntley tp., Ontario, locality not specified
272. Lot 3, con. III, Goulbourn tp., Ontario
273. Lot 13, con. III, Goulbourn tp., Ontario
274. Nepean tp., Ontario, locality not specified
275. Hull, Quebec, locality not specified
276. Muriel street, Ottawa, Ontario
277. Pumphouse, Queen street, Ottawa, Ontario
278. East side of Chaudière Falls, Hull, Quebec
279. The 'Dump', Hull, Quebec
280. Chateau Laurier, Ottawa, Ontario
281. West end of Rideau street, Ottawa, Ontario
282. Major Hill Park, Ottawa, Ontario
283. La Salle Academy, Ottawa, Ontario
284. Montreal road, east of Skead road, east of Ottawa, Ontario
285. Montreal road, east of Roman Catholic Noviciate, east of Ottawa, Ontario
286. Lot 5, con. VI, Clarence tp., Ontario
287. South of Wendover, con. II, N. Plantagenet tp., Ontario
288. One mile south from Treadwell, Ontario
289. Thurso sheet, locality not specified
290. Below bridge at Plantagenet, Ontario
291. Lot 2, con. VIII, Cumberland tp., Ontario
292. Top of hill, lot 8, between cons. VI and VII, Cumberland tp., Ontario
293. Lot 26, con. X, Winchester tp., Ontario
294. Lalonde quarry, west of Alfred, Ontario
295. Old quarry, south of St. Isidore, Ontario
296. Con. IX, Kenyon tp., Ontario
297. West of Dunvegan, Ontario
298. Lots 20 and 21, con. VIII, Kenyon tp., Ontario
299. Lots 9 and 10, con. VII, Kenyon tp., Ontario
300. Dam west of Alexandria, Ontario
301. Lots 3 and 6, con. III, Kenyon tp., Ontario
302. Along stream, southwest of Greenfield, Ontario
303. Indian Lands between Kenyon and Roxborough tps., Ontario
304. Lot 23, con. VII, Roxborough tp., Ontario
305. Lot 35, con. IV, Roxborough tp., Ontario
306. Lot 3, con. IV, Roxborough tp., Ontario
307. Cameron farm, southwest of Gravel Hill, Ontario
308. Lot 46 ? (Indian Lands), con. VII, Charlottenburgh tp., Ontario
309. Half mile east of Cornwall and Charlottenburgh boundary, con. IX, Charlottenburgh tp., Ontario
310. East side of first road, con. IV, Cumberland tp., Ontario
311. Lot 35, Front con., Cumberland tp., Ontario

312. Lot 23, con. I, Kenyon tp., Ontario
313. Allumette Island, Ottawa River, Quebec
314. Lot 24, con. VII, Allumette tp., Quebec
315. Loose, at Lake Doré, Ontario
316. Cobden road, north of Douglas, Ontario
317. South of Cobden road, Bromley tp., Ontario
318. Upper 10 feet of outcrop, south of Cobden road, Bromley tp., Ontario
319. Two miles west of 4th Chûte of Bonnechère River, Ontario
320. Munroe quarry, McNab tp., Ontario
321. Top of hillock a little south of junction of Fitzroy Harbour, MacLaren Landing, and Woodbridge roads, Ontario
322. Northeast of junction of Fitzroy Harbour, MacLaren Landing, and Woodbridge roads, Ontario
323. Southeast end of flat area west of MacLaren Landing, Ontario
324. Road about one mile north of Aylmer, Quebec
325. Near top of hill, Aylmer, Quebec
326. Railway track, one mile northeast of Stittsville, Ontario
327. East of Duntile quarry, Carling ave., west of Ottawa, Ontario
328. North of City View, southwest of Ottawa, Ontario
329. North of C.P.R. tracks west of Parkdale ave., Ottawa, Ontario
330. Primrose Avenue Hill, Ottawa, Ontario
331. Upper layers of quarry at White cottage, Skead road, east of Ottawa, Ontario
332. On hillock east of Skead road, east of Ottawa, Ontario
333. Montreal road, west of Green Creek bridge, east of Ottawa, Ontario
334. Top of cut on crossing, old road 2 miles east of Orleans, Ontario
335. Lot 1, con. XII, Ramsay tp., Ontario
336. Northeast of Orient, Ontario
337. Lot C, con. VII, Cumberland tp., Ontario
338. Lot 3, con. VI, Cumberland tp., Ontario
339. Loose blocks on top of Stewart quarry, Rockland, Ontario
340. Con. X, Russell tp., Ontario, just west of Lemieux road
341. Lots 20 and 21, con. VII, Kenyon tp., Ontario
342. One mile west of Kenyon Station (Greenfield?), Ontario
343. Three miles north of Alexandria, Ontario
344. Two miles southeast of Strathmore, Ontario
345. About one-half mile east of Cornwall tp. boundary, in con. IX, Charlottenburgh tp., Ontario



## DESCRIPTIONS OF SPECIES

Genus, *Dinobolus* HallGenotype, *Obolus conradi* Hall

Subcircular or transversely oval in outline, broken by a prominent pedicle beak; valves convex, thick; concentric striae present.

Pedicle valve with an acute projecting beak; cardinal area of considerable width, triangular, more or less elevated, transversely striated and crossed vertically by the pedicle groove; interior having a small platform, narrow posteriorly, widening towards the front, extending midway and having a V-shaped anterior margin with apex anteriorly pointed; platform vaults abruptly conical; central muscle scar in a groove on the platform, lateral scars occupying most of the rest of the space; anterior median septum and pallial sinuses faint.

Brachial valve with beaks inconspicuous; cardinal area narrow, inner crescent strong; platform narrow and its V-shaped anterior margins more sharply pointed than in the pedicle valve; platform vaults short and conical; central scars deep in furrow, at the front end of which faint anterior scars visible in some specimens; median septum low, but stronger than in pedicle valve; pallial sinuses more or less distinct.

This is the only genus of the *Trimerella* group that occurs in the Ordovician system. The outer form bears a superficial resemblance to *Eichwaldia*, which internally is very different. It can be distinguished externally by the erect and projecting beak of the pedicle valve, as compared with the incurving beak of *Eichwaldia*, and the cardinal area of *Dinobolus* is very different from the internal plate of *Eichwaldia*.

*Dinobolus canadensis* (Billings)

## Plate I, figure 24

*Obolus canadensis* Billings, Can. Nat. Geol., 3, 1858, p. 441, figs. 20-23 (not fig. 19); Geol. Surv., Canada, Rept. of Prog. 1857, 1858, p. 189, figs. 20-23 (not fig. 19).

*Obolellina canadensis* Billings, Can. Nat. Geol. 2nd ser. 6, 1871, pp. 222 and 326, figs. 1-5.

*Dinobolus canadensis* (Billings), Davidson and King, Quart. Jour. Geol. Soc. London, 30, 1874, p. 162, Pl. 19, fig. 7.

Outline oval with posterior end narrower than anterior; biconvex; width, length, thickness, and hinge of holotype: 33 mm., 38 mm., 16 mm., and 21 mm., respectively; cardinal area erect, 5 mm. in height, curving laterally to disappear a little posterior to mid-length; surface with concentric striae, more prominent near the anterior margin.

Pedicle valve with projecting beak, and interior typical of the genus.

Brachial valve: beak incurved, shorter than pedicle valve by the height of the pedicle cardinal area, which makes its length more nearly equal to its width; interior typical of the genus.

Billings originally described two forms under this name. He noted that the species was variable in outline, and later limited the species *D. canadensis* to those forms that are longer than wide.

*Occurrence.* Leray-Rockland beds, localities 7 and 15.

*Type.* Holotype, G.S.C.<sup>1</sup> No. 1150; paratype 1150a; from Leray-Rockland beds, the 4th Chûte of the Bonnechère, Renfrew co., Ontario.

<sup>1</sup>The abbreviation G.S.C. is used for the type specimens in the collections of the Geological Survey, Canada.

*Dinobolus erectus* n.sp.

Plate I, figure 25

A pedicle valve only is known and it is highly silicified. Enough is preserved, however, to show that it is distinct from any described species.

Large, slightly longer than wide, having the typical concentric striæ and the transverse striæ on the cardinal area; pedicle beak very long and prominent; pedicle groove narrow with sub-parallel sides; cardinal area very large; the interior shows the platform large, wide at the interior, and lateral supports widely divergent; platform vault concave toward the front.

The only character of the brachial valve preserved is its outline, which is almost identical with that of *D. magnificus* Billings.

The species differs from *D. magnificus* Billings and *D. canadensis* Billings in having the pedicle valve much longer in proportion to its width, the beak more prominent, and the pedicle groove with sub-parallel sides. In addition, it differs from *D. canadensis* in its more transversely oval brachial valve.

*Occurrence.* Leray-Rockland beds, locality 15.

*Type.* Holotype, G.S.C. No. 6301, from Leray-Rockland beds, the 4th Chôte of the Bonnechère, Renfrew co., Ontario.

*Dinobolus magnificus* (Billings)

Plate I, figures 26, 27

*Obolus canadensis* Billings (part), Geol. Surv., Canada, Rept. of Prog. 1857, 1858, p. 189, fig. 19 (not 20-23); Can. Nat. Geol., 3, 1858, p. 441, fig. 19 (not 20-23).

*Obolellina magnificus* Billings, Can. Nat. Geol., 2nd ser. 6, 1872, p. 329, fig. 7.

*Dinobolus magnificus* (Billings), Davidson and King, Quart. Jour. Geol. Soc. London, 30, 1874, p. 164, Pl. XIX, fig. 8.

This species was originally included under *D. canadensis*, but Billings later distinguished it from the typical *D. canadensis* by its more transversely oval form. Billings and later authors figured the brachial valve only. A poorly preserved paratype showing the beak of the pedicle valve is illustrated here to show that the beak was blunt, that the transverse oval outline is true for the whole specimen, and to compare it with the pedicle valve of the preceding species *D. erectus* n.sp.

*Occurrence.* Leray-Rockland beds, locality 7.

*Type.* Holotype, G.S.C. No. 1161; paratypes, 1161a-1161d; from Leray-Rockland beds, Paquette Rapids, Ontario.

Genus, *Lingula* BruguièreGenotype, *L. anatina* Lamarck (= *L. unguis* Linn.)

Tongue-shaped, elongate, ovate or subquadrate in outline; broad towards the front, sides parallel or tapering towards the beak; valves subequal, often hard to distinguish, the brachial valve generally slightly shorter than pedicle; pedicle opening common to both valves; muscle scars usually indistinct, two pairs of adductors, four pairs of sliders; shell thin, usually compressed, glistening, black, smooth, or with concentric or concentric and radial striæ.

The genus *Lingula* has changed little from Ordovician time to the present. The general shape combined with the glistening black surface distinguishes it from other genera, and the species are generally separated by the variations in outline and the presence or absence of striation.

*Lingula briseis* Billings

## Plate I, figure 7

*Lingula briseis* Billings, Geol. Surv., Canada, Pal. Foss., 1, 1865, p. 48, fig. 52; Geol. Canada, 1863, p. 161, fig. 136.

The species is 18 mm. in length and is characterized by its nearly straight anterior margin, and lack of shoulders on the posterior margin.

*Occurrence.* Sherman Fall beds, locality 42; Cobourg beds, locality 95.

*Type.* Cotypes, G.S.C. Nos. 1643c and 1643e. The types are not from the Ottawa-St. Lawrence Lowland, but from Rivière Bayonne, Berthier co., Quebec.

*Lingula cobourgensis* Billings

## Plate I, figure 16

*Lingula cobourgensis* Billings, Geol. Surv., Canada, Pal. Foss., 1, 1865, p. 50, fig. 54; Geol. Canada, 1863, p. 161, fig. 132.

*Emended Description.* Regularly oval; large, greatest width slightly anterior to middle; length about one-third greater than width, length 25 mm. to 36 mm., width 18.5 mm. to 25 mm.; convexity gentle—a specimen 25 mm. in length is 7 mm. in thickness including both valves; extremities subequal, posterior very obtusely angular, anterior evenly rounded; sides very gently convex centrally, but with a sharper curve towards the extremities; brachial valve gently convex in median line; pedicle valve slightly flattened in the median line above the long umbonal muscle scar, which in one partly exfoliated specimen is 0.72 of the total length; surface, black, smooth, shiny, ornamented by fine concentric growth lines crossed by less conspicuous radiating lines.

The type specimens come from Cobourg, Ontario, but the form is found at Ottawa.

*Occurrence.* Sherman Fall beds, locality 198; Cobourg beds, localities 43, 87, 91, 92, 97, 124, 125, 133, 134, 170, 208, 229, 242, 257.

*Type.* Holotype, G.S.C. No. 1635a. The type is not from this region but from Cobourg beds, Cobourg, Ontario.

*Lingula curta* Conrad

## Plate I, figure 4

*Lingula curta* Conrad, Jour. Acad. Nat. Sci., Philadelphia, 8, 1842, p. 266, Pl. XV, fig. 12; Hall, Pal. New York, 1, 1847, p. 97, Pl. XXX, fig. 6; Billings, Geol. Canada, 1863, p. 161, fig. 138.

This species can be distinguished from others by its small size and almost equal length and width, giving it a subcircular outline except for the slight irregularity at the beak.

*Occurrence.* Hull beds, locality 61; Sherman Falls beds, localities 160, 199, 203, 210; Cobourg beds, locality 141.

*Type.* Plesiotype, G.S.C. No. 6304, from Sherman Fall beds, lot 26, con. V, Osnabrock tp., Ontario.

*Lingula elongata* Hall

## Plate I, figure 5

*Lingula elongata* Hall, Pal. New York, 1, 1847, p. 97, Pl. XXX, fig. 5; Billings, Geol. Canada, 1863, p. 161, fig. 135.

This species can be distinguished from *L. briseis* Billings by its more nearly parallel sides, its lack of radial striæ, and, unless crushed, by its greater convexity.

*Occurrence.* Hull beds, localities 59, 60; Sherman Fall beds, localities 52, 57, 203; Cobourg beds, locality 134.

*Type.* Plesiotypes, G.S.C. Nos. 1639 and 6314, from Sherman Fall beds, lot 26, con. V, Osnabruck tp., Ontario, and from Hull beds, cement quarry, Hull, Quebec.

*Lingula hullensis* n.sp.

Plate I, figure 6

Medium size, elongate-pentagonal; posterior blunt with two sharply rounded shoulders marking the greatest width; beak projecting but little beyond; sides gently converging towards the rounded anterior angles; anterior margin truncated with slightly convex outline; convexity not very great; holotype measuring: width, anterior width, greatest length, and thickness (one valve) 9.5 mm., 6 mm., 15.5 mm., and 1.5 mm., respectively; concentric striae; large median septum evident.

The form is distinguished from *L. elongata* by its blunt posterior shoulders and truncated anterior. In outline it is very like *L. kingstonensis* from which it may be derived, but the specimens seen are all larger and blunter in the posterior region.

*Occurrence.* Lowville-Leray beds, locality 78?; Hull beds, locality 57.

*Type.* Holotype, G.S.C. No. 6318, from Hull beds, Brewery creek, Hull, Quebec.

*Lingula huronensis* Billings

Plate I, figures 14, 15

*L. huronensis* Billings, Can. Nat. Geol. 4, 1859, p. 433, fig. 9; Geol. Canada, 1863, p. 124, fig. 48.

This species differs from others of its size in having three triangular faces and a straight anterior margin.

*Occurrence.* Leray-Rockland beds, locality 147.

*Type.* The holotype is not from the Ottawa-St. Lawrence Lowland but from Lake Huron. Holotype, G.S.C. No. 1159; paratype, G.S.C. No. 1159a; plesiotype, G.S.C. No. 6319; from Leray-Rockland beds, lot 3, con. III, River Front, Gloucester tp., Ontario.

*Lingula narrawayi* Wilson

Plate I, figures 10, 11

*Lingula narrawayi* Wilson, Geol. Surv., Canada, Bull. 33, 1921, p. 44, Pl. III, figs. 4-6.

The species is closest to *L. trentonensis* Conrad, *L. kingstonensis* Billings, and *L. riciniformis* Hall, but can be distinguished from them by its narrowness, its sharper beak, and more truncated anterior.

*Occurrence.* Pamela beds, localities 34, 35, 94; Lowville beds, localities 106, 109.

*Type.* Holotype, from Lowville beds, Parkdale avenue, Ottawa, Ontario, in the collections of the Royal Ontario Museum, Toronto, Ontario.

*Lingula obtusa* Hall

Plate I, figure 3

*L. obtusa* Hall, Pal. New York, 1, 1847, p. 98, Pl. XXX, fig. 7; Billings, Geol. Surv., Canada, 1863, p. 161, fig. 137.

The diagnostic feature of this species is the combination of the obtuse angle of the beak and its non-terminal position.

*Occurrence.* Leray beds, locality 25; Hull beds, locality 60; Hull or Sherman Fall beds, locality 50; Sherman Fall beds, localities 57, 203; Cobourg beds, localities 43, 96, 134, 162, 179, 208.

*Type.* Plesiotype, G.S.C. No. 6323, from Sherman Fall beds, lot 26, con. V, Osnabruck tp., Ontario.

*Lingula philomela* Billings

Plate I, figure 12

*L. philomela* Billings, Geol. Surv., Canada, Pal. Foss., 1, 1865, p. 49, fig. 53; Geol. Canada, 1863, p. 161, fig. 133; Hall and Clarke, Pal. New York, 8, pt. 1, 1892, Pl. I, fig. 8.

Very long, sides slightly convex, almost parallel; beak obtusely angular; anterior end narrowly rounded; length more than twice the width; shell convex; shallow, narrow sinus extending from one-quarter to one-third anterior to the beak along the median line, almost to the anterior margin; ornamentation, fine concentric growth lines interrupted anteriorly by squamose irregularities; colour black.

This form is readily distinguished from all others by its long, narrow outline, median sinus, and anterior ornamentation.

*Occurrence.* Hull beds, locality 60; Sherman Fall beds, locality 160.

*Type.* Holotype, G.S.C. No. 1641a; paratype, No. 1641; from Montmorency, Quebec, not from this region.

*Lingula rectilateralis major* Ruedemann

Plate I, figure 13

*Lingula rectilateralis* Emmons, Geol. New York, Rept. 2nd Dist., 1842, p. 399, fig. 6.

*Lingula quadrata* Hall (not Eichwald), Pal. New York, 1, 1847, p. 96, Pl. XXX, fig. 4; p. 235, Pl. LXXIX, fig. 1.

*Lingula rectilateralis* Emmons, Ruedemann, New York State Mus. Bull., 162, 1912, p. 91, Pl. IV, fig. 1.

*Lingula rectilateralis major* Ruedemann, New York State Mus. Bull. 292, 1925, No. 1, p. 110, Pl. XI, figs. 1 and 2.

This form is of approximately the same size and general appearance as *L. cobourgensis*, but is distinguished from that species by its straight sides and more or less truncated anterior margin.

*Occurrence.* Rockland-Leray beds, locality 147; Hull beds, locality 58.

*Lingula riciniiformis* Hall

Plate I, figure 2

*Lingula riciniiformis* Hall, Pal. New York, 1, 1847, p. 95, Pl. XXX, fig. 2; Winchell and Schuchert, Geol. Minnesota, 3, 1893, p. 343, fig. 24, Pl. XXIX, fig. 9.

The species, from 6 mm. to 8 mm. in length, is characterized by its even convexity and by its somewhat attenuated posterior part ending in an obtuse beak.

*Occurrence.* Leray beds, locality 171; Hull beds, localities 53, 60, 61; Cobourg beds, locality 96.

*Type.* Plesiotype, G.S.C. No. 6324, from Hull beds, Wright's quarry, Hull, Quebec.

*Lingula sinclairi* n.sp.

Plate I, figures 8, 9

Very small, broadly ovate; posterior subangular, anterior broadly rounded; beak not quite terminal, posterior to the beak and to the protogulum a narrow band bearing the continuation of the concentric striæ, not always visible if the beak is slightly buried, often broken off leaving a short straight posterior margin; convexity moderate; position of median septum evident in several crushed specimens; average greatest length, 5 mm., greatest width, 4 mm.; concentric striæ very fine, of two sizes, several exceedingly fine ones between two larger; radial striæ very fine, often interrupted near the anterior by fine squamose-like irregularities.

The species is close to *L. crassa* described by Hall<sup>1</sup>, but it is clearer to give the

<sup>1</sup> Hall, J.: Pal. New York, 1, 1847, p. 98, Pl. XXX, fig. 8.

Ottawa limestone form a new name because Hall does not mention the alternation of concentric striæ, and from his description and illustrations it is evident that he has included more than one species. The species differs from others in its small size, the non-terminal beak, and the ornamentation.

The form is named after G. W. Sinclair who has done considerable collecting in the region.

*Occurrence.* Sherman Fall beds, locality 200.

*Type.* Holotype and paratype from Sherman Fall beds, 1 mile west of Finch, Ontario, in the private collection of G. W. Sinclair.

*Lingula trentonensis* Conrad

Plate I, figure 1

*Lingula trentonensis* Conrad, Jour. Acad. Nat. Sci., Philadelphia, 8, 1842, p. 266, Pl. XV, fig. 11.

*Lingula attenuata* ? Hall (not Sowerby), Pal. New York, 1, 1847, p. 94, Pl. XXX, fig. 1.

This species is characterized by the lack of convexity. It is very close to small forms of *L. obtusa* Hall, but has a sharper and a terminal beak, is longer in proportion to its width, and is less convex.

*Occurrence.* Pamela ? beds, locality 79 (loose); Sherman Fall beds, locality 200; Cobourg beds, locality 114.

*Type.* Plesiotype from Cobourg beds, Parliament Hill, Ottawa, Ontario, in the private collection of G. W. Sinclair.

*Lingulasma* Ulrich

Genotype, *L. schucherti* Ulrich

Outline linguliform, subquadrate or subpentagonal; biconvex; greatest thickness posterior to the middle; greatest width at the squared anterior margin; posterior margin sloping gently to the sides from a slightly projecting beak; pedicle valve extending beyond the brachial; shell substance rather thin, and generally black as in *Lingula*; concentric striæ, with radial striæ showing on slightly exfoliated specimens.

Pedicle valve having the area largely enclosed within the shell, making a small shelf beneath which lie the apical ends of some of the muscle scars; a low concave platform present, the anterior margin of which is not hollowed, extending approximately half the length of the shell, and with a median septum produced from its anterior margin; muscle scars on the platform; transverse scars beneath the platform at the antero-lateral angles.

Brachial valve more convex than the pedicle, having a high platform about the same extent as the platform of the pedicle valve, with a concave anterior margin produced in a long median septum; a smaller median ridge produced from the apical region and lying upon the posterior two-thirds of the platform; on either side of it lie the muscle scars; transverse muscle scars in the antero-lateral margins beneath the platform as in the pedicle valve.

Interiorly *Lingulasma* differs from *Lingula* in the platforms of the two valves. Exteriorly it can be distinguished by the greater convexity of the part of the shell that covers the platform, by the squared front, and usually by its larger size.

*Lingulasma eva* (Billings)

Plate I, figures 21, 22, 23

*Lingula eva* Billings, Can. Nat. Geol., 6, 1861, p. 150; Geol. Surv., Canada, 1863, p. 141, fig. 73.

*Pseudolingula* ? *eva* Billings, Roy. Soc., Canada, 3rd ser. 39, 1945, p. 60.

The species is distinguished by its subpentagonal outline and its very large

size. The holotype is 31 mm. in length but another specimen attains 40 mm. The Ottawa specimen is exfoliated showing the radial striæ clearly.

*Occurrence.* Hull beds?, locality 215; Cobourg beds, localities 113?, 133, 141, 208.

*Type.* Holotype, G.S.C. No. 1160a; paratype 1160b. The types are not from the Ottawa-St. Lawrence Lowland, but from Murray Bay, Quebec, from an horizon thought to be Black River in age; plesiotype, G.S.C. No. 6325, from Cobourg beds?, from an unspecified locality at Ottawa, Ontario.

#### Genus, *Cornwallia* Wilson

##### Genotype, *C. minuta* Wilson?

"A small parasitic shell, subovate in outline, with fine radiating striæ. Pedicle groove wide at the posterior end. The preservation of the specimen is poor and the outer shell layer of the host so covers it that it is difficult to establish its relationship to other members of the family. The radiating striæ are quite distinct from other forms already described."

#### *Cornwallia minuta* Wilson (?)

##### Plate I, figure 17

*C. minuta* Wilson, Roy. Soc., Canada, 26, 1932, sec. 4, p. 388, Pl. IV, fig. 4.

Parasitic; outline suboval; pedicle valve, the only one seen, convex; small, measuring; width, length, and thickness 3 mm., 3 mm., and 2 mm., respectively; fine radiating striæ.

Schuchert<sup>1</sup> thought this the young of some other species, but as no other form like it has been found in the Ottawa formation, and as it does not correspond to any species elsewhere described, it is included here.

*Occurrence.* Cobourg beds, locality 247.

*Type.* Holotype, G.S.C. No. 6609, from Cobourg beds, Indian Lands, con. III, Kenyon tp., Ontario.

#### Genus, *Trematis* Sharpe

##### Genotype, *Orbicula terminalis* Emmons

Circular or transversely oval in outline; pedicle valve depressed posteriorly apex near the posterior margin; pedicle opening below apex, widening posteriorly with straight or outwardly curving sides; pedicle interior with faint furrow between the opening and the apex, from which extend radiating branching sinuses; brachial valve evenly convex, apex marginal or slightly projecting, posterior margin thickened and grooved for passage of pedicle; brachial interior with two transversely elongated posterior scars, between which a median septum begins and becomes more prominent anteriorly; central scars oblique, with divisions, all deeply excavated; surface covered by pits arranged in quincunx or in radiating rows; shell substance an outer punctate calcareous layer, and an inner impunctate corneous layer.

The form is distinguished from *Schizocrania* by its characteristic ornamentation, and the shape of the pedicle notch.

#### *Trematis ottawaensis* Billings

##### Plate I, figures 19, 20 a, b

*T. ottawaensis* Billings, Geol. Surv., Canada, Pal. Foss., 1, 1865, p. 53, fig. 58; Hall and Clarke, Pal. New York, 8, 1892, p. 139, Pl. IVG, figs. 15-17; Winchell and Schuchert, Pal. Minnesota, 3, 1893, p. 369.

The type specimen measures 25 mm. in diameter, but others attain 30 mm. or more in the greatest diameter. To the original description may be added that some

<sup>1</sup> Schuchert, Chas.: Personal communication.



specimens tend to be more transversely oval rather than circular as in the illustrated holotype.

The large size, dark colour, flattened convexity, and reticulate ornamentation are the outstanding features of the species.

*Occurrence.* Hull beds, localities 53, 58, 60; Hull or Sherman Fall beds, locality 52; Sherman Fall beds, locality 203; Cobourg beds, localities 43, 90, 133.

*Type.* Holotype, G.S.C. No. 1651; paratype, No. 1651a; plesiotype, No. 6326; from Hull beds, Hull, Quebec.

*Trematis terminalis* (Emmons)

Plate I, figures 18 a, b

*Orbicula terminalis* Emmons, Geol. New York, Rept. 2nd Dist., 1842, p. 395, fig. 4.

*Trematis terminalis* (Emmons), Sharpe, Quart. Jour. Geol. Soc. London, 4, 1848, p. 68, figs. 1-3; Emmons, Amer. Geol. 1, pt. 2, 1855, p. 201, fig. 63; Pl. VIII, fig. 11.

The species varies from 8.5 to 15 mm. in length, and from 10 to 13 mm. in width. As described by Emmons the brachial valve is gently convex, the concentric striæ very fine, and the punctæ penetrate the inner shell where they are comparatively distant and have a quincuncial rather than a radial arrangement; the punctæ of the outer surface in quincunx arrangement, but becoming crowded and out of either radial or concentric alinement near the anterior.

The species differs from most other species in the quincuncial arrangement of the punctæ; from *T. fragilis* in having the punctæ all over instead of on the posterior part only, from *T. millepunctata* in having punctæ on the inner shell, and from *T. punctostriata* in lacking the linear arrangement of the punctæ.

*Occurrence.* Leray-Rockland ? beds, locality 215; Rockland beds, localities 60, 172; Sherman Fall beds, locality 200.

*Type.* Plesiotype, G.S.C. No. 6327, from Leray-Rockland beds, Murray's quarry, L'Orignal, Ontario.

Genus, *Schizocrania* Hall and Whitfield

Genotype, *Orbicula* ? *filosa* Hall

Parasitic; subcircular in outline; pedicle valve flat or convex; apex subcentral; pedicle notch deep and wide with its apical angle occupied by a plate; brachial valve larger than the pedicle, convex, beak terminal, two sets of muscle scars on the interior, one pair of strong posterior adductor scars, separated by a low median ridge, diverging from the beak and in some cases faintly divided transversely, a second pair of faint, minute scars centrally placed; surface of pedicle valve concentrically wrinkled and of brachial valve radially striated.

The genus is smaller than *Trematis* and lacks its distinctive ornamentation. It can be readily distinguished from other parasitical Ordovician brachiopods by the terminal beak of the brachial valve; and the pedicle valve differs from that of *Orbiculoidea* in its wide notch in place of the narrow limited slit.

*Schizocrania filosa* Hall

Plate II, figures 17, 18

*Orbicula* ? *filosa* Hall, Pal. New York, 1, 1847, p. 99, Pl. XXX, fig. 9.

*Schizocrania filosa* Hall, Hall and Whitfield, Pal. Ohio, 2, 1875, p. 73, Pl. I, figs. 12-15; Hall and Clarke, Pal. New York, 8, pt. 1, 1892, p. 143, Pl. IVG, figs. 22-30.

The species is characterized by the fine thread-like striæ of the brachial valve. It is distinguished from *S. ? rudis* by its more circular outline, from *S. schucherti* by the fineness of the radiating striæ, and from the following new species *S. minuscula* by its size.



*Occurrence.* Lowville beds, locality not specified; Leray-Rockland beds, locality 216; Rockland beds, locality 210; Hull beds, localities 56, 60, 213; Hull or Sherman Fall beds, locality 50; Sherman Fall beds, localities 200, 263; Cobourg beds, locality 89.

*Type.* Plesiotypes, G.S.C. Nos. 6328 and 6329, from Leray-Rockland beds, near L'Orignal, and from Hull beds, cement quarry, Hull, Quebec.

*Schizocrania minuscula* n.sp.

Plate II, figures 25 a-c

Minute, almost circular in outline, 2.25 mm. to 3 mm. in diameter; pedicle valve very flat, smaller than brachial valve and ornamented with strong concentric wrinkles. The only specimen seen is broken, and the edges of the pedicle notch are not preserved, but the specimen shows the brachial valve projecting beyond it. Brachial valve convex, the greatest convexity being in the posterior half, giving the whole a false appearance of greater width than length, beak terminal; valve showing internally two small posterior and two tiny anterior muscle scars; surface of the brachial valve covered with minute sharp radial striæ, ten to 1 mm. at the anterior margin of the largest specimen seen.

The species is distinguished by its minute size and the fine, sharp radial striæ of the brachial valve.

*Occurrence.* Cobourg beds, locality 174.

*Type.* Cotypes, all on one slab, G.S.C. No. 6371, from Cobourg beds, lot 2 ?, con. IV, Cumberland tp.

Genus, *Orbiculoidea* d'Orbigny

Genotype, *Orbicula morrissi* Davidson

Outline circular or subelliptical; valves not equal; pedicle valve flat or depressed, apex excentric, inclined posteriorly, pedicle groove beginning at apex passes posteriorly for a short distance then continues as a tube that opens obliquely into the interior near the posterior margin, but the oblique opening is rarely preserved; brachial valve depressed conical, apex excentric, inclined posteriorly; surface smooth, with concentric striæ or more rarely with radiating striæ.

Brachial valves are most commonly preserved, and are to be distinguished from those of *Crania* in that the apex is less centrally placed and less erect. Pedicle valves of *Crania* lack the pedicle slit. *Orbiculoidea* differs from *Schizotreta* in the reversal of the valves. The pedicle valve of *Schizotreta* with the pedicle slit is convex.

*Orbiculoidea lamellosa* d'Orbigny

Plate II, figures 12, 13

*Orbicula lamellosa* Hall, Pal. New York, 1, 1847, p. 99, Pl. XXX, fig. 10.

*Discina circe* Billings, Geol. Surv., Canada, Pal. Foss., 1, 1865, p. 51, fig. 55.

*Orbiculoidea lamellosa* (Hall), Hall and Clarke, Pal. New York, 8, pt. 1, 1892, Pl. IVE, fig. 12; Winchell and Schuchert, Geol. Minnesota, 3, 1893, p. 364, Pl. XXIX, fig. 25.

Circular outline; both valves convex; diameter 15 to 20 mm.; striæ concentric, coarser near the apex.

Pedicle valve depressed convex; apex subcentral; a pedicle groove extending from the apex but not reaching the margin.

Brachial valve more convex than the pedicle valve, several specimens measuring 4 mm. in height; apex about one-third the diameter from the margin.

The species is distinguished by its circular outline, low convexity, subcentral beak, and concentric ridges.

*Occurrence.* Hull or Sherman Fall beds, locality 212; Cobourg beds, localities 91, 133, 166, 223, 234.

*Type.* Plesiotypes, G.S.C. No. 6372, Cobourg ? beds, Ottawa, Ontario, and Hull or Sherman Fall beds, 4 miles west of L'Orignal, Ontario, in the private collection of G. W. Sinclair.

Genus, *Schizotreta* Kutorga

Genotype, *S. elliptica* Kutorga

Small, subcircular in outline; valves unequal; pedicle valve convex, apex excentric, pedicle groove elliptical, extending half or less distance from apex to posterior margin and then merging into the internal siphon; cardinal slope convex; brachial valve flat or depressed, apex also excentric; surface with simple concentric growth lines interrupted by the pedicle groove.

The genus can be distinguished from *Orbiculoidea* and *Crania* in the reversal of the valves, the pedicle valve of *Schizotreta* with its broader shorter groove is convex, not flat as in the other two genera, and the apex of the valves is more excentric. The convex valve of *Crania* is brachial and has no groove.

*Schizotreta canadensis* n.sp.

Plate II, figures 14, 15

Small, almost circular, 6.5 mm. in diameter; pedicle valve moderately convex, apex very excentric, 2.5 mm. from the posterior margin and inclined anteriorly; pedicle groove narrow and short, being 0.75 mm. in length; brachial valve flat, apex less excentric than that of pedicle valve; surface, black, shiny, having fine concentric growth lines, crossed by low, fine, radial lines not very evident externally, but showing better in exfoliated parts.

The species is distinguished from *S. pelopea* in its smaller size, posteriorly placed apex, narrow pedicle groove, and faint radiating lines.

*Occurrence.* Leray beds, locality 174; Sherman Fall or Cobourg beds, locality 110.

*Type.* Holotype, G.S.C. No. 6373; paratype, No. 6373a; from Leray beds, lot 2, con. IV, Cumberland tp., Ontario.

*Schizotreta pelopea* (Billings)

Plate II, figure 16

*Discina pelopea* Billings, Geol. Surv., Canada, Pal. Foss., 1, 1865, p. 52, fig. 56.

*Schizotreta pelopea* (Billings), Winchell and Schuchert, Geol. Minnesota, 3, 1893, p. 365.

The species is characterized by its conical pedicle valve with the excentric beak and small oval pedicle opening. The differences between it and *S. canadensis* are given under that species. It differs from *S. tenuilamellata* (Hall) in being smaller, having a more convex valve, and in its short canoe-shaped pedicle opening.

*Occurrence.* Cobourg beds, localities 90 and 131.

*Type.* Holotype, G.S.C. No. 1656. The specimen marked as the type came from Montreal. There is considerable doubt as to its being the true type, because of its exfoliated condition. Plesiotype, G.S.C. No. 1655a, from Cobourg beds, Ottawa, Ontario.

Genus, *Crania* Retzius

Genotype, *Anomia craniolaris* Linnaeus

Parasitical, small, subcircular with posterior part slightly wider; pedicle valve flat, depressed convex or conforming to the host, lacking any pedicle opening; brachial valve convex, apex subcentral, posteriorly directed; surface smooth, spinose, concentrically or radially striate; interior of both valves with two pairs of adductor

scars, the posterior pair close to the margin and widely separated from one another, the anterior pair smaller and near the centre; shell calcareous and strongly punctate, the canals dividing near the surface.

The pedicle valve of *Crania* differs from *Orbiculoidea* and *Schizocrania* in having no pedicle opening; the brachial valve is usually smaller, less circular in outline, more conical in convexity, and posteriorly directed.

*Crania setigera* Hall

Plate II, figure 11

*Crania setigera* Hall, Descr. n.sp. of Crinoidea and other Fossils, 1866, p. 12; 24th Rept. New York State Cab. Nat. Hist., 1872, p. 220, Pl. VII, fig. 15; Hall and Clarke, Pal. New York, 8, pt. 1, 1892, Pl. IVH, figs. 14-16; Winchell and Schuchert, Geol. Minnesota, Pal. 3, 1893, p. 372, Pl. XXIX, figs. 32, 33.

The species is cited by W. R. Billings from Ottawa, but has not been seen by the writer.

*Occurrence.* Cobourg ? beds, locality 133.

*Crania trentonensis* Hall

Plate II, figure 10

*Crania trentonensis* Hall, Descr. n.sp. of Crinoidea and other Fossils, 1866, p. 12; 24th Rept. New York State Cab. Nat. Hist., 1872, p. 219, Pl. VII, figs. 11, 12; Hall and Clarke, Pal. New York, 8, pt. 1, 1892, Pl. IVH, figs. 21, 22.

This species is particularly characterized by its strong concentric growth lines. The Ottawa-St. Lawrence Lowland specimens are slightly smaller than the typical species, but in form and muscle scars they conform to it.

*Occurrence.* Leray-Rockland beds, locality 14; Cobourg beds, locality 43.

Genus, *Pholidops* Hall

Genotype, *Orbicula squamiformis* Hall

Small, biconvex, equivalvate, oval or subelliptical, apex subcentral or marginal, unattached, a smooth, broad border at the contact of the valves, which externally are difficult to distinguish; internally, pedicle muscle subcentral within a small, sharply defined, elevated, triangular area having its apical angle pointed anteriorly, posterior adductors at the base of the triangle and lobed posteriorly; brachial posterior adductors similar, but separated by the elongate median anterior muscle scars; surface with strong, concentric growth lines, in a few cases crossed by interrupted radial striæ.

The genus differs externally from other Craniidæ in its biconvex form, internally in its sharply defined subcentral triangular muscle area.

Cooper<sup>1</sup> revived the name *Craniops* for *Pholidops*. Hall is the author of both names, and in 1860 substituted *Pholidops* for *Craniops*. It seems to the writer that it causes confusion to revert to a name dropped by its author, after 80 years of use of his substitute name.

*Pholidops trentonensis* (Hall)

Plate II, figure 1

*Pholidops trentonensis* Hall, Descr. n.sp. of Crinoidea and Other Fossils, 1866, p. 14; 24th Rept. New York State Cab. Nat. Hist., 1872, p. 221, Pl. VII, fig. 8; Hall and Clarke, Pal. New York, 8, pt. 1, 1892, p. 157, Pl. IV I, fig. 17.

The few specimens found are small and may belong to *P. trentonensis minor* Winchell and Schuchert, but are retained in the species rather than in the variety because without more specimens it is not possible to establish a persistency of small size, and the Ottawa-St. Lawrence Lowland is much closer geographically to the deposition basin of the species.

<sup>1</sup>Cooper, G. A.: Wash. Acad. Sci. Jour., 32, No. 8, p. 229 (1942).

*Occurrence.* Hull beds, locality 60; Sherman Fall beds, localities 39, 42, 129; Cobourg beds, localities 43, 119, 218.

*Type.* Plesiotype, G.S.C. No. 6374, Sherman Fall beds, quarry, Val Tetreau, Quebec.

Genus, *Plectorthis* Hall and Clarke

Genotype, *Orthis plicatella* Hall

Transversely elliptical, profile biconvex; anterior margin faintly sulcate; ventral valve deeply convex, ventral area projecting, slightly curved, shorter than the greatest width; dorsal valve less convex, dorsal area straight, shorter than ventral, apex slightly projecting and curved; delthyrium and notothyrium unmodified.

Ventral interior showing delthyrial cavity shallow, teeth small, at the angle of hinge and delthyrium, fossettes oblique, faint; dental plates thin, clearly defined, continued around the crescent diductor area; muscle area heart-shaped, between one-third and one-half shell length, adductors linear within the diductors, a low ridge extends forward from the adductors.

Dorsal interior shows a shallow notothyrium cavity, cardinalia about one-fifth length of shell; brachiophores short, grooved inside, supported by thin converging plates obliterated in many specimens; sockets deep; cardinal process a thick, rounded ridge with crenulated muscle surface; in old specimens a median ridge extending from the anterior of the cardinalia platform.

Most specimens do not preserve the finely drawn characteristics of the interior. For practical use in identification the most easily recognized generic differences are cited here. *Plectorthis* differs from *Hesperorthis* externally in being biconvex instead of concavo-convex or plano-convex, in having a lower cardinal area, and in having a hinge line shorter than its greatest width. The *Plectorthis* ventral valve has a shallow cavity and the muscle area is defined by a prolongation of the dental plates. In *Hesperorthis* ventral valve the cavity is shallow and the dental plates receding. In *Plectorthis* brachial valve the cardinal process is a thick rounded ridge with crenulated scar and the brachiophores are short, stout, grooved inside, and limited by a small plate; in *Hesperorthis* the cardinal process is simple, blade-like, expanded slightly and often cleft, the brachiophores are simple, ventrally carinate, and unsupported. *Plectorthis* is similar to *Hebertella* in the character of its cardinal process, in its brachiophores, and in having the small concave plate attaching the brachiophores to the wall and thus defining the sockets. Externally it can be distinguished by its even convexity lacking the fold and sinus of *Hebertella* at the anterior half, and by its more curved ventral beak. Internally both the ventral and dorsal cavity are shallow, and the teeth small, unlike the deep cavities and strong teeth of *Hebertella*.

*Plectorthis neglecta* (James)

Plate II, figures 8, 9

*Orthis neglecta* (James), *Palaeontologist*, 4, 1879, p. 26.

*Plectorthis dichotoma* Hall and Clarke, *Pal. New York*, 8, pt. 1, 1892, p. 221, Pl. V, fig. 21; Foerste, *Sci. Lab. Denison Univ. Bull.*, 16, 1910, p. 52, Pl. VI, figs. 1a-1e.

The species is characterized by the implantation rather than the bifurcation of the secondary striæ, at various distances from the beak, the first area of implantation being at 2 mm. to 3 mm. from the beak in the Ottawa-St. Lawrence specimens. The secondary striæ soon attain the same height and width as the primary.

The species differs from *P. plicatella* in its smaller size and numerous secondary striæ, from *P. aequalis*, *P. fissicosta*, *P. jamesi*, and others in the introduction of additional striæ by implantation and the consequent lack of fascicles of striæ. The specimens found correspond exactly with the description and illustrations of *P. neglecta*, and it is felt that a lower horizon and geographical distance are not sufficient reasons for introducing a new specific name.

*Occurrence.* Sherman Fall beds, locality 199; Sherman Fall or Cobourg beds, locality 6; Cobourg beds, localities 72, 86, 128, 131, 133, 249.

*Plectorthis ottawaensis* n.sp.

Plate II, figures 5 a-d

Small, semi-oval; profile unequally biconvex, pedicle valve slightly convex, brachial valve less so; neither fold nor sinus, though both valves have a tendency to flatten anteriorly; average specimen having greatest width 10 mm. to 11.5 mm., greatest height 7 mm. to 8.25 mm.; increase in striation once only, by implantation about 1.5 mm. from beak in pedicle valve, and at no other place, by bifurcation in the brachial valve, also near the beak but distance slightly more variable; striæ rapidly attain full size, coarse, about 27 to 30 in number, having interspaces about equal to their width, crossed by almost invisible growth lines.

The form is distinguished from *P. plicatella trentonensis* Foerste by its smaller size and by its method of increasing the striæ. It differs from *P. neglecta* in having only one area of striation increase and in having the increase by bifurcation in the brachial valve. It differs from *P. plicatella laurentina* in its fewer initial plications and their increase by implantation.

*Occurrence.* Leray-Rockland beds, locality 7 (Ami cited a *Plectorthis* from locality 67, which may be this species); Sherman Fall beds, locality 259; Cobourg beds, localities 3, 89, 90, 104, 125, 128, 174, 224.

*Type.* Holotype, G.S.C. No. 6375, from Cobourg beds, corner of Lorne ave. and Maple st., Ottawa.

*Plectorthis plicatella laurentina* n.var.

Plate II, figure 4

The variety averages: width 11 mm., length 8 mm., though a number of specimens are larger. It has 29 to 33 coarse simple plications.

The species *P. plicatella* restricted has 20 to 26 coarse plications, and according to Foerste<sup>1</sup> has a strong tendency to introduce secondary ones. The variety then differs from the species in its smaller size, its more numerous plications, and its lack of secondary plications. It is distinguished from *P. plicatella trentonensis* Foerste, which also lacks secondary plications, by its smaller size and more numerous plications.

*Occurrence.* Sherman Fall beds, localities 13, 56; Sherman Fall or Cobourg beds, locality 6; Cobourg beds, localities 3, 43, 90, 91, 103, 121, 131, 134, 183, 208, 219, 223.

*Type.* Holotype from Research Council Laboratories, Sussex st., Ottawa, in the private collection of G. W. Sinclair.

*Plectorthis plicatella trentonensis* Foerste

Plate II, figures 7 a, b

*Orthis (Plectorthis) plicatella* Winchell and Schuchert, Geol. Minnesota, 3, 1893, p. 436, Pl. XXXIII, figs. 5-7.

*P. plicatella trentonensis* Foerste, Sci. Lab. Denison Univ. Bull., 16, 1910, p. 49.

This variety is large, some specimens attaining a width of 20 mm. It has from 20 to 28 straight, coarse, simple plications. The differences from the species and *P. plicatella laurentina* n.var. are given under the latter variety.

*Occurrence.* Sherman Fall beds, locality 185; Cobourg beds, localities 103, 121, 128, 134, 223.

*Plectorthis pulchella* n.sp.

Plate II, figures 6 a, b

Semicircular; profile almost equally biconvex; neither fold nor sinus present;

<sup>1</sup> Foerste, A. F.: Sci. Lab. Denison Univ. Bull., 16, 1910, p. 49.

medium size, holotype measuring: width, length, and thickness, 19 mm., 15.5 mm., and 6 mm., respectively; hinge 12 mm.; cardinal angles blunt; cardinal area narrow, that of the pedicle valve being the higher; striæ bifurcating regularly, beginning at 4 mm. from the beak and continuing almost to the margin, size of striæ increasing rapidly, but the fascicular bifurcation produces an irregularity in appearance.

The species is close to *P. fissicosta* Hall but differs in its more circular outline, and the striæ of *P. pulchella* increase in size so rapidly that the initial striæ are lost among the rest, whereas in *P. fissicostata* Hall they remain stronger to the margin.

*Occurrence.* Leray-Rockland beds, locality 7; Cobourg beds, localities 121, 133, 134.

*Type.* Holotype, from Research Council Laboratories, Sussex st., Ottawa, in the private collection of G. W. Sinclair.

### Genus, *Platystrophia* King

#### Genotype, *Terebratulites biforatus* Schlotheim

Spiriferoid, strongly biconvex; anterior margin subparallel to hinge; prominent fold in brachial valve and sinus in pedicle valve; cardinal angles acute or obtuse; cardinal areas broadly triangular, curved, subequal; beaks incurved, striated, ventral beak commonly re-absorbed; delthyrium and notothyrium open; strong radial costæ and minute granules; shell impunctate.

Ventral interior: teeth wide, moderately strong; fossettes shallow oblique; dental plates strongly defined; deep umbonal cavities, often filled in gerontic specimens; muscle scars obscure, in young surrounded by a ridge; adductor scars broad and linear; diductors elongate; callosity in the apex; anterior margin costate in youth but only at extreme margin in gerontic specimens.

Dorsal interior: notothyrium cavity shallow, area small; brachiophores grooved on the inside, supports convergent; teeth sockets shallow, having a small delimiting concave plate as in *Plectorthis*; cardinal process a simple low ridge; posterior scars larger than anterior and separated from them by a low ridge at right angles to the median ridge.

The genus is distinguished from all other Orthidæ by its spiriferoid form. Internally it is distinguished from *Plectorthis* in particular by the very low cardinal process, though essential characteristics are often covered by additional shell matter.

The genus is very variable and might have been considered as one species with numerous variations as has been done in the case of the variable species *Camerella hemiplicata* (Hall). *Platystrophia*, however, has been divided into a number of species on the basis of differences in hinge line, height of fold, and striation. The several species have been grouped by Cumings, and the grouping further developed by McEwan. The basis of the grouping is the development of the costæ in the sinus and on the fold.

- I. Uniplicate group
  - 1 plication in the sinus and 2 on the fold.
- II. Biplicate group
  - A. 2 plications in sinus from the bifurcation of the primary, 3 on the fold, 1 implanted between the 2 primaries.
  - B. 3 of equal strength in sinus.
    - 4 of equal strength on fold by bifurcation of median secondary plication, hinge long, and low fold.
  - C. 4 in sinus, primary bifurcates and 2 lateral added, 5 on fold, 1 intercalated then 2 primary bifurcate; hinge line short.
  - D. 5 in sinus, primary bifurcates, 1 median implanted then 2 lateral implanted.
    - 6 on fold, two primaries, one implanted, which then bifurcates, followed by bifurcation of two primaries.
- III. Triplicate group
  - 3 in sinus, the primary unaltered and two lateral implanted.
  - 4 on fold, by bifurcation of two primaries. Three subgroups: low fold, high compressed fold, and high fold.

TABLE III

*Distribution of Parastrophia within the Ottawa Formation*

Species	OTTAWA FORMATION FAUNAL BEDS						
	Pamella	Lowville	Leray	Rockland	Hull	Sherman Fall	Cobourg
<b>UNIFLICATE</b>							
<i>Platystrophia uniplicata</i> McEwan.....							x
<b>BIFLICATE</b>							
<i>Platystrophia precedens</i> McEwan.....							x
<i>P. trentonensis</i> McEwan.....			x				x
<i>P. hermitagenis</i> McEwan.....							x
<b>TRIFLICATE</b>							
<i>Platystrophia extensa</i> McEwan.....						x	x
<i>P. amoena</i> McEwan.....				xx	x	x	x
<i>P. amoena longicardinalis</i> McEwan.....				xx	x	x	x
<i>P. amoena robusta</i> McEwan.....							x
<i>P. elegantula</i> McEwan.....						x	x
<i>P. preponderosa</i> McEwan.....							x
<i>P. sp.</i> .....							x



## I. UNIPlicate GROUP

*Platystrophia uniplicata* McEwan

Plate III, figures 1, 2

*P. uniplicata* McEwan, U.S. Nat. Mus. Proc., 56, 1919, p. 405, Pl. XLII, figs. 1, 2.

The species is characterized by the single plication within the sinus and two on the fold derived from a single bifurcation: The specimens are usually small and have been cited from the Lower Trenton at Lake Champlain. The range is here extended to Upper Trenton.

*Occurrence.* Cobourg beds, localities 93, 115, 162, 247, 249, 257.

*Type.* Plesiotypes, G.S.C. Nos. 6376 and 6378, from Cobourg beds northeast of Dow Lake, Ottawa, and from con. 1, Roxborough tp., where stream crosses road east of Strathmore.

## II. BIPlicate GROUP

## Subgroup A

*Platystrophia precedens* McEwan

Plate III, figure 3

*Platystrophia precedens* McEwan, U.S. Nat. Mus. Proc., 56, 1919, p. 405, Pl. XLII, figs. 7, 8.

The specimen at hand is poorly preserved, but it shows the typical bifurcation of the plication within the sinus, and that the hinge is less than the greatest width.

The Ottawa-St. Lawrence Lowland specimen is a little larger than that illustrated, but the species is the only one cited from beds older than the Richmond.

*Occurrence.* Cobourg beds, locality 88.

## Subgroup B

*Platystrophia trentonensis* McEwan

Plate III, figure 4

*Platystrophia trentonensis* McEwan, U.S. Nat. Mus. Proc., 56, 1919, p. 407, Pl. XLII, figs. 3, 6.

The species is characterized by its wide hinge line, the slightness of the elevation of the fold, and the bifurcation of the median plication of the fold.

Two broken specimens seem to belong to this species.

*Occurrence.* Leray-Rockland beds, locality 25; Cobourg beds, locality 223.

## Subgroup C

*Platystrophia* sp.

All members of Subgroup C have heretofore been cited from the Silurian. The four specimens here assigned to that subgroup are all ventral valves and are too poor for specific description, but they have the plication pattern of the sinus of Subgroup C. In size, length of hinge line, and total number of plications they are closer to *P. brachynota* (Hall) than to *P. reversata* (Foerste) of Subgroup C.

*Occurrence.* Cobourg beds, localities 162, 189.

## Subgroup D

*Platystrophia hermitagensis* McEwan

Plate III, figure 5

*Platystrophia hermitagensis* McEwan, U.S. Nat. Mus. Proc., 56, 1919, p. 409, Pl. XLII, figs. 15-19.

The species is distinguished by its long hinge line and its lack of convexity. Only one pedicle valve is present and is smaller than the Tennessee specimen



described. The hinge is wide, even with the tips broken. The convexity is not great and the plication pattern in the sinus, the proportions of the outline, and the total number of plications are correct. The species is characterized by its wide hinge line and 5 plications in the sinus, which have increased by the bifurcation of the initial one and the implantation of three, one in a median position and two appearing later on the sides.

*Occurrence.* Cobourg beds, localities 223, 252.

*Type.* Plesiotype from McAlpine, Ontario, in the private collection of G. W. Sinclair.

### III. TRIPPLICATE GROUP

#### (a) Low Fold

#### *Platystrophia extensa* McEwan

Plate III, figure 10

*Platystrophia extensa* McEwan, U.S. Nat. Mus. Proc., 56, 1919, p. 410, Pl. XLII, figs. 39-41.

The species is characterized by its wide hinge line, its tendency to flatness on the slopes of the brachial valve, and the 9 to 13 rounded plications on the lateral slopes.

The specimens from the Ottawa-St. Lawrence Lowland are somewhat larger than the typical species, being more like *P. preponderosa* in size, but the number of lateral plications, 9 to 13, places them with *P. extensa* McEwan.

*Occurrence.* Sherman Fall beds, localities 42, 185, 209, 210 ? ; Cobourg beds, localities 85, 168, 218, 225, 238.

*Type.* Plesiotype, G.S.C. No. 6380, from Sherman Fall beds ? , Ange gardien road, 4 miles west of L'Orignal, Ontario.

#### *Platystrophia amoena* McEwan

Plate III, figures 7a, b

*Platystrophia amoena* McEwan, U.S. Nat. Mus. Proc., 56, 1919, p. 412, Pl. XLIII, figs. 1-8.

The hinge is approximately the width of the shell, which is thin, subequally convex, with low, spreading fold and shallow sinus; 4 plications on the fold and 3 in the sinus; 9 plications on the sides.

The forms listed by Ami as *P. biforata* Schlotheim and *P. biforata* var. *lyna* Eichwald probably belong to this species.

The species is by far the most abundant representative of the genus in the Ottawa-St. Lawrence Lowland.

*Occurrence.* Leray-Rockland beds, localities 7, 19, 65, 77, 148, 151, 164; Rockland beds, locality 30; Hull beds, localities 45, 46, 138, 161, 215 ? , 227; Hull or Sherman Fall beds, localities 50, 210; Sherman Fall beds, localities 10, 42, 129, 160, 166, 186, 199, 210, 259, 264; Sherman Fall or Cobourg beds, locality 6; Cobourg beds, localities 43, 85, 86, 90, 91, 101, 107, 110, 111, 115, 116, 119, 131, 134, 140, 168, 169, 174, 175, 189, 191, 198, 208, 224, 225, 233, 236, 239-241, 244-249, 252, 258, 259.

*Type.* Plesiotype, G.S.C. No. 6381, from Cobourg beds corner of Fifth ave. and Percy st., Ottawa, Ontario.

#### *Platystrophia amoena longicardinalis* McEwan

Plate III, figure 8

*Platystrophia amoena longicardinalis* McEwan, U.S. Nat. Mus. Proc., 56, 1919, p. 412, Pl. XLIII, figs. 9-13.

The variety is like the species in its thinness and in its plication pattern, but has extended cardinal extremities.

The form is distinguished from *P. extensa* by its smaller size and few lateral plications.

*Occurrence.* Leray-Rockland beds, localities 151, 164; Hull beds, locality 58; Sherman Fall beds, localities 39, 42, 166, 179, 185, 187, 199, 209; Sherman Fall or Cobourg beds, locality 180; Cobourg beds, localities 43, 85, 88, 90, 95, 101, 119, 121, 131, 133, 134, 162, 168, 189, 208, 224, 226, 235, 241-243, 248, 252, 253, 258.

*Type.* Plesiotype, G.S.C. No. 6382, from Cobourg beds, mill dam at Loch Garry, Ontario.

*Platystrophia amoena robusta* McEwan

Plate III, figure 9

*P. amoena robusta* McEwan, U.S. Nat. Mus. Proc., 56, 1919, p. 412, Pl. XLIII, figs. 14-17.

This variety differs from the species in its greater convexity and generally more robust form. The Ottawa-St. Lawrence Lowland specimens are somewhat larger than the typical form, but otherwise they agree with the description.

*Occurrence.* Cobourg beds, localities 168, 189, 208, 249, 257, 259.

*Type.* Plesiotype, G.S.C. No. 6383, from Cobourg beds, east half of lot 21, con. VIII, Cornwall tp., Ontario.

*Platystrophia elegantula* McEwan

Plate III, figures 6 a, b

*P. elegantula* McEwan, U.S. Nat. Mus. Proc., 56, 1919, p. 410, Pl. XLIII, figs. 44-47.

The species is small and subglobose, with a hinge line shorter than its greatest width, and with 3 plications in the sinus increasing to 5 as maturity is approached.

*Occurrence.* Sherman Fall beds, locality 265; Cobourg beds, localities 240, 242, 258, 259.

*Type.* Plesiotype, G.S.C. No. 6384, from Cobourg beds, lot 9, con. IV, Roxborough tp., east of Gravel Hill, Ontario.

(b) Ponderosa Group (high compressed fold)

*Platystrophia preponderosa* McEwan

Plate III, figures 11, 12

*P. preponderosa* McEwan, U.S. Nat. Mus. Proc., 56, 1919, p. 427, Pl. XLIX, figs. 6-8.

The fold is moderately high and somewhat compressed, the thickness equals the length, the hinge is equal to or less than the greatest width, and there are 8 or 9 plications on the slopes.

The species is distinguished from *P. amoena robusta* by its fewer lateral plications, and from *P. extensa* by its less extended hinge and fewer lateral plications.

The forms identified as this species are somewhat broken, but they appear to agree with the description.

*Occurrence.* Cobourg beds, locality 175 ?, and from an unknown locality.

Genus, *Skenidioides* Schuchert and Cooper

Genotype, *S. billingsi* Schuchert and Cooper

Small, semi-elliptical; hinge line straight; cardinal extremities acute or nearly a right angle; biconvex to concavo-convex; fold and sinus in some cases present; cardinal area erect or inclined anteriorly on the pedicle valve; delthyrium open; surface having radial striae.

Pedicle interior with strong teeth; dental supports forming a shallow spondylium, free in front.

Brachial interior with shallow cavity; concave socket plate present; brachiophores long and slender with supporting plates; a median septum; cardinal process linear.

*Skenidioides ? merope* (Billings)

Plate II, figures 2, 3

*Orthis merope* Billings, Geol. Surv., Canada, Pal. Foss., I, 1865, p. 139, fig. 116.*Scenidium ? merope* (Billings), Hall and Clarke, Pal. New York, 8, 1892, p. 242, Pl. VIIA, figs. 31 and 32.*Skenidioides ? merope* (Billings), Schuchert and Cooper, Peabody Nat. Hist. Mus., Mem. 4, 1932, p. 72.

Sub-elliptical in outline; very minute; greatest width at the hinge line; width and length measuring 4 to 5 mm., and 3 mm., respectively; anterior margin broadly rounded, almost parallel with hinge line; cardinal extremities a right angle or acute; cardinal area of the pedicle valve erect or slightly inclined anteriorly; surface of valve with an even convexity, sloping down abruptly to the margins; brachial cardinal area not so high, valve gently convex with a broad, shallow, median sinus; striæ 24 to 28, simple, coarse for the size of the shell.

Outwardly the form corresponds with the generic description, but no interior has yet been found so that some doubt exists as to its belonging to this genus.

*Occurrence.* Rockland beds, locality 156.

*Type.* Billings types are missing. Neotypes, G.S.C. Nos. 6385 and 6386, Rockland beds, Stewart quarry, Rockland, Ontario.

Genus, *Hesperorthis* Schuchert and CooperGenotype, *Orthis tricenaria* Conrad

Semicircular or semi-elliptical in outline, plano- or concavo-convex; hinge straight; cardinal angles acute or forming a right angle; anterior margin straight or broadly convex; ventral area long, plane or gently curving, dorsal area shorter than ventral area and plane.

Ventral valve convex, beak gently curved; delthyrium long and narrow covered by a partial or complete deltidium; ventral interior having deep cavity; teeth small; crural fossettes shallow and oblique; muscle scars subcircular or sub-cordate; diductors curved or subtriangular; adductors central, lanceolate; three ridges anteriorly directed.

Dorsal valve: notothyrium open or partly closed; cavity shallow; brachiophores simple, supported by a thickened shell substance; cardinal process simple, sometimes cleft; a median ridge present from cavity platform to anterior of the muscle scar; muscle area large; anterior adductors triangular, larger than the posterior.

Simple strong costæ with a few finer ones between them, crossed by concentric growth lines; shell substance impunctate.

This genus practically includes all those American species that have been formerly identified as *Orthis*. Schuchert and Cooper separate it from the typical European genus *Orthis* on features that are persistent but more a matter of degree than real differences. *Hesperorthis* is plano-convex or concavo-convex, which is usual with the European *Orthis*, but some of the latter are biconvex. *Hesperorthis* has a longer cardinal area, the beak is gently not strongly incurved. Internally each rib has a median cleft instead of a ridge; in the ventral valve are small teeth and the shallow crural fossettes, whereas in *Orthis* the teeth are strong and crural fossettes deep; in the dorsal valve the muscular area of *Hesperorthis* is large, that of *Orthis* small.

*Hesperorthis tricenaria* (Conrad)

Plate II, figures 19 a-c

*Orthis tricenaria* Conrad, Proc. Acad. Sci. Philadelphia, I, 1843, p. 333; Salter, Geol. Surv., Canada, Can. Org. Rem., dec. 1, 1859, p. 39, Pl. IX, figs. 1-4.*Hesperorthis tricenaria* (Conrad), Schuchert and Cooper, Peabody Mus. Nat. Hist., 4, pt. 1, 1932, p. 85, Pl. IV, figs. 13, 14, 17-21, 25-27, 29.

The species is characterized by the high cardinal area of the pedicle valve and the large, coarse, simple plications. A large specimen measures: 25 mm., 23 mm.,

and 11 mm., in width, length, and thickness, respectively. More average specimens are approximately 21 mm., 20 mm., and 8 mm., respectively.

This widespread species has been well described and illustrated formerly as an *Orthis*. The reasons for the change in generic name are given under the generic description. The species is not as prolific at the upper horizon as it is at the lower.

*Occurrence.* Leray beds, localities 19, 21, 74, 77, 132, 154, 209; Leray-Rockland beds, localities 7, 20, 28, 67, 78, 81, 83, 140, 142, 146, 147, 152, 156, 164, 187, 206, 220; Rockland beds, localities 27, 30, 136, 148, 156; Cobourg beds, localities 91, 103, 131, 134, 229, 257, 259.

*Type.* Plesiotype, G.S.C. No. 1151c, Leray-Rockland beds, Paquette Rapids, Ottawa River, Ontario.

#### Genus, *Glyptorthis* Foerste

##### Genotype, *Orthis insculpta* Hall

Shell small or large, subquadrate, subelliptical; anterior margin convex or emarginate; hinge wide and straight; cardinal angles right angled or obtuse; unequally biconvex, the dorsal valve being the more convex, and bearing a more or less shallow sinus; ventral beak and area curved or plane, projecting or erect; dorsal area straight or incurving; ornamentation strong frilled costæ, shell impunctate.

Ventral interior moderately deep; teeth strong; fossettes oblique; dental plates strong; muscle scar obcordate, impressed, elevated anteriorly; adductors broad, central, commonly elevated; diductors narrow, divergent, elongate; adjustors narrow, elongate, at the base of the dental plates; a short median ridge present extending anteriorly from the adductors.

Dorsal valve with shallow cavity; cardinalia strong; brachiophores as in *Orthis*; cardinal process a thickened linear ridge, muscle scars on the side; platform thickened, produced part length as a median ridge; posterior adductors smaller than anterior, separated from one another by an arched ridge at right angles or oblique to the median ridge.

Externally *Glyptorthis* differs from both *Hebertella* and *Hesperorthis* in its rugose ornamentation.

Internally the ventral valve of *Glyptorthis* has well-defined adjustor scars, attenuated diductors, broad adductors, a median ridge anterior to the adductors and prominent kidney-shaped ovarian markings as compared with the lack of adjustor scars, diductors expanded in front, adductors borne on a narrow median ridge, the lack of a median ridge anterior to the adductors, and the lack of prominent ovarian markings in *Hebertella*. In the dorsal valve *Glyptorthis* has a thickened linear cardinal process, and sockets defined by shell thickening as compared with the thickened end of the cardinal process and a plate defining the sockets in *Hebertella*.

Internally the dorsal valve is similar to *Hesperorthis*. The ventral valve differs in its strong teeth, broad adductors, divergent narrow diductors and one anteriorly directed median ridge, as compared with the small teeth, lanceolate adductors, subcircular or sub-cordate diductors, and three ridges anteriorly directed as in *Hesperorthis*.

#### *Glyptorthis bellarugosa* (Conrad)

##### Plate III, figures 13, 14, 15

*Orthis bellarugosa* Conrad, Proc. Acad. Nat. Sci., Philadelphia, 1, 1843, p. 333; Hall, Pal. New York, 1, 1847, p. 118, Pl. XXXII, fig. 3.

*Glyptorthis bellarugosa* (Conrad), Foerste, Sci. Lab. Denison Univ., Bull. 17, 1914, p. 258.

The species is smaller than *G. insculpta* (Hall) and the brachial valve has a tendency to be more convex. In both valves the muscle scar is less robust and in the pedicle valve there is a slight difference in the configuration of the shell just anterior

to the muscle scar. (Compare with Schuchert and Cooper, Peabody Nat. Hist. Mus., Mem. 4, 1932, Pl. VI, figs. 18 and 29.)

*Occurrence.* Lowville-Leray beds, locality 156; Leray-Rockland beds, localities 7, 156.

*Type.* Plesiotypes from Leray-Rockland beds, Paquette Rapids, Ottawa River, Ontario, in the private collection of G. W. Sinclair.

*Glyptorthis insculpta* (Hall)

Plate III, figures 16 a, b

*Orthis insculpta* Hall, Pal. New York, 1, 1847, p. 125, Pl. XXXII, fig. 12; Meek, Pal. Ohio, 1, 1873, p. 99, Pl. IX, fig. 1.

*Glyptorthis insculpta* (Hall), Foerste, Sci. Lab. Denison Univ., Bull. 17, p. 258; Schuchert and Cooper, Peabody Nat. Hist. Mus., Mem. 4, 1932, Pl. VI, figs. 17, 18, 20, 21, 26, 29.

The main differences between this species and *G. bellarugosa* Conrad is the larger size of *G. insculpta* (Hall) and the greater number and finer radial striae. In the upper beds of the Ottawa formation one specimen has been found considerably larger than the others and having a slight tendency to a medial depression in the dorsal valve.

*Occurrence.* Cobourg beds, locality 103.

Genus, *Eridorthis* Foerste

Genotype, *E. nicklesi* Foerste

Externally the pedicle valve of *Eridorthis* has a fold at the beak that gradually becomes a sinus at the anterior. The brachial valve begins with a shallow sinus that anteriorly becomes a fold.

*Eridorthis* was originally defined by Foerste as being a subgenus of *Plectorthis*. He did not mention the strongly imbricated ornamentation, but recognized the reversal of the fold and sinus of both valves.

Cooper has shown that the species is most closely related to *Glyptorthis*, but externally differs in that in the latter the sinus of the brachial valve and the convexity of the pedicle valve remain respectively a sinus or shallow depression and a convexity throughout life.

Internally, in the pedicle valve of *Eridorthis* the cavity is shallow, dental plates well defined in maturity, adductor track linear expanding anteriorly, as compared with the same valve of *Glyptorthis* in which the cavity is moderately deep, dental plates strong in youth but obsolete in old age, and adductor tracks broad and commonly elevated.

*Eridorthis rocklandensis* n.sp.

Plate III, figures 17 a-c, 18

Subcircular to subquadrate in outline; greatest width a little anterior to the middle; hinge about two-thirds width; holotype measuring: width, length, thickness, and hinge, 23 mm., 18 mm., 13 mm. (both valves), and 16 mm., respectively; two other pedicle valves averaging: 19 mm., 14 mm., 7 mm. (one valve), and 13 mm., respectively; cardinal angles obtuse; cardinal area of pedicle valve high, the paratype 5 mm., in height; delthyrium large, triangular, and open; teeth strong; striae 50 to 60 in number, strongly imbricated; ventral fold low, becoming a shallow sinus. Interiors not seen.

*Eridorthis rocklandensis* differs from *E. nicklesi* and *E. rogerensis* in being larger, more gibbous, in having more numerous and finer striae, and in having the fold and sinus of the pedicle valve and the sinus and fold of the brachial valve less strongly marked, though this may be due in part to poor preservation.

*Occurrence.* Lowville-Leray beds, locality 156; Leray beds, locality 156.

*Type.* Holotype, G.S.C. No. 6387; paratype; No. 6389; both from Leray beds, Stewart quarry, Rockland, Ontario.

Genus, *Dalmanella* Hall and ClarkeGenotype, *Orthis testudinaria* Hall and Clarke (non Dalman)

Subcircular or subquadrate; slightly biconvex or plano-convex; most species small; hinge shorter than greatest width; cardinal angles rounded; cardinal area small, pedicle area the larger; delthyrium open; striae, sharp, grouped in bundles, generally curving slightly on the wings and along the cardinal region; all crossed by growth lines, and in places rugose concentric lines; shell, punctate.

Pedicle valve longer than the brachial, and having a low fold.

Brachial valve flat, having a shallow sulcus.

Pedicle interior: cavity and fossettes deep; teeth heavy for the size of the valve; plates strong, diverging; muscle scar bilobed anteriorly; adductors linear; diductors elongate usually beyond the adductors.

Brachial interior: cavity occupied by short, stout, divided cardinal process, which in some cases fills the delthyrium; brachiophores simple, divergent, supported by adventitious shell matter; median ridge low; muscle scar small.

The genus is distinguished by its plano-convex profile, its fascicles of striae curving on the wings, and its bilobed ventral muscle scar.

Schuchert and Cooper<sup>1</sup> in reviewing the use of Bancroft's generic name *Onniella* substituted for *Dalmanella* concluded that coarseness or fineness of striation is not a sufficient basis for generic differentiation and retained the genus *Dalmanella*, because the internal structure of *Dalmanella* and *Onniella* is the same. Later Cooper<sup>1</sup> assigned the whole group of North American *Dalmanellas* to Bancroft's genus *Resserella* without giving any reason. The present writer retains the long established genus *Dalmanella*, which is perfectly understood, until the systematists establish a firm basis for a generic difference.

*Dalmanella millepunctata* Wilson

Plate II, figures 20 a, b

*D. millepunctata* Wilson, Roy. Soc., Canada, 3rd ser., 26, 1932, sec. 4, p. 389, Pl. IV, figs. 5, 6.

Comparatively large for the genus; width and length 20-22 mm. and 15-18 mm., respectively, greatest width about mid-length; cardinal area not observed; striae numerous, beginning with 11 and increasing by bifurcation; countless minute punctæ, to a large extent arranged in rows so closely placed as to make the interspaces appear as ridges, particularly when situated upon the striae.

*D. millepunctata* differs from the ubiquitous *D. rogata* in size and in the prominence of the punctæ. It is smaller and more subcircular than *D. emacerata* or *D. whittakeri*.

*Occurrence.* Sherman Fall beds, localities 196, 197, 200, 210, 255, 260; Sherman Fall or Cobourg beds, locality 43; Cobourg beds, locality 247.

*Type.* Holotype, G.S.C. No. 6610, from Cobourg beds, outcrop where a stream crosses the road, one mile east of Strathmore, con. I, Roxborough tp., Ontario.

*Dalmanella paquettensis* (Sinclair)

Plate II, figures 24 a, b

*Onniella paquettense* Sinclair, Can. Field Nat., 59, 1945, p. 73, Pl. II, figs. 2, 3.

Transverse outline; plano-convex, pedicle valve evenly convex, brachial valve flat; cardinal angles broadly rounded; length and width of holotype 11 mm. and 14.5 mm. respectively.

Pedicle valve having a broad, shallow sinus, brachial valve having a corresponding low, gentle, median convexity.

Striae, coarse, few, about 4 to 5 in 2 mm. at the front.

<sup>1</sup> Schuchert, Chas., and Cooper, G. A.: Peabody Mus. Nat. Hist., Mem. 4, 1932, p. 121.

<sup>2</sup> Cooper, G. A.: Index Fossils of North America, 1944, p. 351.



The species is nearest to *O. whittakeri* Raymond, from which it differs in its more rounded cardinal angles and smaller size. It differs from the more prolific *D. rogata* in its larger size, more transverse outline, and coarser striae.

*Occurrence.* Leray-Rockland beds, locality 7.

*Type.* Holotype, from Leray-Rockland beds, Paquette Rapids, Ottawa River, in the private collections of G. W. Sinclair.

*Dalmanella rogata* (Sardeson)

Plate II, figure 21

*Orthis rogata* Sardeson, Minnesota Acad. Nat. Sci., Bull. 3, 1892, p. 33, Pl. V, figs. 1-4.

*Orthis (Dalmanella) testudinaria* (Dalman) Hall and Clarke, New York Pal., 8, pt. 1, 1892, Pl. VB, figs. 27-31.

*Dalmanella rogata* (Sardeson), Raymond, Geol. Surv., Canada, Mus. Bull. 31, 1921, p. 14, Pl. V, figs. 5, 6.

Outline suborbicular; profile plano-convex; small, averaging: width, length, and thickness, 11 mm. to 14 mm., 10 mm. to 12 mm., and 4 mm. to 6 mm., respectively; hinge a little shorter than the greatest width.

Pedicle valve moderately convex, with convexity prominent, almost forming a fold along the median line; brachial valve flat with a shallow depression from beak nearly to the anterior margin.

Striae, as Raymond has shown, 11 primaries bifurcating with one, two, or three secondaries, which increase slowly in size giving the valve an irregular fasciculate ornamentation.

The species has been for years designated as *D. testudinaria* (Dalman) from Europe, but Raymond has shown that it differs in having 11 primaries instead of approximately 30, the secondaries originate farther from the beak and increase less rapidly, producing a less regular appearance.

The species differs from *D. whittakeri* in its more subcircular outline, smaller size, shorter hinge line, and less numerous striae. It differs from *D. millepunctata* in its smaller size, fewer striae, and less striking punctae.

*Occurrence.* Lowville beds, locality 156; Leray beds, localities 4, 31, 77, 109, 156, 164, 171, 214, 264; Leray-Rockland beds, localities 7, 20, 145; Rockland beds, localities 22, 24, 65, 139, 148, 156, 163, 173, 211; Rockland or Hull beds, localities 136, 209; Hull beds, localities 44, 51, 53, 58, 60, 82, 138, 215, 217, 227; Hull or Sherman Fall beds, locality 50; Sherman Fall beds, localities—at all exposures; Cobourg beds, localities—at all exposures.

*Type.* Plesiotype, G.S.C. No. 6390, from Leray beds, quarry west of L'Orignal, Ontario.

*Dalmanella whittakeri* Raymond

Plate II, figures 22, 23

*Dalmanella, whittakeri* Raymond, Geol. Surv., Canada, Mus. Bull. 31, 1921, p. 16, Pl. V, figs. 11-14.

Plano-convex; wider than long; large for the genus, holotype a large specimen measuring: width, length, and hinge, 25 mm., 18 mm., and 22 mm., respectively; striae, thread-like, increasing rapidly by bifurcation with ten to twelve finer striae between two coarser.

Pedicle valve moderately convex, and lacking a median ridge.

Brachial valve almost flat, with a slight median groove near the beak.

Interiors not known.

It has not been cited before from Eastern Ontario.

The species differs from *D. rogata* and *D. millepunctata* in its greater size, more transverse outline, longer hinge line, and more numerous striae.

*Occurrence.* Sherman Fall beds, localities 11, 13; Cobourg beds, locality 252.

*Type.* Holotype, G.S.C. No. 3240; paratype, No. 3240a; from Peterborough, Ontario.

Genus, *Dinorthis* Hall and ClarkeGenotype, *Orthis pectinella* Emmons

Transversely semi-elliptical, suborbicular to subquadrate; profile biconvex or concavo-convex, except for the umbo; margin broadly rounded, straight or faintly emarginate; a broad sinus often in the pedicle valve, also some having a narrow, shallow depression in the brachial valve; cardinal areas almost straight, pedicle area almost at right angles to the brachial area and longer than and projecting over it; delthyrium generally uncovered, but many filled by cardinal process; ornamentation, costæ not very numerous, crossed by fine concentric growth lines; shell impunctate, but occasionally having tubulose costæ.

Pedicle interior shallow; teeth strong; sockets shallow; fossettes oblique; dental plates not receding, obscure in gerontic individuals; muscle area quadrate, anteriorly bilobed; adductors small, forming an oval field divided by a low median ridge; diductors diverging, expanded in front, enclosing the adductors; adjustors distinct; pallial markings prominent; anterior margin finely crenulate.

Brachial interior: cavity small; brachiophores orthoid, diverging, supported by shell thickening, bluntly pointed; cardinal process strong, crenulated, often appearing bilobed; median ridge short, posterior adductors smaller than anterior.

*Dinorthis* is distinguished by its biconvex or concavo-convex profile, and the bilobed anterior muscle field of the pedicle valve. The genus exhibits two types of brachial valves, those that are convex throughout, and those in which the regularity of the convexity is broken by a median depression or sinus. The genus has also been divided according to the fineness or coarseness of striæ. The subgenus *Plaesiomys* has been established to designate those forms having numerous fine striæ.

*Dinorthis* differs from *Hebertella* in having a more simple profile and coarser and fewer striæ.

*Dinorthis browni* n.sp.

Plate IV, figures 18, 19

Sub-elliptical outline; resupinate or plano-convex, except at the umbo; large, holotype measuring: width, length, and thickness, 29 mm., 23.5 mm., and 8 mm. (brachial valve), many specimens larger; hinge, 22 mm; cardinal angles rounded; anterior margin broadly rounded.

Pedicle valve flat or resupinate, except at the umbo, showing a tendency to have a broad shallow depression extending from behind the umbo to the anterior margin.

Brachial valve convex, without a sinus, a tendency to flatten in the median region.

Striæ, 40 to 55, strong, coarse, rounded on top, with interspaces equal to or greater than themselves, multiplying about one-third the distance from the beak, in the brachial valve: one, two, or even three new striæ implanted between the primaries, rapidly increasing in size, so that the alternation of striæ, characteristic about mid-length, becomes uniform near the margin; multiplication by implantation in brachial valve and by bifurcation in the pedicle valve, in a few cases one striæ becomes three, but the increase in size is so rapid that the regularity is only slightly disturbed; an occasional additional striæ occurs near the margin of both valves; striæ on cardinal wings not numerous nor exceptionally fine.

The species differs from *D. pectinella* in its size and multiplication of striæ. It differs from *D. subquadrata* in being larger, in lacking a sinus in the brachial valve, and in the multiplication of striæ once in place of twice. It is similar to *D. iphigenia* in having no sinus in the brachial valve, but differs in its much greater



size, in multiplication of striæ once instead of twice, in the coarser and in the more pronounced alternation of striæ in the mid region, and in not having numerous fine striæ on the cardinal wings.

*Occurrence.* Rockland beds, locality 165; Rockland or Hull beds, locality 158; Hull beds, localities 58, 60, 167, 195, 213; Hull or Sherman Fall beds, locality 212; Sherman Fall beds, localities 186, 263; Cobourg beds, locality 251.

*Type.* Holotype not from the Ottawa-St. Lawrence Lowland, but from Belleville, Ontario, G.S.C. No. 1620; paratype No. 6391, from Hull or Sherman Fall beds, north of west red brick house, Ange gardien road, 4 miles west of L'Orignal, Ontario.

*Dinorthis calderi* n.sp.

Plate IV, figures 16 a-c

Sub-elliptical in outline; resupinate, medium size, measuring: width, length, and thickness of holotype, 29 mm., 21 mm., and 7 mm., respectively; hinge 14 mm.; cardinal angles blunt; cardinal areas very narrow at the extremities, that of the pedicle valve rising abruptly near the beak; anterior margin slightly sinuate.

Pedicle valve flat except for a broad, shallow depression that includes about one-third of the area.

Brachial valve without sinus, convex in the median region, almost a broad, low fold, becoming flattened towards the sides.

Striæ, about 40 to 60 at the margin, threadlike, sharp, multiplying once near the beak, and again about two-thirds the distance to the margin, increasing rapidly in size; interspaces equal to or greater than the striæ.

*D. calderi* belongs to the group of the genus that lacks a sinus or depression in the brachial valve. It differs from *D. iphigenia* and its varieties in its larger size, more flabellate form, and more pronounced fold in the brachial valve and sinus in the pedicle valve, and it lacks the tendency to form numerous small striæ on the cardinal wings.

*Occurrence.* Sherman Fall beds, localities 127, 160, 199, 263.

*Type.* Holotype, from Sherman Fall beds 1 mile west of Finch, in the private collection of J. A. Calder.

*Dinorthis dubia* n.sp.

Plate IV, figure 20

Sub-elliptical in outline, flabellate; plano-convex, except at the umbo; large, width, length, and thickness averaging: 35 mm., 25 mm., and approximately 5 mm. (brachial valve); cardinal angles rounded; anterior margin broadly rounded.

Pedicle valve almost flat, except at the umbo.

Brachial valve with moderate convexity considering the size of the species, flattening out at the wings; having a broad, shallow sinus, particularly defined in the umbonal region and disappearing towards the margin.

Striæ approximately 60, sharp, comparatively fine, multiplying at approximately 6 mm. from the beak, and again at 11 mm., occasionally two implanted almost at the same stage of growth between two primaries, and occasionally a tertiary stria; increase in size so rapid as to give a general impression of uniformity; interspaces equal to or greater than the striæ.

All of the few specimens present are crushed. Better material would yield more satisfactory results. The species belongs to the group having a mesial sinus. It differs from *D. subquadrata* and *D. subquadrata alternata* in its larger size and more flabellate outline.

*Occurrence.* Rockland or Hull beds, locality 79; Hull ? beds, locality 215; Sherman Fall beds, locality 13.

*Type.* Holotype, from Hull ? beds, Murray's quarry, L'Original, Ontario, in the private collection of G. W. Sinclair.

*Dinorthis iphigenia* (Billings)

Plate IV, figures 9, 10

*Orthis iphigenia* Billings, Geol. Surv., Canada, Pal. Foss., 1, 1865, p. 133, fig. 110.

Subelliptical or subquadrate in outline; moderately biconvex, width, length, and thickness averaging: 23 mm., 19 mm., and 8 mm., respectively; hinge short, 12 mm.; cardinal angles rounded; cardinal area low, neither valve projecting far; brachial beak slightly incurved; anterior margin straight or broadly rounded.

Pedicle valve gently convex at the umbo, almost flat on the sides, and having a broad, shallow, mesial depression at the anterior.

Brachial valve moderately convex, no mesial depression but a slight flattening of the convexity in the central region.

From 45 to 60 very fine, subangular striæ, multiplying about one-quarter distance or less from the beak, and in some instances again near the anterior margin; by implantation in the brachial and by bifurcation in the pedicle valve, growth in size rapid so that the regularity of ornamentation is more or less retained; interspaces equal to or greater than striæ; striæ on the cardinal wings fine and numerous.

*D. iphigenia* differs from all others in the numerous fine striæ on the cardinal wings. It differs from *D. pectinella* in its multiplication of striæ and in its short hinge line. It differs from *D. subquadrata* in its smaller size, proportionately shorter hinge line, low cardinal area, lack of a mesial depression in the brachial valve, and in the rapid increase in size of striæ with broader interspaces.

*Occurrence.* Rockland beds, locality 165; Hull beds, localities 137, 210, 217; Sherman Fall beds, localities 13, 42, 186, 210, 263; Cobourg beds, localities 43, 96, 133, 189, 208, 232.

*Type.* Cotypes, G.S.C. Nos. 1634a-c, from Cobourg beds ?, an unspecified locality at Ottawa, Ontario.

*Dinorthis iphigenia media* n.var.

Plate IV, figures 1, 2

Sub-elliptical to sub-orbicular in outline; plano-convex except at the umbo; small, holotype (brachial valve): width, length, and thickness, 20 mm., 16 mm., and 6 mm., respectively; hinge line 13 mm.; paratype (pedicle valve of another specimen) 18 mm., 13 mm., and 3 mm.; cardinal angles rounded; pedicle cardinal area erect, brachial area not seen but, apparently, more incurving.

Pedicle valve flat with very little elevation at the umbo.

Brachial valve convex, though some specimens are slightly less convex across the median region, and without a sinus.

About 18 primary striæ, multiplying to 35 or 40 at the margin; the holotype has an additional 5 minute striæ added just posterior to the margin; other specimens show an occasional one or two; multiplication of striæ by implantation on the brachial, and by bifurcation on the pedicle valve; in most cases new striæ in the brachial valve alternate with the primaries, but occasionally two are added simultaneously; multiplication begins 6 mm. to 8 mm. from the beak; enlargement rapid so that there is an appearance of comparative regularity; in pedicle valve multiplication 6 to 9 mm. from the beak, one striæ dividing into two or in some cases three, and in one instance into four, plications, or the primary may continue simple to the anterior margin. Unexfoliated specimens exhibit a tendency to have several finer striæ crowded on the cardinal wings, as in *D. iphigenia*. Exfoliated specimens show sharper striæ, and a greater difference in the alternation of primaries and secondaries.

*D. iphigenia media* is like the species in general outline, in the brachial valve lacking a sinus, and in the comparative evenness of the striæ. It differs in being smaller and in having more numerous striæ.

The variety differs from *D. iphigenia minor* in being a little larger, in having a greater alternation of striæ, and in having a flatter pedicle valve.

The variety differs from *D. meedsi* in having few striæ, and these are not strikingly arranged in bundles.

*Occurrence.* Leray-Rockland beds, localities 3, 7 (loose), 16, 19, 24, 207; Sherman Fall beds, localities 13, 43, 84, 160, 166, 186, 199, 212, 261, 263.

*Type.* Holotype, G.S.C. No. 6392; paratype, No. 6392a; both from Sherman Fall ? beds, Jessops Rapids, Bonnechère River, Ontario.

*Dinorthis iphigenia minor* n.var.

Plate IV, figures 3, 4

Transversely sub-elliptical; gently biconvex at the umbo; small, width, length, and thickness averaging 17 mm., 13 mm., and 7 mm., respectively (both valves, the brachial being the more convex); hinge about 11 mm.; cardinal angles rounded; cardinal area low; both beaks slightly incurved; anterior margin straight or broadly rounded.

Pedicle valve gently convex at the umbo, becoming flat on the sides and flat or slightly depressed in the central region.

Brachial valve evenly convex, no mesial depression.

From 35 to 45 striæ of two orders, secondary ones not increasing in size rapidly, giving the whole an aspect of alternation of striæ right to the anterior margin; a group of very fine striæ on the wings as in the species; implantation on the brachial valve and bifurcation on the pedicle valve as a rule occurs once only, beginning about one-third the distance from the beak, very rarely one or perhaps two additional striæ near the margin.

The species is like *D. iphigenia* in having no sinus in the brachial valve, and in having numerous very fine striæ on the cardinal wings. It is smaller, and exhibits a much more marked alternation of striæ. It differs from *D. meedsi* W. and S. in having fewer striæ, and in the definite alternation of striæ. It differs from *D. meedsi plana* n.var., described below, in these same features and in being more robust.

*Occurrence.* Rockland beds, localities 24, 155, 165; Hull or Sherman Fall beds, localities 50, 210; Sherman Fall beds, localities 182, 186, 199, 216, 263; Cobourg beds, localities 43, 111, 179, 258.

*Types.* Holotype, G.S.C. No. 6393; paratype, No. 6393a; from Cobourg beds, lot 1, con. VIII, Cornwall tp., Ontario.

*Dinorthis (Plaesiomys) meedsi germana* (W. and S.)

Plate IV, figure 6

*Orthis meedsi germana* Winchell and Schuchert, Amer. Geol., 9, 1892, p. 290.

*Orthis (Dinorthis) meedsi germana* W. and S., Geol. Minnesota, 3, 1893, p. 428, Pl. XXXII, figs. 43-45.

*D. meedsi* is characterized by its biconvex profile, with the brachial valve strongly convex, and its striæ grouped in twos and threes. This variety is similar but smaller, the ventral valve has a slight angulated fold, and the dorsal valve a shallow but distinct sinus.

The two specimens found correspond to the description except that the brachial valve is more convex, the size a little greater than the illustrated type, and there are several coarser concentric growth lines.

*Occurrence.* Cobourg beds, localities 91, 258.

*Type.* Plesiotype, G.S.C. No. 6405, from Cobourg beds, lot 1, con. VIII, Cornwall tp., Ontario.

*Dinorthis meedsi plana* n. var.

Plate IV, figures 5 a-c

*Orthis retrorsa* (Salter), Billings, Geol. Surv., Canada, Pal. Foss., 1, 1865, p. 138, fig. 111 (pars).

Subquadrate in outline; plano-convex except at the umbo; small, averaging: width, length, and thickness, 18.5 mm., 14.5 mm., and 4.5 mm., respectively; hinge not quite three-quarters greatest length; cardinal angles rounded; cardinal area narrow, that of pedicle valve low, but rising abruptly with the brachial valve projecting beyond it; short, wide, triangular delthyrium.

Pedicle valve almost flat, except for slight rise at the umbo.

Brachial valve almost flat, except at the umbo, without a true sinus, but exhibiting a flattening in the central third of the anterior.

Striæ 55 to 60, crowded on the wings; fine, enlarging gradually, producing an irregularity in size; multiplying three times, secondaries beginning about 3 mm. from the beak, the tertiaries at 10 mm., and the quaternaries very close to the margin; multiplication by implantation in the brachial valve, by bifurcation in the pedicle valve, where, in a few cases, the striæ divide into bundles of threes.

The variety is like the species in general size and outline, but differs in being very thin and flat, and in having the brachial project beyond the pedicle valve.

*Occurrence.* Sherman Fall beds, locality 57; Cobourg beds, localities 100, 217, 226 (loose ?), 258.

*Type.* Holotype, G.S.C. No. 6395, from Cobourg beds, old limekiln, Rochester street, Ottawa, Ontario.

*Dinorthis ottawaensis* n.sp.

Plate IV, figure 17

Subquadrate in outline; profile of pedicle valve not known; medium size, width, length, and thickness averaging 26 mm., 20 mm., and 9 mm., respectively; hinge equal to length; cardinal angles blunt; cardinal area not seen.

Pedicle valve uncertain, no complete specimen found; one broken valve, showing approximately the average number of striæ, appears to belong to the species.

Brachial valve gibbous over two-thirds of the shell, curving down rather steeply to narrow wings; mesial depression present, varying from a flattened area to a narrow sinus from beak to anterior margin, comparatively deep on the umbonal region.

Striæ, 60 to 75, fine, with interspaces wider than themselves, multiplying twice, once at about one-third or less from the beak and again near the anterior margin, where the number is practically doubled, appearing like a fine frill; interspaces equal to or greater than striæ.

The species differs from all others in its gibbous brachial valve combined with the numerous fine striæ with their multiplication near the margin.

*Occurrence.* Cobourg beds, localities 101, 105, 121, 168, 174, 185, 191, 208, 236, 243.

*Type.* Holotype, G.S.C. No. 6398, from lot 23, con. VII, Roxborough tp., Ontario.

*Dinorthis pectinella* (Emmons)

Plate IV, figures 12, 13

*Orthis pectinella* Emmons, Geol. New York, 2nd Distr., 1842, p. 394, fig. 2.

*Dinorthis pectinella* (Emmons) Hall and Clarke, Pal. New York, 8, 1892, pt. 1, p. 228, Pl. V, figs. 27-33; Willard and Raymond, Mus. Comp. Zool., 68, 1928, p. 268.

The species restricted is suborbicular; plano-convex, except at the umbo, width, length, and thickness of specimens in this region averaging 22 mm., 18 mm., and 7 mm., respectively; hinge line approximately 18 mm., somewhat less than the

greatest width; cardinal angles blunt; pedicle area higher than brachial; anterior margin broadly rounded.

Pedicle valve prominent at the umbo, becoming flat and almost concave towards the margins.

Brachial valve regularly convex, most prominent in the middle; no mesial sinus.

Striæ numbering 22 to 30, rounded, coarse, simple, with intervening spaces equal to or greater than the striæ.

Many forms have been included under the name *Dinorthis pectinella*. Emmons' type has simple strong plications, and Willard and Raymond have restricted the species to those having this ornamentation. The species can be distinguished from others by this characteristic striation. The Minnesota species *D. pectinella sweeneyi* has the same type of striæ but it is smaller.

A variety of *Dinorthis pectinella*, found at the quarry about 1 mile west of Finch, is much larger.

*Occurrence.* Leray-Rockland beds, localities 144, 187; Rockland beds, localities 165, 211; Hull beds, locality 210; Sherman Fall beds, localities 10, 186, 193, 200, 202.

*Type.* Plesiotypes, G.S.C. No. 6399, from Sherman Fall beds, Castor River 1 mile east of Embrun, Ontario, and from Hull ? beds, Murray quarry, L'Orignal, in the private collection of G. W. Sinclair.

*Dinorthis pectinella* cf. *sweeneyi* (N. H. Winchell)

Plate IV, figures 11 a, b

*Orthis sweeneyi* N. H. Winchell, 9th Rept. Geol. Nat. Hist. Surv., Minnesota, 1881, p. 187.

*Orthis (Dinorthis) pectinella* var. *sweeneyi* (N. H. Winchell), Winchell and Schuchert, Geol. Minnesota, 3, 1893, p. 426, Pl. XXXII, figs. 35-38.

*Dinorthis pectinella sweeneyi* (N. H. Winchell) is like *D. pectinella* in its general outline, profile, and straight, simple plications. It differs from the species in being consistently smaller, averaging approximately 17 mm. in width and 12 mm. to 13 mm. in length.

The specimens found in the region are few and broken, but they appear to correspond in all particulars.

*Occurrence.* Leray-Rockland beds, locality 151; Hull beds, locality 60; Sherman Fall beds, localities 183, 202.

*Dinorthis porcata* (McCoy)?

*Orthis porcata* (McCoy), Billings, Geol. Surv., Canada, Pal. Foss., 1, 1865, p. 135, fig. 111.

Billings cites this form from Ottawa and L'Orignal. McCoy's original illustration is very poor, but it has the large simple striæ of *D. pectinella*. Billings also cites the species from the Richmond of Anticosti, and it is probable the drawing was made from an Anticosti specimen. No such species has been seen by the writer.

*Dinorthis regularis* n.sp.

Plate IV, figure 15

Suborbicular to sub-elliptical in outline; profile, plano-convex, except at umbo if the identification of the pedicle valve is correct; large, holotype (brachial valve): width, length, and thickness, 34 mm., 25 mm., and 7 mm., respectively.

Pedicle valve not established.

Brachial valve without sinus, convexity greatest about 6 mm. from the beak, sloping down evenly to the anterior and sides, but flattening out somewhat at the wings.

Striæ, sharp, round, rather fine, 19 or 20 primaries, multiplying to 45 to 50 at the margin by implantation of the secondaries at about 9 mm. from the beak and a few tertiaries near the margin, all increasing so rapidly in size that a general uniformity is maintained; an evident tendency to have a number of finer striæ on the wings; interspaces broader than striæ.

The species belongs to the group of the genus lacking a sinus in the brachial valve. It differs from *D. iphigenia* and its varieties in being subcircular, in its larger size, in averaging larger interspaces, and in lacking the fine striæ on the cardinal wings. It differs from *D. browni* in lacking the mesial sinus in the brachial valve, in its more suborbicular outline, and in the greater regularity of the striæ.

*Occurrence.* Rockland beds, localities 22, 165; Hull beds, localities 215, 221, 227; Hull or Sherman Fall beds, localities 61, 212; Sherman Fall beds, localities 13, 263.

*Type.* Holotype, G.S.C. No. 6402, from Sherman Fall beds, Aux Raisins River, just east of Black River Station, Ontario.

*Dinorthis strathmoriana* Wilson

Plate IV, figures 8 a, b

*Dinorthis strathmoriana* Wilson, Roy. Soc., Canada, ser. 3, 26, sec. 4, p. 391, Pl. IV, figs. 7, 8.

*Dinorthis strathmoriana* in size and shape is most closely allied to *D. iphigenia minor* n.var., but the striæ are finer, more numerous, 70 to 90, and, so far as can be seen, they lack the alternation of striæ.

It is curious that no other specimens have been found of like size and having such numerous fine striæ.

*Occurrence.* Cobourg beds, locality 247.

*Type.* Holotype, G.S.C. No. 6611, from Cobourg beds, outcrop in stream crossing the road 1 mile east of Strathmore, Ontario.

*Dinorthis subquadrata* (Hall)

Plate IV, figures 7 a, b

*Orthis subquadrata* Hall, Pal. New York, 1, 1847, p. 126, Pl. XXXIIA, fig. 1.

*Orthis (Dinorthis) subquadrata* (Hall) Winchell and Schuchert, Geol. Minnesota, 3, 1893, p. 428, Pl. XXXII, figs. 46-50.

*Dinorthis (Plesiomys) subquadrata* (Hall) Schuchert and Cooper, Peabody Mus. Nat. Hist., Mem. 4, pt. 1, 1932, Pl. X, figs. 15, 17, 18, 24-26.

This species belongs to the group included in the subgenus *Plesiomys* because of the number and fineness of the striæ, 50 to 75. It is characterized by its subquadrate outline, the mesial sinus in the brachial valve, the multiplication of the striæ once near the beak, and in many cases again near the margin, with increase in size so rapid as to give the striation an appearance of uniformity.

The type species is cited from the Richmond, but there are a number of specimens in the collections that correspond to the description and illustrations.

*Occurrence.* Hull beds, localities 60, 137, 138; Hull or Sherman Fall beds, locality 61; Sherman Fall beds, localities 42, 188; Cobourg beds, localities 43, 86, 99, 123, 133, 185, 189, 226.

*Type.* Plesiotype, G.S.C. No. 6403, from Hull beds, Robillard quarries, east of Ottawa, Ontario.

*Dinorthis subquadrata alternata* n.var.

Plate IV, figures 14 a, b

*Orthis subquadrata* Billings, Geol. Canada, 1863, p. 165, fig. 146.

Outline subquadrate; profile plano-convex, except at the umbo; large, holotype measuring: width, length, and thickness, 27 mm., 21 mm., and 8 mm., respectively; hinge 20 mm.; cardinal angles bluntly angular; cardinal area narrow, but pedicle area rising abruptly, in the centre third, almost at right angles to the plane of the shell; wings gently deflected, more pronounced in some specimens than in others; anterior margin almost straight.



Pedicle valve flat, except for the slight convexity at the umbō and in some specimens the deflexion at the wings.

Brachial valve moderately convex, but having a shallow sinus that becomes flattened anteriorly, producing the rather straight anterior margin.

Striæ, approximately 45 to 60 multiplying twice, once near the beak and again near the margin, increase in size gradual, producing an alternation in striation more marked in some specimens than in others.

The variety is like the species in size, in having a mesial sinus in the brachial valve, and in having a subquadrate outline, though in many specimens the ratio of width to length is proportionately greater than in the typical species. The greatest difference, however, is the variability of the increase in size of the secondary and tertiary striæ and the consequent appearance of alternation.

The holotype is the specimen figured by Logan as *Orthis subquadrata* Hall.

*Occurrence.* Hull beds, localities 44, 217; Sherman Fall beds, localities 55, 199, 263; Cobourg beds, localities 118, 133, 162, 258.

*Type.* Holotype, G.S.C. No. 1630, from Cobourg ? beds, an unspecified locality, Ottawa, Ontario.

There are in the collections five types of pedicle valves of *Dinorthis*. All specimens are detached, and it is not possible to assign them to any known species, therefore, no name is given them, but until relationship can be established attention is drawn to these several forms. The contrasts are so great that the specimens are described below.

With these pedicle valves are several crushed brachial valves, having striæ of about the same order. They are larger and more convex than most *Dinorthis*.

#### Pedicle valve No. 1

Plate IV, figure 23

Sub-orbicular; flat; large, width, length, and hinge measuring: 37 mm., 32 mm., and 30 mm. respectively; a few specimens are a little smaller; cardinal angles blunt; anterior margin rounded; striæ, broad and rounded on top, having flat interspaces less than the width of the striæ and with angular margins, as shown from the inner side; bifurcation of striæ at least twice; the first a little obscure from the inner side but apparently at about mid-length, a second near the margin and exhibiting one, two, or even three smaller striæ between two larger; muscle scar typical and strong.

*Occurrence.* Sherman Fall beds, locality 200.

*Type.* Holotype from Sherman Fall beds, the quarry 1 mile west of Finch, Ontario, in the private collection of G. W. Sinclair.

#### Pedicle valve No. 2

Plate IV, figure 22

Subquadrate; flat or slightly convex; large, width 28 mm., length 20 mm., hinge 25 mm.; cardinal angles blunt, anterior margin rounded; 38 ribs, strong, generally wider than their interspaces; multiplying at one-third distance from the beak, and again at three-quarters distance.

*Occurrence.* Sherman Fall beds, locality 84.

*Type.* Holotype, G.S.C. No. 6404, from Sherman Fall beds, Governor Bay, Ottawa, Ontario.

#### Pedicle valve No. 3

Plate IV, figure 21

Subquadrate; flat; beak more prominent than in No. 1; comparatively large, width 29 mm., length 20 mm., hinge 20 mm.; cardinal angles blunt; anterior margin rounded, 55 striæ, multiplying first at mid-length, a few in bundles of three; interspaces about equal to striæ.

The form is very similar to No. 1 in size and shape, but has finer and more numerous striæ.

*Occurrence.* Hull beds, locality 210.

*Type.* Holotype from old quarry 4 miles east of L'Orignal, Ontario, in the private collection of G. W. Sinclair.

#### Pedicle valve No. 4

#### Plate IV, figure 25

Subquadrate; gently convex, particularly at the umbo, flattened almost to a sinus in the median third; width 31 mm., length 23 mm., hinge equal to length; cardinal angles obtuse; anterior margin almost straight; striæ, 100, first dividing at 4 mm. from the beak, a second division at 9 mm., and a third near the margin; interspaces equal to striæ; all crossed by fine growth lines, and there are in addition several coarse imbrications near the margins.

The form is a little larger than the two preceding, the striæ are more numerous, and considerably finer.

*Occurrence.* Sherman Fall beds, locality 186.

*Type.* Holotype from Sherman Fall beds, Castor River below Embrun, Ontario, in the private collection of G. W. Sinclair.

#### Pedicle valve No. 5

#### Plate IV, figure 24

Subquadrate; flat, with a faint depression at the anterior margin; width, length, and hinge measuring: 34 mm., 26 mm., and 26 mm., respectively; cardinal angles rounded; cardinal area high, sloping forward beyond the perpendicular; anterior margin broadly curved, almost parallel to the hinge; striæ, about 120, fine for the genus, having interspaces less than their own width; bifurcation of striæ, four or even five times, each striæ enlarging rapidly.

The form is like pedicle valve No. 4 in its rounded cardinal angles, and in its numerous and frequently bifurcating striæ, but it is larger, flatter, and in the cardinal area slopes forward.

*Occurrence.* Cobourg beds, locality 95.

*Type.* Holotype, Cobourg beds, corner Rochester and Lydia streets, Ottawa, Ontario, in the private collection of G. W. Sinclair.

The following table reveals a number of tendencies in the development of *Dinorthis* as it occurs in this region. Although the genus was present in older rocks it did not make its appearance in the Ottawa-St. Lawrence Lowland until the first hundred feet or more had been deposited. In its development within Black River-Trenton time the group without a sinus or depression in the brachial valve entered the region first. Those first introduced apparently disappeared first. Some of the younger forms lived on until the retreat of the depositing sea. The forms with a sinus or depression in the brachial valve appeared later than the first of those lacking the sinus, and of the six species and varieties found, five continued until the end of deposition.

It is evident, also, that there is a tendency for increase in the number of striæ in the younger forms.

So far as they go these findings do not bear out the suggestion of Schuchert and Cooper<sup>1</sup> that "*D. pectinella* and related forms represent a culmination of a trend in the direction of the simplification of ribs".

<sup>1</sup> Schuchert, Chas., and Cooper G. A.: Peabody Museum Nat. Hist., Mem. 4, pt. 1, p. 96 (1932).



TABLE IV  
Range and Striae of *Dinorthis*

Species	OTTAWA FORMATION FAUNAL BEDS								Number of striae
	Pamella	Lowville	Lery	Rockland	Hull	Sherman Fall	Cobourg		
WITHOUT SINUS									
<i>D. iphigenia media</i> n.var.			x					x	35-40
<i>D. pectinella</i> (Emmons)			x	x	x			x	22-30
<i>D. pectinella sueaneyi</i> N. H. Winchell.			x	x	x			x	25-30
<i>D. browni</i> n.sp.			x	x	x			x	40-45
<i>D. iphigenia minor</i> n.var.			x	x	x			x	35-45
<i>D. regularis</i> n.sp.			x	x	x			x	45-50
<i>D. iphigenia</i> (Billings)					x			x	45-60
<i>D. calderi</i> n.sp.								x	40-60
<i>D. strathmaria</i> Wilson.								x	70-90
WITH SINUS									
<i>D. subquadrata alternata</i> n.var.					x			x	45-60
<i>D. subquadrata</i> (Hall)					x			x	50-75
<i>D. dubia</i> n.sp.				x	?			x	60
<i>D. meesii germana</i> (W. and S.)								x	55+
<i>D. meesii plana</i> n.var.								x	55-60
<i>D. ottawaensis</i> n.sp.								x	60-75

Genus, *Doleroides* CooperGenotype, *Orthis gibbosa* Billings

Semi-elliptical; biconvex; wide, shallow, anteriorly developed sinus in pedicle valve and fold in the brachial valve; hinge line straight; shorter than greatest width; delthyrium open, notothyrium modified by cardinal process; many radial striae crossed by growth lines; shell fibrous and impunctate.

In the ventral valve the dental lamellæ are prominent; diductors crescent shaped and elongate, outlined by a thickened margin; adductor ridge single, elliptical; adjustors elongate, narrow; ovarian ridges radial.

In the brachial valve the cardinal process is a thick ridge; brachiophores long, blunt, with converging supports; concave plates present, limiting sockets as in *Plectorthis*.

Externally the genus differs from *Hebertella* in being subequally convex; internally the ventral muscle area lacks the double adductor ridge of that genus. The dorsal valve is similar.

The genus can be readily distinguished from *Pionodema* by its impunctate shell. In addition it has a wider hinge line and a more pronounced fold and sinus. Internally the ventral valve diductors are curved and elongate, not subflabellate. In the brachial interior the brachiophore supports are convergent not divergent as in *Pionodema*.

Billings' type specimen of *Orthis gibbosa*, which would automatically become the genotype, has unfortunately been lost, and Cooper has designated as neotypes three shells from widely distant areas, two from Minnesota and one from the type locality, presented to Dr. Schuchert by Walter Billings.

*Doleroides gibbosus* (Billings)

Plate III, figures 27 a, b

*Orthis gibbosa* Billings, Geol. Surv., Canada, Rept. of Prog. 1856, 1857, p. 296.

*Pionodema* Foerste, Sci. Lab. Denison Univ., Bull. 14, 1909, p. 221, and Bull. 17, 1912, p. 139.

*Doleroides gibbosus* (Billings), Cooper, Jour. Pal., 4, 1930, p. 382, Pl. XXXV, figs. 7 and 14, Pl. XXXVII, fig. 2.

Subcircular in outline; gibbous; plesiotype measuring: width, length, thickness, and hinge, 20 mm., 19 mm., 13 mm., and 14 mm., respectively; a low fold and shallow sinus present; striae numerous and fine.

*D. gibbosus* differs from *D. pervetus* and *D. pervetus ottawanus* in being proportionately less transverse, in having a relatively shorter hinge line, in being more gibbous, and in having a more definite sinus in the pedicle valve.

*Occurrence.* Pamela-Lowville beds, locality 33; Leray beds, localities 38, 74, 109, 152; Leray-Rockland beds, localities 7, 147.

*Type.* Billings' holotype is lost. Cooper has named three neotypes, one of which comes from the type locality; plesiotype, G.S.C. No. 6409, from Leray-Rockland beds, lot 3, con. III, R. F., Gloucester tp., Ontario.

*Doleroides pervetus ottawanus* Wilson

Plate III, figures 28, 29

*Doleroides pervetus ottawanus* Wilson, Can. Nat., 46, No. 6, 1932, p. 136, Pl. I, figs. 3-5, Pl. II, figs. 14, 15.

This form from the Ottawa-St. Lawrence Lowland was identified as *Pionodema subaequata* (Conrad) in all the older literature, until Cooper showed that the genus *Pionodema* is punctate, whereas the species from the Ottawa formation is impunctate.

Broader than long, holotype measuring: width, length, thickness, and hinge line, 19 mm., 14 mm., 7 mm., and 14 mm., respectively; fold and sinus very shallow and with indefinite sides; striæ numerous and fine.

The species differs from *D. pervetus* in being smaller and in having fold and sinus less well developed. The differences between it and *D. gibbosus* (Billings) are given under that species.

*Occurrence.* Lowville-Leray beds, localities 80, 109; Leray beds, localities 12, 15, 17, 30, 40, 41, 62, 73, 75, 77, 78, 139, 143, 144, 146, 156, 159, 171, 220, 262 (loose), 264, 266; Leray-Rockland beds, localities 74, 76, 83, 140, 147, 256.

*Type.* Holotype, G.S.C. No. 6727; paratype, No. 6727a; from Leray beds, Rockland, Ontario.

#### Genus, *Sowerbyella* Jones

##### Genotype, *S. sericea* Sowerby (pars)

Semi-oval or semicircular; concavo-convex, pedicle valve convex, brachial valve concave; greatest width at or near the hinge; cardinal angles acute, in some cases extended; cardinal area low, usually striated, occasionally crossed by transverse wrinkles; delthyrium triangular, partly closed by deltidium.

Striæ fine, rounded, of two orders, several finer striæ between two coarser striæ on the pedicle valve, more even on the brachial valve; corrugations in some cases present along the hinge line.

Pedicle interior having small teeth, supported by dental lamellæ that curve around halfway to the margin, forming the outside of the muscle area; muscle scar elongate or oval; a short septum, which divides into two diverging prongs.

Brachial interior with simple cardinal process, posterior face having two grooves; crural plates short, straight, or curved; median septum in many specimens a pair of short septa arising near the middle of the crural bases and converging towards the median line where they are joined by a pair of sub-parallel septa, which extend nearly to the anterior margin; muscle scars diffuse and subtriangular, or distinct and oval; vascular ridges present; some forms punctate.

Until the publication of O. T. Jones' Memoir<sup>1</sup> on "Plectambonites and some Allied Genera" all American species of *Sowerbyella* had been assigned to the genus *Plectambonites*. Jones has shown that *Plectambonites* is geniculate, especially evident in the interior of the brachial valve, as contrasted with the curve of *Sowerbyella*; that in the pedicle interior of *Plectambonites* the indistinct muscle scars are within a visceral depression; that a low median elevation is connected posteriorly with the dental lamellæ by short cross septa, whereas in *Sowerbyella* the muscle scars are prominent and usually distinct, and the short median septum is forked with divergent prongs. In the brachial valve of *Plectambonites* the indistinct muscle scars are also in a visceral depression, and a median elevation and two lateral ridges disappear short of the hinge line. In the brachial valve of *Sowerbyella* the muscle scars are bordered on the inside by a pair of submedian septa between which is another narrow median septum, in some cases.

#### *Sowerbyella* ? *minuta* n.sp.

##### Plate III, figure 23

Subtriangular in outline; pedicle valve very convex; cardinal angles acute, almost auriculate; size, extremely small, width, length, and thickness of largest specimen 10 mm., 6 mm., and 3 mm., respectively; greatest width at the hinge line; striæ, few and simple, 7 to 9 in number, with broad flat spaces between; strong concentric growth lines; shell substance fibrous and finely punctate beneath the outer layer.

<sup>1</sup> Jones, O. T.: Geol. Surv., Great Britain, 1, pt. 5, 1928

Brachial valve not recognized.

Interiors not seen.

The species is put in *Sowerbyella* with a query because of the lack of interiors and of the brachial valve. The outline and profile are of the *Sowerbyella* type, although there is a simplification of striation.

*S. ? minuta* differs from other species in its minute size and simplification of striæ.

*Occurrence.* Cobourg beds, localities 89, 134.

*Type.* Holotype and paratype from Cobourg beds, Notre Dame cemetery, Eastview, Ontario, in the private collection of G. W. Sinclair.

*Sowerbyella punctostriata* Mather

Plate III, figure 24

*Plectambonites punctostriata* Mather, Ottawa Nat. 31, 1918, p. 38, Pl. I, figs. 15-17.

Transversely semi-elliptical in outline; medium size, width and length measuring 16 to 21 mm. and 9.5 to 12 mm., respectively; cardinal angles slightly acute, but not auriculate; striæ numerous, one to two finer ones between a pair of coarser ones; rows of minute punctæ in the interspaces between the striæ.

Pedicle valve having its greatest convexity a little posterior to mid-length; cardinal margins having low oblique crenulations; a low narrow mesial fold originating near the beak and broadening anteriorly.

Brachial valve not recognized.

The species is similar to *S. sericea* in size, but is distinguished from it in having a more rounded anterior margin, by its very fine but more conspicuous punctæ, by rarely lacking the cardinal crenulations, and by the presence of a low, narrow mesial fold on the pedicle valve, originating near the beak and broadening out anteriorly.

The specimens of the Ottawa-St. Lawrence area are more punctate than *S. sericea*, but they show a slight variation from the typical *S. punctostriata* in that the fold is less conspicuous.

*Occurrence.* Leray beds, locality 3; Leray-Rockland beds, locality 256; Rockland beds, localities 106, 156, 254.

*Type.* Plesiotype, G.S.C. No. 6410, from Rockland beds, Rockland, Ontario.

*Sowerbyella sericea* (Sowerby)

Plate III, figure 26

*Leptaena sericea* Sowerby, Murchison's Sil. Sys., pt. 2, 1839, p. 636, Pl. XIX, figs. 1, 2.

*Plectambonites sericeus* (Sowerby) Hall and Clarke, Pal. New York, 8, pt. 1, 1892, Pl. XV, fig. 15-19.

*Sowerbyella sericea* (Sowerby), Jones, Geol. Surv., Great Britain, Mem. 1, 1928, p. 414, Pl. XXI, figs. 1-4.

Medium size, moderate curvature; subquadrate or semicircular outline; cardinal angles slightly acute; fine, primary, secondary, and tertiary striæ, differentiated in size on pedicle valve, but more equal on the brachial valve; a few wrinkles present along the hinge line in some cases.

Pedicle interior with well-defined dental lamellæ; two elongate-oval muscle scars, extending halfway to the anterior; median septum 2 mm. to 3 mm. in length, forking, the prongs almost at right angles to one another, forming the inner side of the muscle scar.

Brachial valve having short divergent crural plates; two prominent subparallel septa originating just anterior to cardinal process and forming the inner side of the muscle scar.

The specimens found in the Hull beds are larger than average for the species, and might be considered a different variety. In the Rockland beds, where the species is prolific, a few large specimens occur, but by far the greater number are normal,

and there is a gradation from the normal to the large form. For this reason the large form has not been considered a variety, the size probably being due to some difference in the local environment.

*Occurrence.* Lowville-Leray beds, locality 156; Leray beds, localities 3, 5, 8, 20, 41, 109, 152, 156, 164, 171, 214, 230, 264; Leray-Rockland beds, localities 19, 144, 256; Rockland beds, localities 27, 29, 139, 149, 150, 157, 165, 187; Hull beds, localities 44, 58, 60, 138, 210, 222, 227; Sherman Fall beds, localities 10, 13, 42, 56, 57, 84, 129, 160, 166, 183, 186, 193, 200, 201, 203, 210, 260, 261, 263, 265; Cobourg beds, localities 3, 43, 86, 89, 96, 121, 185, 190, 235, 252.

*Type.* Plesiotypes, G.S.C. No. 6613, from Cobourg beds of Gravel Hill, Ontario, and No. 6411, from Leray-Rockland beds, Rockland, Ontario.

*Sowerbyella subovalis* Wilson

Plate III, figures 25 a, b

*Sowerbyella subovalis* Wilson, Roy. Soc., Canada, 26, 1932, sec. 4, p. 393, Pl. 4, figs. 10, 11.

Semi-oval outline; concavo-convex, pedicle valve being quite convex; average width, length, and thickness 13 mm., 9 mm., and 2.5 mm.; cardinal wings not prominent; cardinal margins commonly bearing faint crenulations.

Pedicle valve evenly curved on the umbo, with sides more abruptly curved. Interior not known.

Brachial valve not distinguishable from small specimens of *S. sericea*.

The species differs from *S. sericea* in its less quadrate outline, in its smaller size, and in its proportionately more convex umbo. It is commonly dark in colour. The manner of preservation also distinguishes it. The combination of smaller size and proportionately more convex umbo often results in a breaking of the cardinal wings; or in their being buried in the matrix, leaving the small rotund umbonal region exposed. A slab covered with broken or partly buried specimens gives the suggestion of a smaller species.

*Occurrence.* Hull beds, locality 44; Hull or Sherman Fall beds, localities 50, 52; Sherman Fall beds, localities 3, 13, 42, 56, 57, 84, 166, 183, 193, 200, 203, 210, 260, 261; Cobourg beds, at practically all exposures.

*Type.* Holotype, G.S.C. No. 6612, from Cobourg beds, Gravel Hill, Ontario.

Genus, *Leptaena* Dalman

Genotype, *Conchita rhomboidalis* Wilckens

Outline transversely subquadrate or semi-oval; plano-convex in youth, becoming concavo-convex at maturity; greatest width at the hinge line, which is straight; cardinal extremities subauriculate; pedicle valve with a narrow area; delthyrium covered by perforated convex deltidium; brachial area narrower, covered posteriorly by chilidium; surface marked by conspicuous concentric corrugations extending forward to region of abrupt geniculation; radiating costæ, increasing by bifurcation and implantation, crossed by fine concentric growth lines; punctæ in the intermediate shell layers arranged in rows between the striæ as in *Rafinesquina*.

Interior of pedicle valve having teeth strong, divergent, dental plates continued forward around muscle area; adductors narrow; diductors flabellate.

Brachial interior cardinal process large, bifid, with broad, flat, striated surfaces; sockets deep; crural plates not sharply defined; broad ovate muscle area with ramifications; two low posterior callosities from either base of cardinal process unite and are produced as a median septum.

The genus is most closely allied to *Rafinesquina*, from which it can be distinguished by the concentric corrugations and the definite geniculation.

There is a group of small semi-oval shells that seems to be transitional between *Leptaena* and *Rafinesquina*. The outline and geniculation suggest *Leptaena*. The

concentric corrugations, however, are only faintly developed. *Leptaena radialis* Okulitch and *Leptaena ? diminuta* n.sp. belong to this group.

*Leptaena ? nitens* Billings from the Richmond of Anticosti Island also may belong here, but the punctæ of that species are not so regularly arranged as in the other *Leptaena* species and in *Rafinesquina*.

*Leptaena affinis* n.sp.

Plate III, figure 19

No complete specimen of *L. affinis* has been found, so that particulars of size are not known. The posterior part along the 10th crenulation from the beak shows the proportion of width to length to be 2:1.

Striæ and crenulations very fine, the latter numbering 10 in 8 mm., along the median line.

*Leptaena affinis* is distinguished from any other species in the extreme fineness of its crenulations.

*Occurrence.* Cobourg ? beds, locality 129.

*Type* Holotype, from Cobourg ? beds, Governor Bay, Ottawa, Ontario, in the private collection of G. W. Sinclair.

*Leptaena ? diminuta* n.sp.

Plate III, figures 20, 21 a, b

Small, transversely sub-oval; sides at less than a right angle to the hinge; broadly rounded anterior margin; width, length, and height of the two specimens seen 14.5 mm., 11.5 mm., and 5 mm., respectively; geniculation not sharp, but distinct, centred about 8.5 mm. from the beak, accentuating the transverse appearance of the outline; posterior and anterior parts only slightly convex, most of the convexity being due to the geniculation; striæ of two sizes, not greatly differentiated, one to five or more fine ones between two slightly coarser; a few faint crenulations present; punctæ large for the size of the specimens but closely spaced; brachial valve and interior not known.

The sub-oval outline and continuous, though faint, crenulations are more suggestive of *Leptaena* than of *Rafinesquina*.

*L. ? diminuta* n.sp. is closely allied to *L. radialis* Okulitch from the Leray horizon at Montreal. The species here described differs, however, in being larger and more gibbous.

*Occurrence.* Cobourg beds, localities 105, 121.

*Type.* Holotype, from the Cobourg beds at the Research Laboratories, Sussex street, Ottawa, in the private collection of G. W. Sinclair; paratype, G.S.C. No. 6412, from Cobourg beds, corner Spadina and Somerset streets, Ottawa, Ontario.

*Leptaena trentonensis* Wilson

Plate III, figure 22

*Leptaena trentonensis* Wilson, Roy. Soc., Canada, 3, ser. 26, 1932, sec. 4, p. 394, fig. 12.

No complete specimen of *Leptaena trentonensis* has been found, the part below the geniculation being broken. The posterior part is very like *L. richmondensis* in size, but the striæ and crenulations are finer.

Compared with *L. tenuistriata* the crenulations are deeper and broader.

*Occurrence.* Cobourg beds, localities 246, 257.

*Type.* Holotype, G.S.C. No. 6636, from Cobourg beds, cheese factory, Strathmore, Ontario.

*Rafinesquina* discussion

The great variability of the genus *Rafinesquina* has been treated elsewhere<sup>1</sup>, and the information is included here in order that this account of the brachiopoda of the Ottawa-St. Lawrence Lowland may be as complete as possible.

The genus shows a great variability in the convexity, length, and width, and in the presence or absence of ears, and species and variations could be grouped in several ways. They are here divided into three groups according to the convexity of the shell, namely,

- I. Low-convexity forms
- II. High-convexity forms
- III. Genuiculate forms

Between the low-convexity and high-convexity groups there are a few moderately convex forms that might be placed in either category, but usually the ratio of the convexity to the size is sufficient to classify them. The line between high-convexity and genuiculate form is sharper than that between the low- and high-convexity forms, but there are a few forms that are rounded externally and show angular genuiculation when exfoliated.

There is marked tendency toward development from large low-convexity species to shorter, narrower, thicker forms, suggested by Miss E. S. Salmon<sup>2</sup>. Even in the low-convexity group, the forms from the older Leray-Rockland beds are often larger, more robust, and have a more pronounced alternation of striae than the corresponding forms from the Cobourg beds. In some instances the differences are very slight, and for such an endeavour has been made to show the relation by the name. Some forms among the high-convexity and genuiculate groups here described as new species are really variations, but until further investigation it seems impossible to be sure of the lines of their development.

Each of the tables below is arranged from forms of least to those of greatest convexity in proportion to their length. The progressive increase in convexity from low to high convexity to genuiculate groups is evident.

## I. Low-convexity Group

The known forms of the low-convexity group are really all variations of the genotype *Rafinesquina alternata* (Conrad), although some have been previously named as species by the writer, and by Salmon in her excellent paper on the Mohawkian *Rafinesquina*, and are here left as originally described.

Two of the varieties are almost a sub-group in themselves because of their extreme flatness in proportion to their length and width.

<sup>1</sup> Wilson, A. E.: Roy. Soc., Canada, 3rd ser., 33, 1944, sec. 4, pp. 147-188.

<sup>2</sup> Salmon, E. S.: Jour. Pal., 16, 1942, p. 600.

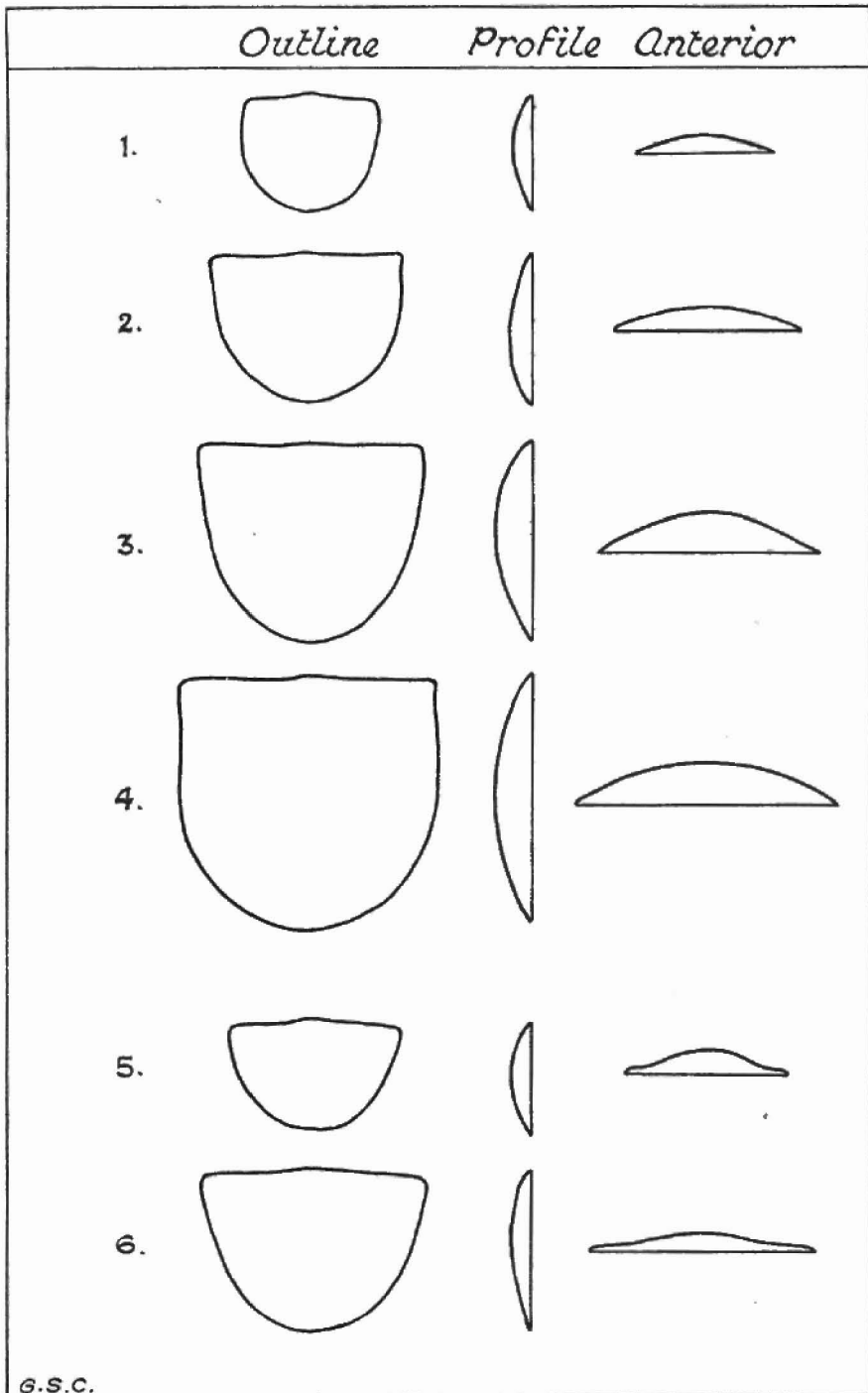
*Rafinesquina**Low Convexity*

Figure 1. 1. *Rafinesquina alternata plana* Wilson; 2. *R. intermedia* Wilson; 3. *R. alternata* (Conrad); 4. *R. lennozensis* Salmon; 5. *R. carlottina* Wilson; 6. *R. alternata transversa* Wilson.



*Rafinesquina* Low Convexity

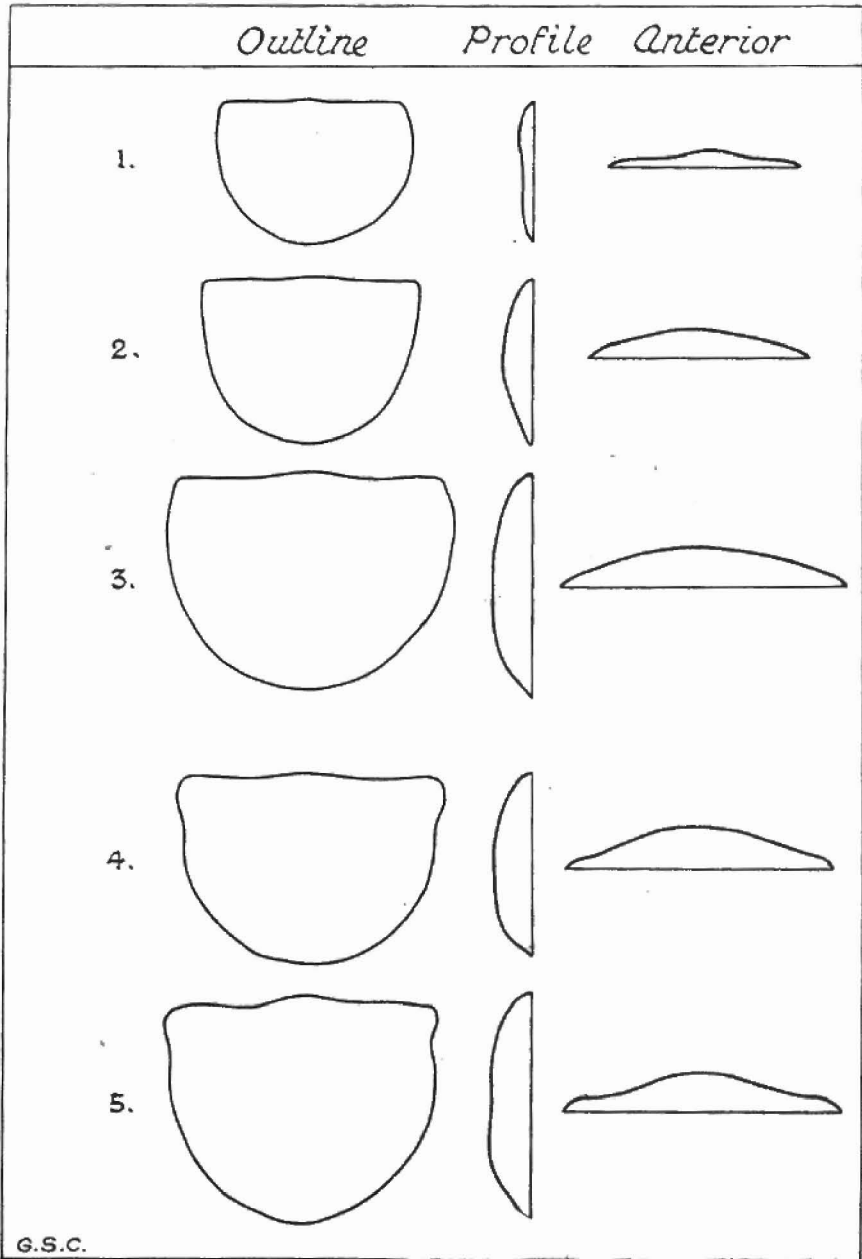


Figure 2. 1. *Rafinesquina alternata platys* Wilson; 2. *R. alternata quadrata* Wilson; 3. *R. alternata semiquadrata* Wilson; 4. *R. alternata alata* Wilson; 5. *R. alternata pota* Wilson.

*Ratio of Convexity to Length and to Width*

	Convexity	Length	Width
<i>R. alternata platys</i> Wilson.....	1	8.4	12.0
<i>R. alternata transversa</i> Wilson.....	1	8.2	12.8
<i>R. alternata plana</i> Wilson.....	1	7.5	9.0
<i>R. lennoxensis</i> Salmon.....	1	6.6	6.8
<i>R. alternata quadrata</i> Wilson.....	1	6.3	8.1
<i>R. alternata pota</i> Wilson.....	1	6.0	7.2
<i>R. alternata semiquadrata</i> Wilson.....	1	5.7	7.6
<i>R. alternata intermedia</i> Wilson.....	1	5.7	7.1
<i>R. alternata alata</i> Wilson.....	1	5.3	7.7
<i>R. alternata</i> (Conrad).....	1	5.2	6.0
<i>R. carlottina</i> Wilson.....	1	5.0	7.3

## II. High-convexity Group

A comparison of the figures of the low-convexity group (*See* Figures 1 and 2) with those of the high-convexity group (*See* Figures 3 to 5) shows clearly that the species of the high-convexity group are proportionately narrower and thicker, and in some instances shorter, than those of the low-convexity group.

*Rafinesquina* High Convexity

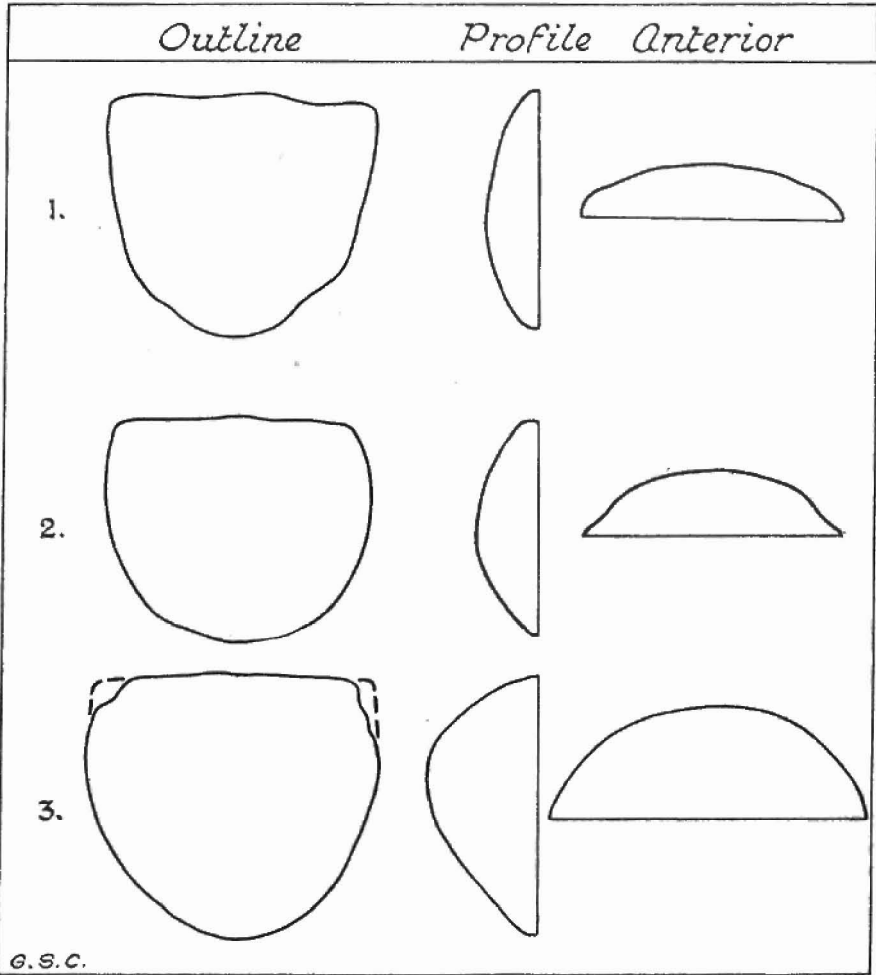


Figure 3. 1. *Rafinesquina equipunctata* Wilson; 2. *R. patula* Wilson; 3. *R. robusta* Wilson.

Most of the high-convexity group begin higher up in the Ottawa formation than those of the low-convexity group, and most of them continue to the top.

*Rafinesquina*      *High Convexity*

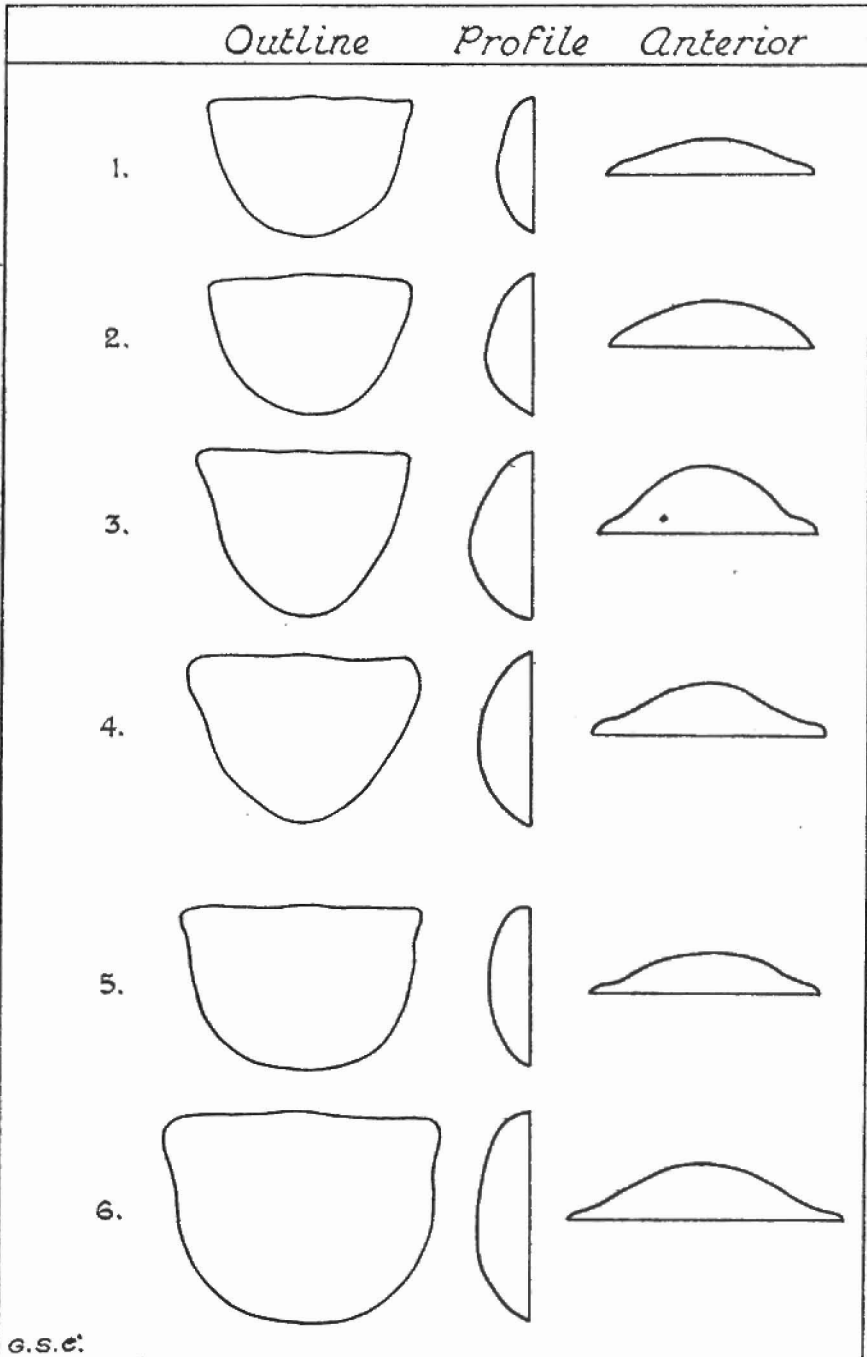


Figure 4. 1. *Rafinesquina esmondensis borealis* Wilson; 2. *R. calderi* Wilson; 3. *R. praecursor* Raymond; 4. *R. subtrigonalis* Wilson; 5. *R. prestonensis* Salmon; 6. *R. hullensis* Wilson.

*Rafinesquina* - High Convexity

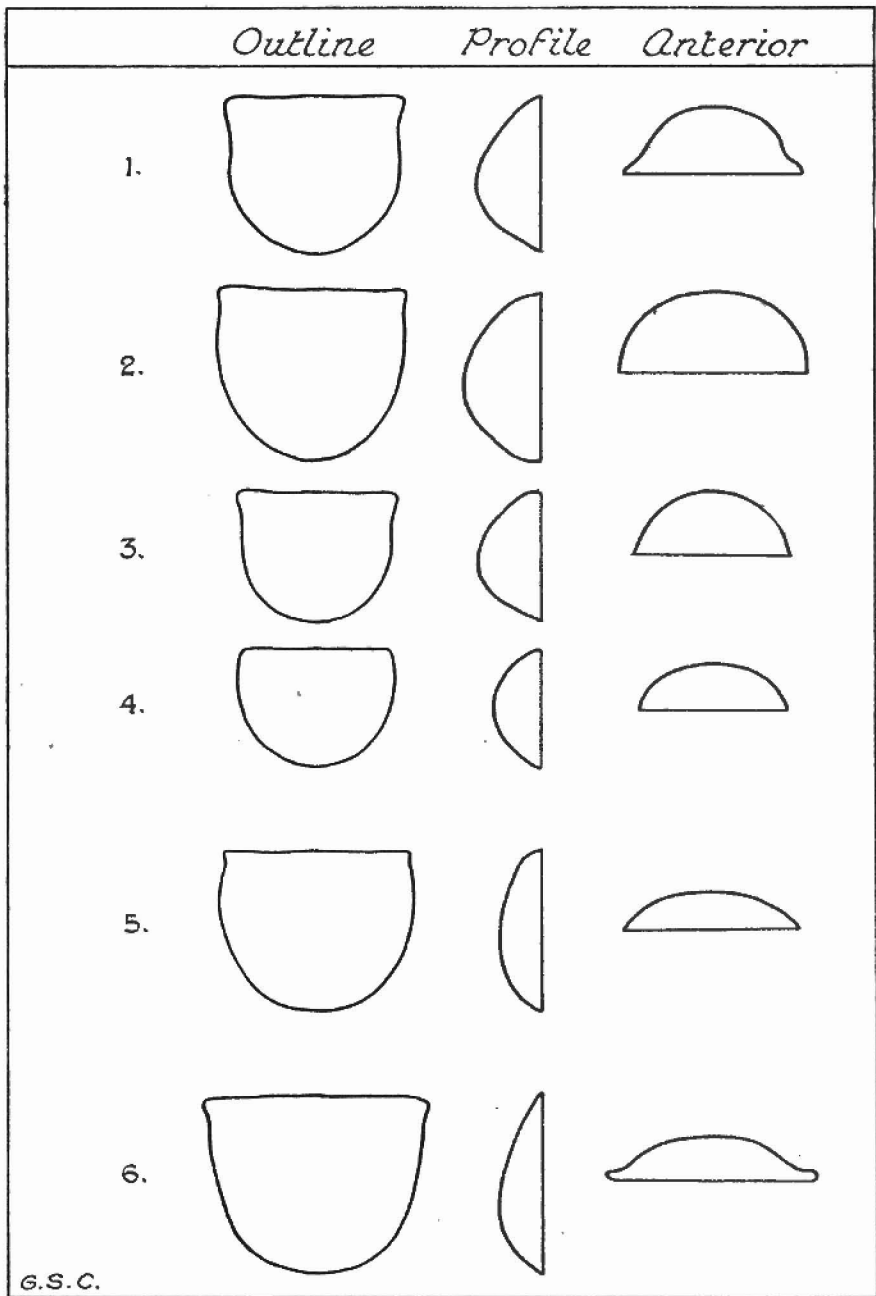


Figure 5. 1. *Rafinesquina apicalis* Wilson; 2. *R. camerata* (Conrad); 3. *R. subcamerata* Wilson; 4. *R. rotunda* Wilson; 5. *R. opeongoensis* Wilson; 6. *R. orleansensis* Wilson.

*Rate of Convexity to Length and to Width*

	Convexity	Length	Width
<i>Rafinesquina orleansensis</i> Wilson.....	1	4.9	6.0
<i>R. opeongoensis</i> Wilson.....	1	4.8	5.5
<i>R. prestonensis</i> Salmon.....	1	4.3	6.2
<i>R. hullensis</i> Wilson.....	1	4.0	5.1
<i>R. equipunctata</i> Wilson.....	1	4.0	5.0
<i>R. subtrigonalis</i> Wilson.....	1	3.7	4.6
<i>R. esmondensis borealis</i> Wilson.....	1	3.6	5.2
<i>R. calderi</i> Wilson.....	1	3.2	4.5
<i>R. patula</i> Wilson.....	1	3.2	3.8
<i>R. rotunda</i> Wilson.....	1	2.9	3.8
<i>R. robusta</i> Wilson.....	1	2.9	3.1
<i>R. praecursor</i> Raymond.....	1	2.4	3.1
<i>R. apicalis</i> Wilson.....	1	2.2	2.5
<i>R. subcamerata</i> Wilson.....	1	2.2	2.4
<i>R. camerata</i> (Conrad).....	1	2.0	2.1

## III. Genuiculate Group

That there was a progressive tendency towards smaller and proportionately more convex shells is evident from the drawings in the following figures of the genuiculate group.

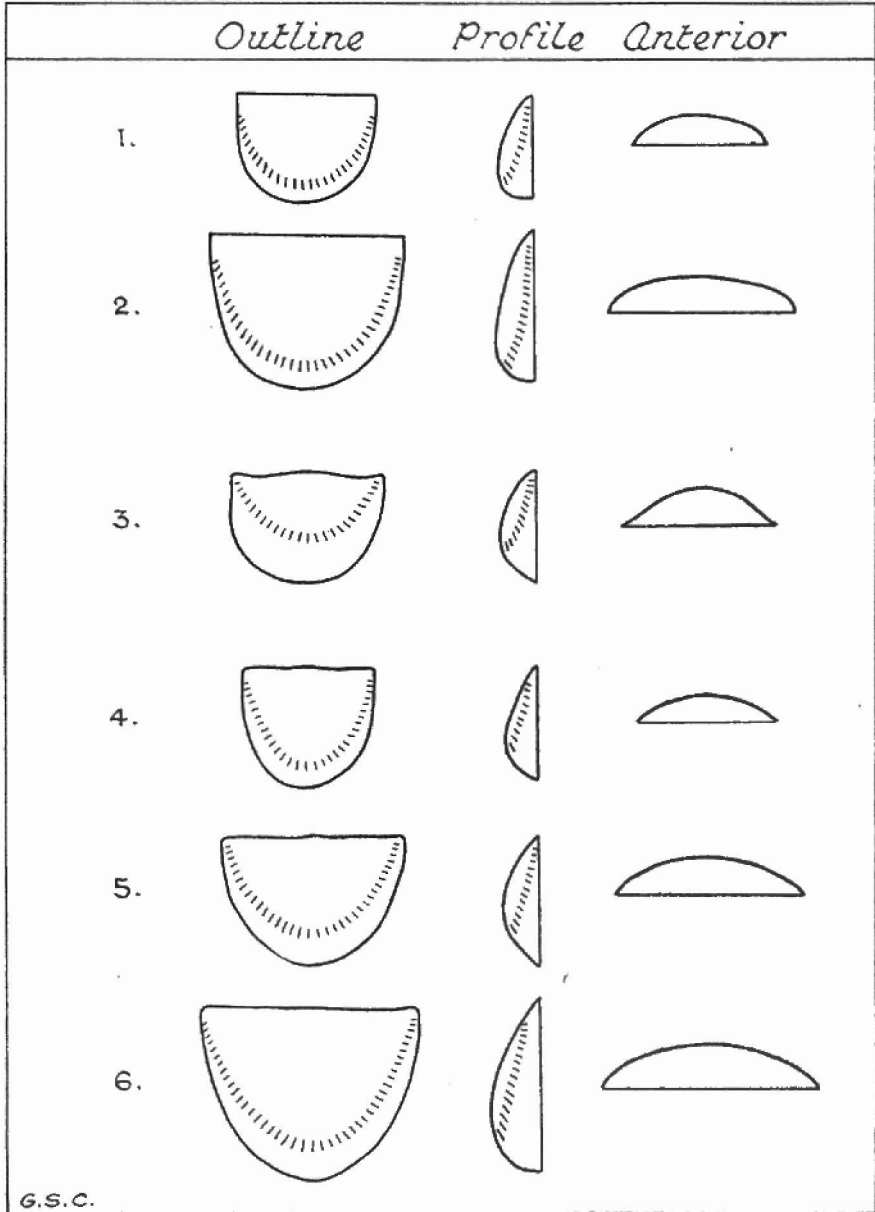
*Rafinesquina Genuiculate*

Figure 6. 1. *Rafinesquina semicircularis minor* Wilson; 2. *R. semicircularis* Wilson; 3. *R. salmoni* Wilson; 4. *R. declivis* (James); 5. *R. cf. deerensis* Salmon; 6. *R. normalis* Wilson.

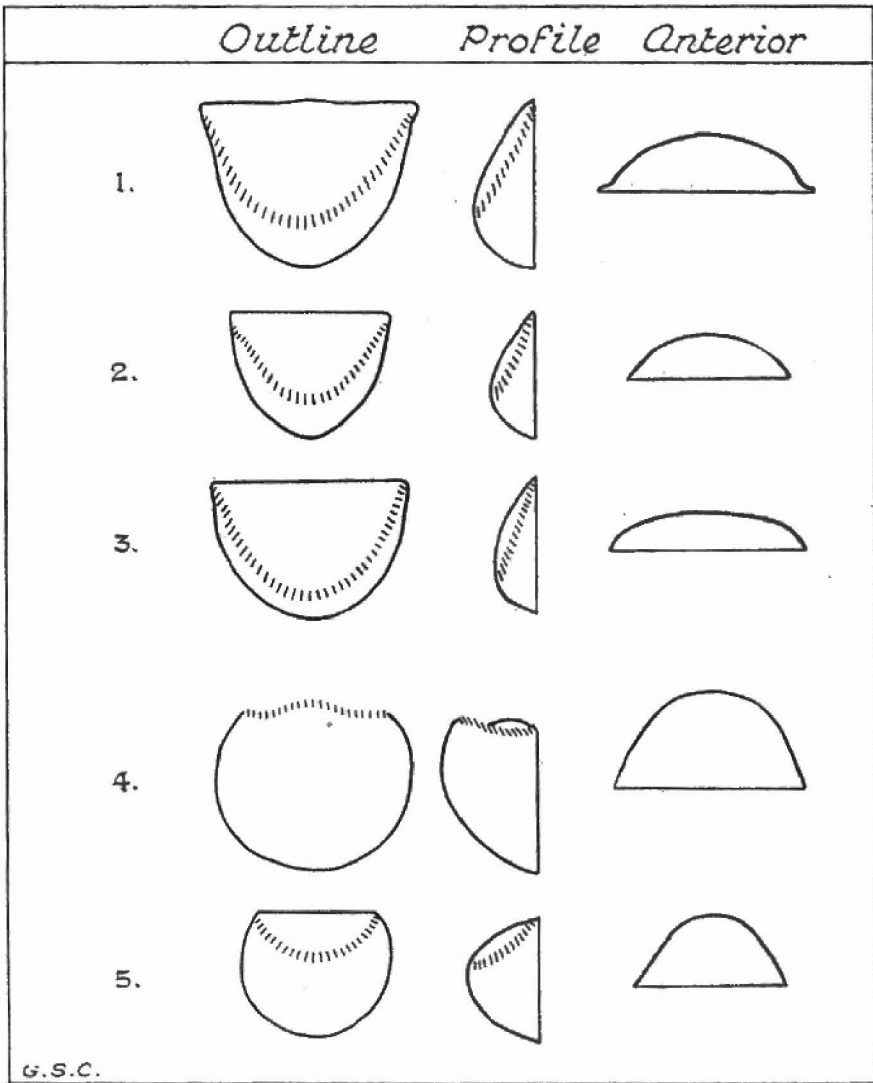
*Rafinesquina Genuiculate*

Figure 7. 1. *Rafinesquina normaloides* Wilson; 2. *R. okulitchi* Wilson; 3. *R. sardsoni* Salmon?; 4. *R. laurentina* Wilson; 5. *R. sinuata* Wilson.



*Rafinesquina Genuiculate*

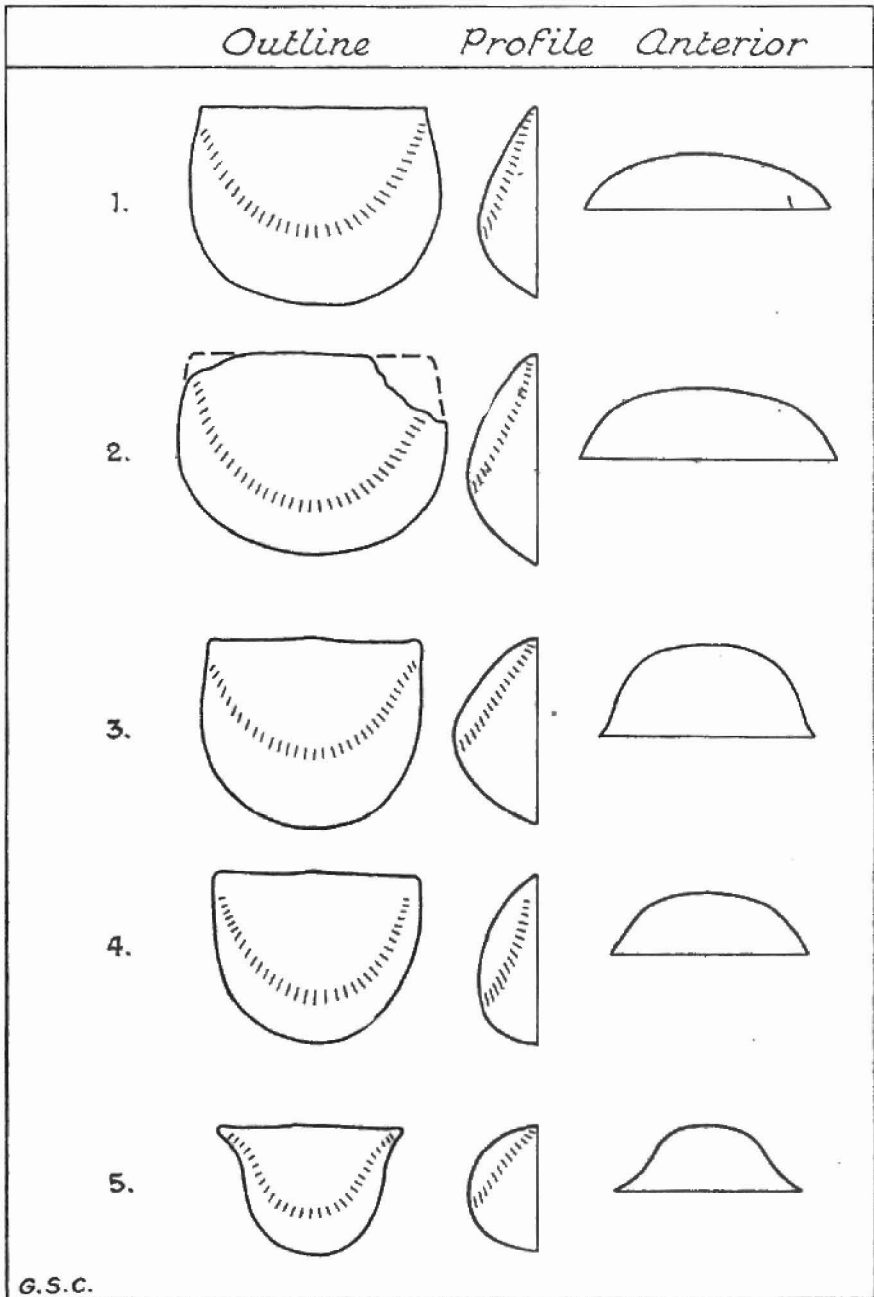


Figure 8. 1. *Rafinesquina deltoidea* (Conrad); 2. *R. miodeltoidea* Wilson; 3. *R. praedeltoidea* Wilson; 4. *R. gibbosa* Wilson; 5. *R. ottawaensis* Wilson.

## Ratio of Convexity to Length and to Width

	Convexity	Length	Width
<i>Rafinesquina salmoni</i> Wilson.....	1	2.6	4.0
<i>R. declivis</i> (James).....	1	4.3	4.8
<i>R. semicircularis minor</i> Wilson.....	1	3.1	4.0
<i>R. deerensis</i> Salmon.....	1	2.6	3.3
<i>R. semicircularis</i> Wilson.....	1	4.4	5.5
<i>R. okulitchi</i> Wilson.....	1	3.0	3.8
<i>R. normalis</i> Wilson.....	1	3.6	4.8
<i>R. normaloides</i> Wilson.....	1	2.9	3.5
<i>R. sardesoni</i> Salmon ?.....	1	2.0	2.5
<i>R. laurentina</i> Wilson.....	1	3.1	3.7
<i>R. praedeltoidea</i> Wilson.....	1	4.1	5.5
<i>R. deltoidea</i> (Conrad).....	1	2.2	2.6
<i>R. miodeltoidea</i> Wilson.....	1	2.6	3.0
<i>R. sinuata</i> Wilson.....	1	1.8	2.6
<i>R. ottawaensis</i> Wilson.....	1	1.7	1.9
<i>R. gibbosa</i> Wilson.....	1	1.4	1.7

In the Ottawa formation, *Rafinesquina* first appears in the Leray beds. Brachiopods of any sort are not common below this. The tendency to a threefold division of *Rafinesquina* was inherent in the genus when it first appeared in the area. The increase in number of species and the development of divergence of form, however, were slow during the deposition of the lower beds. Variation was practically confined to the low-convexity group. The inclination to progressively greater convexity and then to geniculation was accelerated during the deposition of the upper half of the formation. By the end of the deposition of the Ottawa formation there was a wide divergence and a multiplicity of forms.

Genus, *Rafinesquina* Hall and ClarkeGenotype, *Strophomena alternata* Conrad

Semicircular or semi-oval; concavo-convex, pedicle valve convex, brachial valve concave; hinge straight, generally, but not always, the greatest width of the shell; cardinal area long and narrow; cardinal extremities with or without ears; deltidium and chilidium present; surface ornamented with radiating striae increasing by implantation, the older striae gradually becoming larger so that there are one to seven finer striae between two coarser; all crossed by very fine concentric growth lines; a few corrugations present along the hinge line in some species; shell material punctate and inner surface pustulose.

Pedicle interior with weakly impressed muscle area and two broad flabellate diductors enclosing elongate adductors.

Brachial interior showing a low, bilobed cardinal process and well-defined vascular markings.

The genus is most closely allied to *Leptaena*, from which it is distinguished on the exterior by lacking the pronounced concentric wrinkles of *Leptaena*, and on the interior the pedicle scar is faintly impressed, not sharply as in *Leptaena*. In the brachial valve, the cardinal process is low.

Externally, the genus resembles *Öpikina*, but can be readily distinguished by its rather coarse, radially arranged pores in contrast with the very fine irregular pores of *Öpikina*. Internally, the musculature of the brachial valves of the two genera is very different. Externally *Rafinesquina* resembles *Strophomena*, but the convexity of the valves is reversed.

## I. Low-convexity Group

*Rafinesquina alternata* (Conrad)

Text figure 1, No 3; Plate V, figure 4

*Leptaena alternata* Conrad, 2nd Ann. Rept. New York Geol. Surv., 1838, p. 115.*Strophomena alternata* (Conrad), 3rd Ann. Rept. New York Surv., 1839, p. 63; Emmons, Geol. New York, Rept. 2nd Dist., 1842, p. 395, fig. 3.*Leptaena alternata* (Conrad), Hall, Pal. New York, 1, 1847, pp. 102, 286, Pl. XXXI, fig. 1.*Rafinesquina alternata* (Conrad), Hall and Clarke, Pal. New York, 8, pt. 1, 1892, p. 232, Pl. VIII, figs. 6-11, 27, 28, pt. 2, 1895, Pl. LXXXIV, figs. 17, 18.*Rafinesquina trentonensis* (Conrad), Salmon, Jour. Pal., 16, No. 5, 1942, p. 574, Pl. LXXXV, figs. 1-10.

U-shaped outline, almost semicircular; cardinal angles rectangular or very slightly auriculate; greatest width at the hinge; convexity of the pedicle valve even, a little greater in the posterior half; brachial valve flat or gently concave; width, length, and thickness averaging 30 mm., 26 mm., and 5 mm., respectively; radial striae alternating, 1 to 3 fine ones between two coarser, crossed by minute concentric growth lines; occasionally a few crenulations along the hinge line; punctæ numerous and rather small, 6 to 9 in 2 mm.

The interior of both valves is typical of the genus.

The species is differentiated from others of the low-convexity *Rafinesquinae* by its length, size, and evenness of convexity. It has a tendency to be larger and thicker in the Leray-Rockland beds, but otherwise no difference in it can be seen in the higher beds.

In her paper on Mohawkian *Rafinesquinae* Salmon<sup>1</sup> substitutes *R. trentonensis* for *R. alternata*, basing the change on Hall's statement that Conrad had suggested that name in manuscript because of a possible confusion with a name of Sowerby's. Sowerby's species, however, belongs to another genus, so that the reason for the change becomes null and void, and Hall's continued use of *R. alternata* was justified. Quite apart from that, the name *R. alternata* has been used frequently for more than a century without a doubt as to the form. Classification and names are for clearness in interpretation, the servants, not the masters. The incident has historic interest, but the change in name does not add to the clearness. Therefore, the present writer is using the name causing the least confusion, crediting it to its author, until such times as some international committee rules specifically on a number of such species.

*Occurrence.* Leray beds, localities 17, 79, 133, 156, 159, 220, 269, 286, 288; Leray-Rockland beds, locality 216; Rockland beds, locality 210; Hull beds, localities 37, 46, 49, 51, 60, 61, 215, 222, 227, 284, 290, 293; Hull or Sherman Fall beds, locality 210; Sherman Fall beds, localities 6 (?), 57, 84, 129, 166, 196, 200, 203, 213, 249, 263, 265, 308; Cobourg beds, localities 95, 96, 174, 258, 298.

*Type.* Plesiotype, G.S.C. No. 8961, Hull or Sherman Fall beds, from Ange gardien road, 4 miles west of L'Orignal, Ontario.

*Rafinesquina alternata alata* Wilson

Text figure 2, No. 4; Plate V, figure 18

*Rafinesquina alternata alata* Wilson, Roy. Soc., Canada, Trans. 3rd ser., 38, 1944, sec. 4, p. 160, text fig. 2, No. 4, Pl. I, fig. 17.

Broadly U-shaped; cardinal extremities extended; auriculate wing rather broad; cardinal angle less than a right angle; sides anterior to the wing almost straight for a short distance, curving into a broadly rounded anterior margin; greatest width at the hinge line; profile showing the convexity, like that of *R. alternata subquadrata*, more abrupt at the posterior and anterior with only a slightly convex curve across the top; width, length, and thickness, 35 mm., 24 mm., and 4.5 mm., respectively; alternation of striae 2 to 7 finer ones between two coarser; fine growth lines; a tendency to crenulations along the wings; punctæ as in the species, 6 to 9 in 2 mm.

<sup>1</sup> *Ibid.*, pp. 567 and 574.

Brachial valve not known.

Interiors not known.

*R. alternata alata*, as its name suggests, differs from the other varieties of *R. alternata* in its alate form. Like the other variations of *R. alternata* from the Leray-Rockland beds, it is more convex than the forms from the Cobourg beds.

*Occurrence.* Leray-Rockland beds, localities 159, 215.

*Type.* Holotype, G.S.C. No. 8945, Leray-Rockland beds, lot 19 or 21, Front con., Clarence tp., Ontario.

*Rafinesquina alternata intermedia* Wilson

Text figure 1, No. 2; Plate V, figure 3

*Rafinesquina alternata intermedia* Wilson, Roy. Soc., Canada, Trans. 3rd ser., 38, 1944, sec. 4, p. 161, text fig. 1, No. 2, Pl. I, fig. 2.

This variety is intermediate in size between the typical species and the variety *R. alternata plana*. The type specimen measures in width, length, and thickness, 25 mm., 20 mm., and 3.5 mm., respectively. In other respects it is similar to, and may be an immature form of, *R. alternata*, from broken specimens of which it is difficult to distinguish it. In only one of three localities has it been associated with the species or with *R. alternata plana*. Were it an immature form it would probably occur where the other two are abundant.

*Occurrence.* Leray-Rockland beds, localities 15, 152, 215 ?, 216; Hull beds, localities 61, 213; Sherman Fall beds, localities 84, 203.

*Type.* Holotype, G.S.C. No. 8946, Leray-Rockland beds, southeast of Cumberland, Ontario.

*Rafinesquina alternata plana* Wilson

Text figure 1, No. 1; Plate V, figures 1, 2

*Rafinesquina alternata plana* Wilson, Roy. Soc., Canada, Trans. 3rd ser., 38, 1944, sec. 4, p. 161, text fig. 1, No. 1, Pl. I, fig. 1.

Small, U-shaped; cardinal extremities making a right angle with the almost straight sides; anterior broadly rounded; greatest width at the hinge line, continuing for some distance anterior to it; profile showing convexity, low, particularly so in specimens from the upper horizons, a little higher posteriorly, the anterior almost flat; measurements averaging: width, length, and thickness, 18 mm., 15 mm., and 2 mm., respectively; striæ of two sizes in the central region, 1 to 3 finer ones between each two coarser ones, differentiation decreasing and disappearing toward the wings; crossed by fine concentric growth lines; a slight tendency to concentric crenulations at the extreme anterior and faint minute oblique crenulations at the cardinal extremities of some specimens; punctæ 5 to 8 in 2 mm.

Pedicle interior not known.

Brachial valve slightly concave; differentiation of striæ obscure.

Brachial interior typical of the genus.

This little variety is a small edition of *R. alternata* (Conrad), having the same proportions. The forms might be considered as immature, but it would be curious that all should cease growth at the same stage, and a range of intermediate forms would be found wherever the two occur at the same locality. There are intermediate forms at some localities in the lower, but not in the higher beds, and variety and species differ slightly. Some specimens of the variety exhibit a slight tendency to concentric rugæ on the anterior margin and the punctæ are a little less numerous.

*Occurrence.* Lowville beds, locality 156; Leray-Rockland beds, localities 16, 133, 143, 215?, 216, 220, 286; Rockland beds, locality 156; Hull beds, localities 50, 51, 60, 195, 290; Hull or Sherman Fall beds, localities 203, 210, 213, 263, 275; Sherman Fall beds, localities 3, 265, 308; Cobourg beds, localities 85, 108, 110, 119, 208, 236, 245, 292, 300.

*Type.* Holotype, G.S.C. No. 8948, Hull beds, quarry south side Ange gardien road, 4 miles west of L'Orignal, Ontario; paratype, No. 8947, Sherman Fall beds, aux Raisins River, east of Black River station on New York Central, Ontario.

*Rafinesquina alternata platys* Wilson

Text figure 2, No. 1; Plate V, figure 11

*Rafinesquina alternata platys* Wilson, Roy. Soc., Canada, Trans. 3rd ser., 38, 1944, sec. 4, p. 162, text fig. 2, No. 1, Pl. I, fig. 10.

Subquadrate outline; surface uneven; cardinal extremities not auriculate; sides almost parallel from hinge to mid-length; anterior margin very broadly rounded, subparallel to the hinge; greatest width anterior to the hinge line; convexity very slight; greatest width, length, and thickness, 25.5 mm., 19 mm., and 2 mm., respectively; striæ very fine, alternation not greatly differentiated, 1 to 3 finer between two slightly coarser ones, crossed by very fine concentric growth lines; no corrugations; punctæ, only the odd one or two exposed, not enough to measure.

Brachial valve not known.

Interiors not known.

The species differs from *R. alternata* and *R. lennoxensis* in its size, subquadrate outline, and flatness.

*Occurrence.* Leray-Rockland beds, locality 159 ?; Cobourg beds, locality 177.

*Type.* Holotype, Cobourg beds, from escarpment on Navan-Sarsfield road, Ontario, in the private collection of J. A. Calder.

*Rafinesquina alternata pota* Wilson

Text figure 2, No. 5; Plate V, figure 19

*Rafinesquina alternata pota* Wilson, Roy. Soc., Canada, Trans. 3rd ser., 38, 1944, sec. 4, p. 163, text fig. 2, No. 5, Pl. I, fig. 18.

Large, kettle-shaped; cardinal extremities extended, auriculate; sides, anterior to the ears, slightly convex, curving into the broadly rounded anterior margin; greatest width at the hinge line; convexity gently rounded to a maximum at 20 mm. from the beak, from there gradually rounded down to the anterior margin; width, length, and thickness averaging 36 mm., 30 mm., and 5 mm., respectively; striæ and concentric growth lines as in the species; a few low crenulations near the ears; punctæ 4 to 5 in 2 mm.

This variation of *R. alternata* (Conrad) is distinguished from the species by its larger punctæ, more auriculate cardinal extremities, and its larger size.

The writer is in doubt whether or not to place this specimen in a new variation. In her description of *R. lennoxensis*, Salmon distinctly states that that species has "no cardinal ears". The specimens identified as *R. lennoxensis* from the Ottawa-St. Lawrence Lowland correspond in every particular to her description and measurements. In her illustration<sup>1</sup>, however, the brachial valve of *R. lennoxensis* has ears. It is recognized that the brachial valve may have a slight invagination not represented in the pedicle valve, but as the pedicle valve of the variety here described definitely has ears, and as its transverse diameter is greater in proportion to its length, it is here dissociated from *R. lennoxensis* Salmon.

*Occurrence.* Sherman Fall beds, localities 160, 210; Cobourg beds, localities 91, 96, 103, 119, 189, 277.

*Type.* Holotype, G.S.C. No. 8949, Cobourg beds, Steamboat landing, foot of Sussex street, Ottawa, Ontario.

<sup>1</sup> Salmon E. S.: Op. cit., Pl. 85, fig. 20.

*Rafinesquina alternata quadrata* Wilson

Text figure 2, No. 2; Plate V, figure 6

*Rafinesquina alternata quadrata* Wilson, Roy. Soc., Canada, Trans. 3rd ser., 38, 1944, sec. 4, p. 164, text fig. 2, No. 2, Pl. I, fig. 5.

Broad, quadrate outline; cardinal extremities not extended, making a right angle with the almost straight sides; anterior broadly rounded, subparallel to the hinge line; greatest width at the hinge and for some distance anterior to it; convexity very even; width, length, and thickness of the holotype 28.5 mm., 22 mm., and 3.5 mm., respectively; striæ very fine, alternations not prominent, in places 3 to 9 finer ones between two stronger; very fine growth lines; punctæ as in the species.

The variety is like the species in its cardinal angles and numerous punctæ. It differs in having finer striæ and in its quadrate outline. These differences seem to persist.

*Occurrence.* Hull or Sherman Fall beds, locality 210; Sherman Fall beds, localities 84, 160, 186, 203; Sherman Fall or Cobourg beds, locality 308.

*Type.* Holotype, G.S.C. No. 8950, Sherman Fall or Cobourg beds, lot 46 ? (Indian Lands), con. VII, Charlottenburgh tp., Ontario.

*Rafinesquina alternata semiquadrata* Wilson

Text figure 2, No. 3; Plate V, figure 7

*Rafinesquina alternata semiquadrata* Wilson, Roy. Soc., Canada, Trans. 3rd ser., 38, 1944, sec. 4, p. 164, text fig. 2, No. 3, Pl. I, fig. 6.

Large, wide, U-shaped outline; cardinal extremities slightly flattened, not extended; cardinal angles greater than a right angle; sides gently convex, anterior margin broadly rounded, subparallel to the hinge line; greatest width anterior to the hinge line; convexity more abrupt near the posterior and anterior margins, slight and evenly distributed along the top; hinge, greatest width, length, and thickness averaging 35 mm., 38 mm., 28.5 mm., and 5 mm., respectively; differentiation of striæ marked, 1 to 3 or 4 finer ones between two coarser; no crenulations; punctæ 6 $\frac{1}{2}$  or 7 in 2 mm.

Brachial valve not known.

Interiors not known.

This is a larger, more robust form than *R. quadrata*, with more pronounced ornamentation, and it is not quite so quadrate in outline. It has been noted that the *Rafinesquinae* of the Leray-Rockland beds tend to be more robust than the younger forms, and it may be that *R. quadrata* is a development of *R. semiquadrata*.

*Occurrence.* Leray-Rockland beds, locality 159; Hull or Sherman Fall beds, locality 210.

*Type.* Holotype, G.S.C. No. 8951, Leray-Rockland beds, lot 19 or 21, Front con., Clarence tp., Ontario.

*Rafinesquina alternata transversa* Wilson

Text figure 1, No. 6; Plate V, figure 12

*Rafinesquina alternata transversa* Wilson, Roy. Soc., Canada, Trans. 3rd ser., 38, 1944, sec. 4, p. 165, text fig. 1, No. 6, Pl. I, fig. 11.

Outline subtriangular; surface very flat, with a tendency to resupination at the greatly extended cardinal extremities; cardinal angles rounded, but making an angle of less than 90 degrees with the oblique sides; anterior margin more narrowly rounded than usual; greatest width at hinge line; width, length, and thickness 30 mm., 21 mm., and 2.5 mm., respectively; striæ very fine, 1 to 4 between two coarser; fine concentric growth lines; faint, short crenulations at hinge extremities; punctæ 5 to 6 in 2 mm.; concentric arrangement conspicuous.

Brachial valve not known.

Interiors not known.

The variety differs from the species in being considerably wider in proportion to its length, and in having extended cardinal extremities making an angle of less than 90 degrees with the oblique sides, which converge toward the more narrowly rounded anterior margin.

It is very like *R. alternata platys* n.var. in flatness of surface and fineness of striæ, but differs in having oblique sides.

It differs from *R. alternata quadrata* Wilson in its triangular outline, in being wider in proportion to its length, in the smaller angle at the cardinal extremities, and in the slight tendency toward resupination.

The outline is very similar to *R. esmondensis* Salmon, but the specimen is smaller than the measurements given for that species, the proportion of width to length is less, and the convexity is considerably less.

*Occurrence.* Leray-Rockland beds, locality 216; Hull beds, locality 60.

*Type.* Holotype, G.S.C. No. 8952, Hull beds, cement quarry, Hull, Quebec.

#### *Rafinesquina carlottina* Wilson

Text figure 1, No. 5; Plate VII, figures 8 a, b

*R. carlottina* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 26, 1932, sec. 4, p. 395, Pl. V, figs. 3, 4.

The holotype measures: width, length, and thickness, 22 mm., 15 mm., and 3 mm., respectively.

Reed<sup>1</sup> suggests that the species belongs to Bancroft's new genus *Kjaerina*, which is based upon the prominent median rib and some variation in the size of the flabellate ventral muscle scar. The description of *Kjaerina*<sup>2</sup> makes no mention of the pore system. *R. carlottina* is here left in the genus *Rafinesquina* because it has the pore system of that genus, the interior is not known, and because there is such variation in the ribbing of *Rafinesquina* that it is felt the enlargement of the median rib is not sufficient basis for changing the genus.

The species differs from *R. alternata* in being smaller and shorter in proportion to its width, the sides curve more directly toward a narrower anterior margin, the profile is more convex in proportion to the length, and the slight concentric depression breaks the evenness of the profile from the beak to the anterior margin.

*Occurrence.* Sherman Fall beds, locality 186; Cobourg beds, localities 43, 85, 121, 226, 305.

*Type.* Holotype, G.S.C. No. 6652, Cobourg beds, lot 35, con. IX, Charlottenburgh tp., Ontario.

#### *Rafinesquina lennoxensis* Salmon

Text figure 1, No. 4; Plate V, figure 5

*R. lennoxensis* Salmon, Jour. Pal., 16, No. 5, 1942, p. 576, Pl. LXXXV, figs. 18-20.

The specimens agree with the description in outline, profile, and measurements (width, length, and thickness averaging 33 mm., 34 mm., and 5 mm., respectively), but are somewhat longer than the form illustrated, which, however, is a brachial valve.

*R. lennoxensis*, too, is a variation of *R. alternata*, and to its original description it may be added that, like the species, the punctæ occur 6 to 9 in 2 mm.

*Occurrence.* Leray-Rockland beds, localities 15, 159, 216; Rockland beds, locality 157; Hull beds, locality 213; Hull or Sherman Fall beds, locality 210.

*Type.* Plesiotype, G.S.C. No. 8953, Leray-Rockland beds, lot 19 or 21, Front con., Clarence tp., Ontario.

<sup>1</sup> Reed, F. R. C.: Geol. Soc. Glasgow, 19, 1937, p. 340.

<sup>2</sup> Bancroft, B. B.: Manchester Lit. and Phil. Soc. Mem. and Proc. 73, 1929, No. 4, pp. 41-45.



## II. High-convexity Group

*Rafinesquina apicalis* Wilson

Text figure 5, No. 1; Plate VI, figure 2

*Rafinesquina apicalis* Wilson, Roy. Soc., Canada, Trans. 3rd ser., 38, 1944, sec. 4, p. 167, text fig. 5, No. 1, Pl. II, fig. 2.

U-shaped outline; length and width, subequal; cardinal extremities slightly auriculate; sides straight to about the middle except for the invagination anterior to the ears; greatest width at the hinge line and anterior to the ears; area of greatest convexity centrally placed in the form of a rounded, circular apex from which the shell curves down to the sides as well as to the anterior and posterior; width, length, and thickness measuring: 23 mm., 20.5 mm., and 9 mm., respectively; no geniculation; striæ largely exfoliated, those visible rather coarse, with an occasional larger one occurring irregularly; fine concentric growth lines; no crenulations visible; punctæ not well exposed, large and more irregularly arranged than is usual in the genus.

Brachial valve not known.

Interiors not known.

*R. apicalis* differs from *R. præcursor* Raymond in that it curves gradually from the region of greatest convexity, whereas in the latter the sides flatten making three roughly triangular faces. The species differs from others in its subequal length and width, and the central elevated position of its greatest convexity.

*Occurrence.* Cobourg beds, localities 85, 86, 88.

*Type.* Holotype, G.S.C. No. 8954, Cobourg beds, between Fourth and Fifth avenues, Ottawa, Ontario.

*Rafinesquina calderi* Wilson

Text figure 4, No. 2; Plate V, figure 10

*Rafinesquina calderi* Wilson, Roy. Soc., Canada, Trans., 3rd ser., 38, 1944, sec., 4, p. 168, text fig. 4, No. 2, Pl. I, fig. 9.

Outline subtriangular, considerably wider than long; cardinal extremities quite extended; greatest length at the hinge line; sides converging directly from the cardinal extremities to the narrowly rounded anterior margin; convexity not pronounced, greatest a little anterior to middle, from which region the curve is more gradual; width, length, and thickness averaging: 27 mm., 19 mm., and 6.5 mm., respectively; striæ of two orders, 2 to 5 small ones between two coarser, differentiation more conspicuous in the anterior median region; very fine concentric growth lines; the punctæ not visible.

Brachial valve not known.

Interiors not known.

The species is mostly closely allied to *R. apicalis* Wilson and *R. carlottina* Wilson in its outline, but compared with the former it is considerably longer in proportion to its width and is proportionately much less convex; compared with the latter it is larger and much more convex. The outline is narrower anteriorly than that of *R. esmondensis* Salmon and the whole shell is less robust.

The species is named after J. A. Calder, Ottawa, who has kindly lent his private collection for this and other studies.

*Occurrence.* Sherman Fall beds, locality 57; Cobourg beds, localities 85, 282.

*Type.* Holotype, G.S.C. No. 8955, Cobourg beds, Major Hill Park, Ottawa, Ontario.

*Rafinesquina camerata* (Conrad)

Text figure 5, No. 2; Plate VII, figures 6, 7

*Strophomena camerata* Conrad, Jour. Acad. Nat. Sci. Philadelphia, 8, p. 254, Pl. XIV, fig. 5.*Lepiaena camerata* (Conrad), Hall, Pal. New York, 1, 1847, Pl. XXXIA, figs. 2a, 2b.*Rafinesquina camerata* (Conrad), Hall and Clarke, Pal. New York, 8, pt. 1, 1892, p. 283;

Raymond, Geol. Surv., Canada, Mus. Bull. 31, 1921, p. 21, Pl. VI, figs. 12 and 13, Pl. VII, fig. 2.

The representatives in the Cobourg beds average: width, length, and thick-



ness, 24 mm. to 26 mm., 23 mm., and 11 mm., respectively; punctæ fine and numerous and usually poorly preserved, 5 to 6 in 2 mm. on the posterior part, increasing to as many as 10 in 2 mm. at the anterior.

The species is distinguished by its compact, gibbous form. It differs from *R. deltoidea* in lacking geniculation, in its rounded outline, and in its greater and more evenly distributed convexity.

The writer differs from Salmon<sup>1</sup> in referring to Raymond's *R. camerata* (Conrad) from Craigeleith her new species *R. sardesoni*. Raymond's specimens and many similar ones from the Ottawa-St. Lawrence Lowland correspond to the early illustrations. They are larger than Salmon's illustrations of *R. camerata*, though they have a tendency to be smaller than her measurements of *R. sardesoni*.

*Occurrence.* Cobourg beds, localities 84, 85, 88, 89, 96, 97, 103, 108, 119, 123, 131, 134, 162, 168, 174, 176, 177, 184, 189, 192, 208, 226, 229, 235, 237, 238, 241, 242, 244 (loose), 251, 257, 258, 280, 282, 283, 300-304, 307.

*Type.* Plesiotypes, G.S.C. Nos. 3256a and 3258, not from the Ottawa-St. Lawrence Lowland, but from higher beds at Craigeleith, Ontario.

### *Rafinesquina equipunctata* Wilson

Text figure 3, No. 1; Plate VII, figures 11 a, b

*R. equipunctata* Wilson, Roy. Soc., Canada, Trans. 3rd ser., 26, 1932, sec. 4, p. 394, Pl. V, figs. 1 and 2; Salmon, Jour. Pal., 16, No. 5, 1942, p. 586, Pl. LXXXVI, figs. 27, 28.

The holotype measures: width, length, and thickness, 36 mm., 31 mm., and 7 mm., respectively. The outstanding characteristics of the species are: its large size, relatively large posterior area in which length and width are more nearly subequal than in many other species, its tendency to a more or less irregular anterior margin, and usually more sparsely placed punctæ.

It differs from *R. normalis* Wilson in being convex rather than geniculate, in its larger size, more robust appearance, and more irregular anterior margin. *R. robusta* Wilson is more gibbous, has a small and less pronounced posterior area except on enfolded specimens, and the punctæ are generally irregular.

*Occurrence.* Cobourg beds, localities 43, 85, 86, 90, 95, 119, 121, 123, 131, 133, 162, 168, 177, 185, 208, 232, 241, 252, 257-259, 302.

*Type.* Holotype, G.S.C. No. 6637, Cobourg beds, lot 21, con. VIII, Cornwall tp., Ontario.

### *Rafinesquina esmondensis borealis* Wilson

Text figure 4, No. 1; Plate V, figure 9

*Rafinesquina esmondensis borealis* Wilson, Roy. Soc., Canada, Trans. 3rd ser., 38, 1944, sec. 4, p. 169, text fig. 4, No. 1, Pl. I, fig. 8.

The specimens agree with the description<sup>2</sup> of the species in general outline, in profile, and in having the alternation of the striæ practically all over the shell, but the variety found in the Cobourg beds is persistently smaller; width, length, and thickness averaging 26 mm., 18 mm., and 5 mm., respectively, as compared with 36+mm. in width, and 22 mm. in length of the species.

*R. esmondensis* var. *borealis* Wilson differs from *R. lewisensis* Salmon in its smaller size, more transverse outline, more abrupt downward curve in the anterior, and in the wider distribution of the alternating striæ. It differs from *R. prestonensis* Salmon in its smaller size, less prominent cardinal ears, and more transverse outline.

*Occurrence.* Rockland beds, locality 173; Hull or Sherman Fall beds, locality 50; Cobourg beds, localities 3, 95, 100, 162 ?, 280.

*Type.* Holotype, G.S.C. No. 8956, Cobourg beds, south side of Lake Clear, Ontario.

<sup>1</sup> Salmon, E. S.: Op. cit., p. 588.

<sup>2</sup> Salmon, E. S.: Op. cit., p. 285, Pl. 86, figs. 25, 26.

*Rafinesquina hullensis* Wilson

Text figure 4, No. 6; Plate V, figure 20

*Rafinesquina hullensis* Wilson, Roy. Soc., Canada, Trans. 3rd ser., 38, 1944, sec. 4, p. 170, text fig. 4, No. 6, Pl. I, fig. 19.

Large, U-shaped; cardinal extremities extended and slightly resupinate, making less than 90 degrees of an angle with the sides, which converge toward a broadly rounded anterior margin; greatest width just anterior to the hinge line; width, length, and thickness averaging: 36 mm., 28 mm., and 7 mm., respectively; no true geniculation; greatest convexity about three-quarters the whole length from the beak; profile making an abrupt convex curve just anterior to the beak, continuing with a slight curve to the region of greatest convexity, from which in the last quarter length it curves downward and continues with slight convexity to the anterior margin, the whole presenting a posterior part as a raised platform with a slightly convex upper surface; alternation of striæ pronounced, 3 to 6 or even 7 finer ones between two coarser, crossed by fine growth lines; crenulations not evident; punctæ small and numerous, 6 to 9 in 2 mm., in the region of greatest convexity.

Brachial valve not known.

Interiors not known.

*R. hullensis* Wilson is nearest in outline to *R. alternata* and *R. lennoxensis* of the "low-convexity" *Rafinesquinae*, but differs from them in its greater convexity. Of the high-convexity group it is closest to *R. prestonensis* Salmon but is larger, and a comparison of the profiles shows it to have a more flattened elevated posterior part.

*Occurrence.* Rockland beds, locality 276; Hull beds, locality 227; Hull or Sherman Fall beds, locality 210.

*Type.* Holotype, G.S.C. No. 8957, Hull beds, old right-of-way, west of Skye, Ontario.

*Rafinesquina opeongoensis* Wilson

Text figure 5, No. 5; Plate V, figure 17

*Rafinesquina opeongoensis* Wilson, Roy. Soc., Canada, Trans., 3rd ser., 38, 1944, sec. 4, p. 171, text fig. 5, No. 5, Pl. I, fig. 16.

Medium size, pot-shaped; cardinal extremities not extended, slightly auriculate, making an angle larger than 90 degrees with the slightly convex sides; anterior rounded; greatest width about midway between hinge and anterior; convexity greatest about two-thirds length from beak, profile rising somewhat abruptly from the hinge, continuing with a slight curve to the area of greatest convexity, thence curving down more narrowly to the anterior margin; holotype measuring: greatest width, hinge, length, and thickness, 25 mm., 24 mm., 22 mm., and 5 mm., respectively; striæ fine, 1 to 5 smaller ones between two coarser; fine concentric growth lines; no crenulations or very faint ones near the cardinal extremities; punctæ small, numerous, 5 to 9 in 2 mm.

Brachial valve not known.

Interiors not known.

In general outline *R. opeongoensis* is nearest *R. camerata*, but it is much less convex. Compared with *R. prestonensis* and *R. orleansensis* it has less extended cardinal extremities, this difference being best revealed in the anterior view of *R. orleansensis* and, in addition, it is considerably more convex than *R. prestonensis* in proportion to its width.

*Occurrence.* Leray-Rockland beds, locality 216; Hull beds, locality 227; Sherman Fall beds (?), locality 6; Cobourg beds, locality 3.

*Type.* Holotype, G.S.C. No. 8958, Sherman Fall ? beds, Opeongo road, west of Esmond, Ontario.

*Rafinesquina orleansensis* Wilson

Text figure 5, No. 6; Plate V, figure 14

*Rafinesquina orleansensis* Wilson, Roy. Soc., Canada, Trans., 3rd ser., 38, 1944, sec. 4, p. 171, text fig. 5, No. 6, Pl. I, fig. 13.

Medium size, pot-shaped, somewhat elongate; cardinal extremities slightly extended, slightly auriculate; sides convex anterior to the invagination; anterior rounded; greatest width at the hinge line; convexity greatest about two-thirds length from hinge; holotype measuring: width, length, and thickness, 30 mm., 24.5 mm., and 5 mm., respectively; striae not well preserved in the holotype, but other specimens showing a strong differentiation with 1 to 5 between the coarser; fine concentric striae; punctae 5 to 6 in 2 mm.

The species is very similar to *R. sinclairi* Salmon in its outline, size, and blunt ears, but its greatest convexity lies nearer the anterior.

It differs from *R. alternata* (Conrad) in the position and amount of its convexity, and the alternation of striae is not so marked.

*Occurrence.* Rockland beds, locality 148; Sherman Fall beds, locality 199; Cobourg beds, localities 121, 131, 252.

*Type.* Holotype, G.S.C. No. 8959, Rockland beds, north of Orleans, Ontario.

*Rafinesquina patula* Wilson

Text figure 3, No. 2; Plate V, figure 13

*Rafinesquina patula* Wilson, Roy. Soc., Canada, Trans., 3rd ser., 38, 1944, sec. 4, p. 172, text fig. 3, No. 2, Pl. I, fig. 12.

The form is midway between a large, rounded, convex species and a geniculate species. In the region of greatest convexity, the planes of the posterior and anterior parts meet at an angle of 135 degrees. The change of direction is rounded off on the outer shell, but when exfoliated the curve is more abrupt and in some cases the presence of rugae in this region suggests geniculation.

Pot-shaped, without ears; cardinal extremities blunt; sides slightly convex; anterior margin broadly convex; greatest width at the region of greatest convexity, about 18 mm. from the beak along the median line; hinge, greatest width, length, and thickness measuring: 32 mm., 34 mm., 29 mm., and 8 mm., respectively; broad, wide-spreading anterior and side slopes giving an impression of a very small anterior part; alternation of striae not very marked, 2 to 7 finer between two coarser; fine concentric growth lines, often accentuated by rugae; punctae 5 to 6 in 2 mm. on the anterior part.

Brachial valve not known.

Interiors not known.

The outline is suggestive of *R. okulitchi*, but *R. patula* is larger and the anterior and side slopes more widespread.

It differs from other forms in the small size of its posterior part in comparison with the total size.

*Occurrence.* Hull or Sherman Fall beds, localities 57, 210.

*Type.* Holotype, G.S.C. No. 8960, Hull or Sherman Fall beds, Ange gardien road, 4 miles west of L'Original, Ontario.

*Rafinesquina praecursor* Raymond

Text figure 4, No. 3; Plate V, figure 15

*R. praecursor* Raymond, Geol. Surv., Canada, Mus. Bull. 31, 1921, p. 22, Pl. VII, fig. 5.

The species is distinguished by the flattening of the sides of the anterior down-curved part, so that the shell is composed of three subtriangular convex faces, subequal in size. This characteristic distinguishes it from all other species.

The holotype, here re-illustrated, measures: width, length, and thickness, 28 mm., 22.5 mm., and 9 mm., respectively.

*Occurrence.* Sherman Fall beds, locality 42; Cobourg beds, localities 208, 242.

*Type.* Holotype, G.S.C. No. 3259, not from the Ottawa-St. Lawrence Lowland, but from Middle Trenton beds, Trenton, Ontario.

*Rafinesquina prestonensis* Salmon

Text figure 4, No. 5; Plate VII, figures 4 a-c

*R. prestonensis* Salmon, Jour. Pal., 16, No. 5, 1942, p. 578, Pl. LXXXV, figs. 28-33.

The species has been adequately described and illustrated. The specimens so identified from the Ottawa-St. Lawrence Lowland average: width, length, and thickness, 31 mm., 21.5 mm., and 5 mm., respectively. It is rare, but appears to correspond with the description in every respect.

*R. prestonensis* differs from *R. alternata* and *R. lewisensis* in having prominent ears, in its transverse outline, and in its more convex profile.

*Occurrence.* Leray-Rockland beds, locality 216; Sherman Fall beds, locality 200; Cobourg beds, locality 95.

*Rafinesquina robusta* Wilson

Text figure 3, No. 3; Plate VII, figures 9 a, b, 10

*R. robusta* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 26, 1932, sec. 4, p. 396, Pl. V, figs. 14-16; Salmon, Jour. Pal., 16, No. 5, 1942, p. 577, Pl. LXXXV, figs. 23-25.

The species is very large, the holotype measuring: width, length, and thickness, 37 mm., 35 mm., and 12 mm., respectively. It is distinguished by the curvature of the convexity, producing rather short posterior and long anterior parts. There are forms transitional between this species and *R. equipunctata*. It is often difficult to identify such when partly exfoliated because of the somewhat less convex umbonal region. If visible, the punctæ of *R. robusta* are more numerous and more irregular.

*Occurrence.* Cobourg beds, localities 88, 101, 123, 131, 134, 168, 185, 189, 191 (loose), 208, 230, 237, 240, 241, 280, 299, 302, 304-306, and 308.

*Type.* Holotype, G.S.C. No. 6655; paratype, No. 6655a; both from Cobourg beds, lot 9, con. IV, Roxborough tp., Ontario.

*Rafinesquina rotunda* Wilson

Text figure 5, No. 4; Plate V, figure 8

*Rafinesquina rotunda* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 174, text fig. 5, No. 4, Pl. I, fig. 7.

The holotype is the only specimen found. Small and gibbous; cardinal extremities non-auriculate; cardinal angles blunt; sides convex posteriorly, becoming slightly oblique; anterior margin rounded; greatest width just anterior to the hinge; convexity, rounded, centred slightly anterior to the middle, decreasing toward the cardinal extremities; width, length, and thickness: 21 mm., 16 mm., and 5.5 mm., respectively; striæ not well preserved, apparently rather coarse for the size of the specimen, and alternation not prominent; growth lines fine; no crenulations; punctæ very fine, 12 to 15 in 2 mm. on the anterior slope, more widely spaced on the posterior part.

This is one of the smallest *Rafinesquinae*. It is most closely related to *R. subcamerata* but is shorter, its greatest convexity is more posterior with a tendency to flatten on the cardinal extremities, and the pores are finer.

In the fineness and number of the pores *R. rotunda* is closer to *R. camerata* and may be a forerunner of that species, though it is proportionately more convex.

*Occurrence.* Leray-Rockland beds, locality 77.

*Type.* Holotype, G.S.C. No. 8962, Leray-Rockland beds, Merivale road, southeast of Carlington, Ottawa.

*Rafinesquina subcamerata* Wilson

Text figure 5, No. 3; Plate VI, figure 1

*Rafinesquina subcamerata* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 175, text fig. 5, No. 3, Pl. II, fig. 1.

Small; hemispherical; cardinal extremities not extended, slightly auriculate, making a right angle or less with the slightly curved sides; anterior rounded; greatest width at the hinge; extremely gibbous; region of greatest convexity a little anterior to the middle, rounding down to all margins; width, length, and thickness averaging: 19 mm., 18 mm., and 8 mm., respectively; striæ very fine, occasionally a coarser one; growth lines fine; crenulations present in some specimens, faint in others; punctæ rather large and sparsely placed considering the small size of the mature shell, 5 or so in 2 mm.

Only fragments of the brachial valve preserved, showing it to be concave, closely following the curvature of the pedicle valve.

Interiors not known.

The species is like a small *R. camerata*. But an increase in growth at the anterior of the individuals would make them less instead of more like *R. camerata*, so that they cannot be an immature form of that species. *R. subcamerata* also differs from *R. camerata* in having fewer and coarser punctæ.

*Occurrence.* Sherman Fall ? beds, localities 6, 186; Cobourg beds, localities 85, 86, 89, 177, 179, 208, 225, 229, 237, 241, 248, 249, 257, 259.

*Type.* Holotype, G.S.C. No. 8963, Cobourg beds, west end of Fifth avenue, Ottawa, Ontario.

*Rafinesquina subtrigonalis* Wilson

Text figure 4, No. 4; Plate V, figure 16

*Rafinesquina subtrigonalis* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, p. 175, text fig. 4, No. 4, Pl. I, fig. 15.

Subtriangular outline; cardinal extremities not auriculate, but the hinge line makes less than a right angle with the sides, which slope with very little convexity toward a narrowed anterior margin; greatest width just anterior to the hinge line; no geniculation, convexity greatest just anterior to the middle, from which it is more or less even on all sides; holotype: width, length, and thickness, 30 mm., 23 mm., and 6.5 mm., respectively; outer surface mostly exfoliated, but striæ apparently of one grade only, rather coarse; very slight indication of crenulations on the cardinal extremities; punctæ rather numerous, 6 to 7 in 2 mm. at the region of greatest convexity.

Brachial valve not known.

Interiors not known.

The Paquette Rapids specimen is larger and more robust in every way, but otherwise seems the same.

*R. subtrigonalis* is most like *R. praecursor*, but differs from that species in being larger, and proportionately less convex; it has less acute cardinal extremities, and its region of greatest convexity does not culminate in a rounded apex as in that species, as seen in the profile and anterior views, with the result that it lacks the acutely sloping sides.

*Occurrence.* Leray-Rockland beds, locality 7; Hull beds, locality 213; Sherman Fall beds, locality 200; Cobourg beds, locality 168.

*Type.* Holotype, G.S.C. No. 8964, Sherman Fall beds, quarry 1 mile west of Finch, Ontario.

## III. Genuiculate Group

*Rafinesquina declivis* (James) Foerste

Text figure 6, No. 4; Plate VII, figures 1 a-d

*Strophomena declivis* James, Cincinnati, Quar. Jour. Sci. 1, 1874, p. 24.*Rafinesquina declivis* (James), Foerste, Denison Univ. Sci. Lab., Bull. 16, 1910, p. 43, Pl. V, fig. 12D.

Foerste claims that James' holotype is crushed and he illustrates another specimen that he considers as typical of the species. The few specimens found in the Ottawa-St. Lawrence Lowland average: width, length, and thickness, 17 mm., 15 mm., and 3.5 mm., respectively, with the rounded geniculation 13 mm. from the beak. They agree with the typical species as chosen by Foerste.

The species differs from *R. salmoni* Wilson and *R. semicircularis minor* Wilson in its more elongated outline accentuated by its more elongated and less convex posterior part.

*Occurrence.* Cobourg beds, localities 123, 134.

*Rafinesquina cf. deerensis* Salmon

Text figure 6, No. 5; Plate VII, figures 2 a-d

*Rafinesquina deerensis* Salmon, Jour. Pal., 16, No. 5, 1942, p. 581, Pl. LXXXVI, figs. 1, 2.*Rafinesquina cf. deerensis* Salmon, Wilson, Roy. Soc., Canada, Trans., 3rd ser. 33, 1944, sec. 4, p. 176, text fig. 6, No. 5.

The Ottawa-St. Lawrence specimens, measuring, width, length, and thickness, 22 mm., 17.5 mm., and 5 mm., respectively, have a tendency to be slightly smaller than the type as given by Salmon, and some of them lack the crenulations, but otherwise they are similar.

The species is very close to *R. semicircularis minor* Wilson, but is larger, and the position of the geniculation gives the posterior part a more transverse outline.

*Occurrence.* Sherman Fall beds, localities 6, 57, 129, 186, 188, 199, 247; Cobourg beds, localities 3, 85, 86, 88, 91, 93, 95, 100, 108, 119, 121, 123, 176, 177, 188, 223, 225, 232, 237, 241, 242, 249, 258, 259, 277, 280, 281, 295, 300, 304, 306, 309.

*Rafinesquina deltoidea* (Conrad)

Text figure 8, No. 1; Plate VII, figures 5 a, b

*Strophomena deltoidea* Conrad, 3rd Ann. Rept. New York Geol. Surv., 1839, p. 64; 5th Ann. Rept., *ibid.*, 1841, p. 37.*Rafinesquina deltoidea* (Conrad), Hall and Clarke, Pal. New York, 8, p. 1, 1892, Pl. IXA, figs. 1, 2, 4; Salmon, Jour. Pal. 16, No. 5, 1942, p. 583, figs. 16-20.

Outline subtriangular; cardinal extremities slightly auriculate; anterior margin narrowly rounded or projecting; geniculation abrupt, about three-quarters to four-fifths the total length from the beak; the posterior part slightly convex and subtriangular; anterior part also slightly convex, narrow at the cardinal extremities, widening until it is one-third the total length along the median line, though not increasing the length to that extent because of the angle of geniculation; width, length, and thickness averaging: 27 mm., 22 mm., and 8 mm., respectively; striæ not much differentiated posteriorly, nor on the brachial valve, but developing alternations of one to several finer ones between each two coarser ones, on the anterior part; all crossed by fine concentric growth lines; crenulations of varying degrees in the cardinal region continuing more or less over the subtriangular posterior part, concentric with the outline of the geniculation.

Brachial valve concave, following very closely the convexity of the pedicle valve.

Interior rarely exfoliated. The pedicle muscle scar is narrowly flabellate and the brachial valve shows a low bifid process.



Salmon<sup>1</sup> in her discussion on the species, states that the specimens from Ontario are somewhat smaller than the New York specimens. Her measurements of width 20 mm., and length 15 mm. correspond to those of the following species. In eastern Ontario, in the Ottawa-St. Lawrence Lowland, specimens of *R. deltoidea* have the average size given by her for that species. Though there are many 24 mm. or 23 mm. in width that maintain a length of 20 mm., there are others 28 mm. or 30 mm. in width.

Usually, specimens of *R. deltoidea* have to be identified from the exterior. The size and subtriangular outline repeated in the elevated, usually crenulated, posterior part are the outstanding external characteristics that distinguish it from other *Rafinesquinae*.

*Occurrence.* Sherman Fall beds, locality 84; Cobourg beds, found at all exposures.

*Type.* Plesiotype, G.S.C. No. 1613a, not from the Ottawa-St. Lawrence Lowland, but from Upper Trenton beds, Lachine, Quebec.

*Rafinesquina gibbosa* Wilson

Text figure 8, No. 4; Plate VI, figure 13

*Rafinesquina gibbosa* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 178, text fig. 8, No. 4, Pl. II, fig. 13.

Outline almost a circle except for the small segment cut off by the hinge line; profile approximately a semicircle; hinge line shorter than the greatest width; convexity very great; geniculation rounded, beginning about 10 mm. from the beak; posterior part small, almost flat, transverse, perpendicular to the line of the length of the shell; anterior part almost three times the posterior in length, very convex, curving back until at the anterior margin it is nearly parallel with the posterior face; hinge, greatest width, length, and thickness of the holotype: 18.5 mm., 24.5 mm., 21 mm., and 12.5 mm., respectively; striæ of two sizes not greatly differentiated, 2 to 5 fine between two slightly coarser; very fine concentric lines; crenulations present on the posterior part; punctæ very numerous.

The form is readily distinguished from any other by its extreme gibbosity.

*Occurrence.* Cobourg beds, localities 86, 131, 134, 189, 229, 241, 257.

*Type.* Holotype, G.S.C. No. 8965, Cobourg beds, west end of Fifth avenue, Ottawa, Ontario.

*Rafinesquina laurentina* Wilson

Text figure 7, No. 4; Plate VI, figure 12

*Rafinesquina laurentina* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 178, text fig. 7, No. 4, Pl. II, fig. 12.

U-shaped, slightly auriculate, but angles rounded; greatest width just anterior to the hinge line; geniculation rounded, angle of posterior and anterior planes approaching 100 degrees, both parts moderately convex, the posterior part being considerably wider than long, giving the whole an appearance of much greater width than length; width, length, and thickness averaging: 26 mm., 22 mm., and 7 mm., respectively; striæ of two sizes, 2 or 3 finer ones between every two coarser, crossed by concentric growth lines; crenulations absent or poorly developed; punctæ rather finer than in *R. deltoidea*.

Brachial valve slightly concave, almost flat.

Interiors not known.

There are transitional forms between this species and *R. deltoidea* (Conrad) and also between it and *R. semicircularis* Wilson, but the average *R. laurentina*

<sup>1</sup> Salmon, E. S.: Op. cit., p. 584.

differs from *R. deltoidea* in its rounded anterior margin, and the transverse outline of the elevated posterior part. It differs from *R. semicircularis* Wilson in its size, its more transverse, elevated posterior part, and in its greater growth anterior to the geniculation.

*Occurrence.* Sherman Fall beds, localities 42, 186; Cobourg beds, localities 3, 85, 86, 89, 90, 100, 116, 133, 168, 185, 208, 226, 237, 248, 251, 253, 257-259, 275, 283, 297 (loose), 303-305, 309.

*Type.* Holotype, G.S.C. No. 8966, Cobourg beds, excavations for La Salle Academy, Ottawa, Ontario.

*Rafinesquina miodeltoidea* Wilson

Text figure 8, No. 2; Plate VI, figure 9

*Rafinesquina miodeltoidea* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 179, text fig. 8, No. 2, Pl. II, fig. 9.

Outline bluntly triangular; cardinal angles auriculate; greatest width at the hinge line; geniculation more or less sharp, the planes of the two parts at 100 to 110 degrees to one another, the posterior part bluntly triangular like the shell outline, and constituting three-quarters of the total length along the median line; width, length, and thickness averaging: 20 mm., 17 mm., and 6 mm. or 7 mm., respectively; striae of two sizes, several finer ones between every two coarser; punctae very close.

Brachial valve not known.

Interiors not known.

The shell is like a small *R. deltoidea*, but it is not the young of that species because the geniculation occurs before the posterior part has reached the size of the corresponding part in *R. deltoidea*. Additional growth would merely lengthen the anterior part, a process that has occurred in some gerontic forms.

In size *R. miodeltoidea* is very like *R. ottawaensis* Wilson but it differs in that it is more triangular, its greatest width is at the hinge line, and growth after geniculation is more sloping, at a less abrupt angle to the posterior part.

It is very suggestive of *R. declivis*, but the posterior part is more transverse, and it seems to have been established that the type of *R. declivis* is distorted; Foerste and Salmon have re-described *R. declivis* from co-types that are much less convex than *R. miodeltoidea*. This species would have been described as a small variety of *R. deltoidea*, but, like *R. praedeltoidea*, it first appears at a considerably lower horizon, and it may be that *R. deltoidea* is derived from one or the other of them. *R. miodeltoidea*, however, continues and appears side by side with *R. deltoidea*. No other specimen of *R. praedeltoidea* was found.

*Occurrence.* Leray beds, localities 17, 143, 147; Sherman Fall beds, localities 6?, 186, 188; Cobourg beds, localities 84-86, 88, 90, 92, 101, 103, 108, 114, 116, 121, 128, 131, 133, 162, 168, 188, 208, 223, 225, 229, 232, 241, 242, 244 (loose), 250, 257, 258, 275, 276, 284, 287, 289, 302-306, 312.

*Type.* Holotype, G.S.C. No. 8967, Cobourg beds, west end of Fifth avenue, Ottawa, Ontario.

*Rafinesquina normalis* Wilson

Text figure 6, No. 6; Plate VIII, figures 10, 11

*Rafinesquina normalis* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 26, 1932, sec. 4, p. 395, Pl. V, figs. 5, 6.

To the original description it may be added that the width, length, and thickness average 29 mm., 22 mm., and 6 mm., respectively. The convexity is not great in proportion to the size, but it is largely confined to the region of geniculation. In this respect, the species approaches *R. equipunctata* Wilson, but it is less robust, has a shorter anterior part, and lacks the tendency to an irregular anterior margin.



The subtriangular posterior part of *R. normalis* overshadows the more U-shaped outline of the whole specimen.

The paratype of *R. normalis* (G.S.C. No. 6654) is included in the following species, *R. normaloides* Wilson.

*Occurrence.* Sherman Fall beds, localities 57, 198-200; Cobourg beds, localities 46, 88, 95, 119, 121, 176, 229, 237, 241, 242, 246, 249, 257, 259, 283, 287, 303.

*Type.* Holotype, G.S.C. No. 6653, Cobourg beds, lot C, con. IX, Cornwall tp., Ontario.

*Rafinesquina normaloides* Wilson

Text figure 7, No. 1; Plate VI, figure 5; Plate VII, figure 3

*Rafinesquina normalis* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 26, 1932, sec. 4, Pl. V, fig. 7.

*Rafinesquina normaloides* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 181, text fig. 7, No. 1, Pl. II, fig. 5.

U-shaped outline; cardinal extremities not auriculate; greatest width a little anterior to the cardinal angles; almost straight for half the length, curving into the broadly rounded anterior margin; greatest convexity about two-thirds the length from the beak; width, length, and thickness averaging: 32 mm., 26.5 mm., and 9 mm., respectively; striæ not greatly differentiated, a few coarse ones irregularly placed; all crossed by fine growth lines; crenulations over the posterior part, most marked near the region of geniculation; punctæ as in *R. equipunctata*.

Brachial valve not known.

Interiors not known.

*R. normaloides* Wilson differs from *R. normalis* Wilson in its larger size, more U-shaped posterior part, greater convexity, more posterior position of the geniculation, and more pronounced crenulations.

The species differs from *R. equipunctata* Wilson in the presence of crenulations and in the shorter posterior part.

*Occurrence.* Cobourg beds, localities 43, 96, 119, 131, 189, 303, 307.

*Type.* Holotype, G.S.C. No. 8968, Cobourg beds, Rideau Hall grounds, Ottawa, Ontario; paratype, No. 6654, Cobourg beds, Gravel Hill, Ontario.

*Rafinesquina okulitchi* Wilson

Text figure 7, No. 2; Plate VI, figure 7

*Rafinesquina okulitchi* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 181, text fig. 7, No. 2, Pl. II, fig. 7.

Gibbose, subcircular, cardinal extremities not extended; cardinal angles showing a slight tendency to auriculation; sides and anterior margin rounded; greatest width about midway between hinge and anterior margin; geniculation centring about 20 mm. from the beak; making an angle of about 120 degrees in the median line, but sides more flaring; posterior and anterior parts very slightly convex, almost flat; width, length, and thickness of the holotype: 34 mm., 27 mm., and 9 mm., respectively; alternation of striæ marked, 4 to 5 finer ones between two considerably coarser ones; fine growth lines; no corrugations seen, but growth lines more conspicuous at the cardinal extremities; punctæ not well exposed, apparently 5 to 6 in 2 mm.

Brachial valve not known.

Interiors not known.

*R. okulitchi* has something of the outline of *R. robusta* Wilson, but it is smaller, is geniculate, and has a marked differentiation of striæ.

*Occurrence.* Leray beds, locality 15; Leray-Rockland beds, localities 216, 220; Rockland beds, localities 148, 156; Hull ? beds, locality 215.

*Type.* Holotype, G.S.C. No. 8969, Rockland beds, north of Orleans, Ontario.

*Rafinesquina ottawaensis* Wilson

Text figure 8, No. 5; Plate VI, figures 14 a, b

*Rafinesquina ottawaensis* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 182, text fig. 8, No. 5, Pl. 2, figs. 14a, 14b.

Outline semicircular, in some cases roughly circular; some specimens showing a faint triangularity at the median region of the geniculation, which disappears in the down-flected anterior part; cardinal angles slightly auriculate; hinge, straight, shorter than the greatest width, which is about one-third to one-half length distant from the beak; geniculation not sharp, but confined within rather narrow limits centring about 10 mm. or 11 mm. from the beak, in all making almost a right angle or less; convexity very great due to the angle of geniculation, but posterior and anterior parts only slightly convex, the anterior being longer than the posterior; hinge, greatest width, length, and thickness averaging: 15 mm., 19 mm., 17 mm., and 10 mm., respectively. The holotype and many others have a total length of 16.5 mm. from hinge to anterior, but if measured along the convex umbo would be 23 mm.; low, broad, radial corrugations on the anterior part often making a slightly irregular anterior margin; striæ variable, several finer ones between two coarser, the differentiation being more pronounced anteriorly; punctæ very irregular, the coarser more sparsely placed ones continuing from the posterior part, side by side with fine, closely spaced ones between the more anterior striæ.

Brachial valve slightly concave posteriorly, but bending abruptly at the line of geniculation; lacking the differentiation of striæ, and finely punctate.

Interiors not known.

The species is very close to *R. imbrex* (Pander) as originally figured<sup>1</sup>, but the Canadian form is consistently smaller. It would have been named a variety of that species but for complications in the use of the name *R. imbrex*. Billings described a *Strophomena imbrex* that later was called *R. imbrex*, quite different from Pander's form. Twenhofel considered it a *Leptaena*, but the two forms stood under the same name for some time. Again Høltedahl includes under *R. imbrex* Pander a more triangular form originally identified by Pander as *Plectambonites triangularis*.

The species is so closely allied to *R. minuta* Salmon that it may be a local variation of it. Typically, however, it is not broadly triangular, averages larger, has a more pronounced region of geniculation and a more prolonged anterior region, and there is a differentiation of striæ. It differs from *R. miodelloidea* in its shorter posterior part and usually more rounded anterior. It is very like a small *R. camerata* (Conrad) but the position of the geniculation is considerably nearer the beak, and increased growth would not result in *R. camerata* but a much greater difference between the posterior and anterior regions.

*Occurrence.* Cobourg beds, localities 43, 85, 86, 88, 90-92, 97, 99, 103, 104, 114, 119, 121, 122, 162, 168, 177, 179, 184, 185, 189, 191, 208, 223, 226, 235-237, 241, 242, 244, 257-259, 284, 287, 291, 294, 300, 303, 306.

*Type.* Holotype, G.S.C. No. 8970, Cobourg beds, lot 22, con. III, Roxborough tp., Ontario.

*Rafinesquina praedelloidea* Wilson

Text figure 8, No. 3; Plate VI, figure 11

*Rafinesquina praedelloidea* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 183, text fig. 8, No. 3, Pl. II, fig. 11.

Rather small; broadly U-shaped outline; cardinal extremities very slightly extended, faintly auriculate; anterior to the very small invagination, sides almost straight for a short distance then curving into a broadly rounded, slightly uneven anterior margin; greatest width at the hinge line; geniculation abrupt, at 16 mm.

<sup>1</sup> Beitrage zur Geognosie des russischen Reiches, p. 91, Pl. XIX, fig. 12.

from the beak, anterior bending down approximately at right angles to the plane of the posterior part; width, length, and thickness measuring: 25 mm., 18.5 mm., and 5 mm., respectively; convexity slight on both anterior and posterior parts; outer surface largely exfoliated from the anterior part of the type, and only specimen, but striæ are very fine, and alternation not marked except for a strong median stria; fine growth lines present; crenulations on the posterior part very fine, continuing from one side of the beak to the other, completing a semicircle, and with the striæ forming a fine reticulate ornamentation on the posterior part; punctæ, large for the size of the shell, 5 or 6 in 2 mm. at the anterior.

Brachial valve not known.

Interiors not known.

*R. praedeltoidea* is nearest to *R. deltoidea*, and, as suggested by the name, either it or *R. miodeltoidea* may be ancestral to *R. deltoidea*. *R. praedeltoidea* in outline is more transverse, is smaller, and the crenulations are finer and more complete.

The outline and profile are very similar to *R. laurentina*, but the latter lacks the reticulate ornamentation.

The complete crenulations are suggestive of *Leptaena*, but the whole surface ornamentation is finer than that of any known *Leptaena*, and the outline and profile are those of a *Rafinesquina*.

*Occurrence.* Leray-Rockland beds, locality 20.

*Type.* Holotype, G.S.C. No. 8971, Leray-Rockland beds, southeast of Pakenham, Ontario.

#### *Rafinesquina salmoni* Wilson

Text figure 6, No. 3; Plate VI, figure 8

*Rafinesquina salmoni* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 184, text fig. 6, No. 3, Pl. II, fig. 8.

Small, transverse; convexity moderate; extremities extended; cardinal angles forming a right angle or less, slightly resupinate; sides converging from cardinal extremities to the broadly rounded anterior margin; greatest width at the hinge line; geniculation not sharp, centre of curve about 9 mm. from beak, somewhat flattening out toward the cardinal extremities; width, length, and thickness of the holotype: 20 mm., 15 mm., and 5 mm., respectively; some specimens a little smaller; striæ very fine, alternation not prominent, one strong median costa present on some specimens, 2 to 4 finer striæ between two coarser anterior to the geniculation; very fine growth lines—in some instances a few together make fine, uneven, and indistinct rugæ; punctæ large for the size of the specimens, but closely placed, 6 to 8 in 2 mm., a few faint crenulations near the hinge line in some specimens.

Brachial valve not known.

Interiors not known.

The form is small for a *Rafinesquina*. It differs from *R. declivis* (James) in its shorter length and more transverse outline; from *R. minuta* Salmon in its transverse outline, its larger posterior part, and in being less convex.

The species is named for Salmon, who has done much to clarify the confusion in the species of *Rafinesquina*.

*Occurrence.* Sherman Fall ? beds, locality 6; Cobourg beds, localities 19, 43, 86, 90, 93, 105, 176, 177, 179, 208, 223.

*Type.* Holotype, G.S.C. No. 8972, Cobourg beds, Booth street, Ottawa, Ontario.

*Rafinesquina sardesoni* Salmon (?)

Text figure 7, No. 3; Plate VI, figure 6

*Rafinesquina sardesoni* Salmon, Jour. Pal., 16, No. 5, 1942, p. 538, Pl. LXXXVI, figs. 35-38.

The specimens here identified as *R. sardesoni* Salmon (?) correspond to the description of that species in form and punctæ, but they are proportionately shorter, and the few specimens found are consistently somewhat smaller. Also, there is not the marked differentiation in striæ. The largest specimen is illustrated, and measures: width, length, and thickness, 28 mm., 25 mm., and 12 mm., respectively.

*Occurrence.* Cobourg beds, localities 86, 225, 229, 250, 257.

*Type.* Plesiotype, G.S.C. No. 8973, Cobourg beds, lot 21, con. VIII, Cornwall tp., Ontario.

*Rafinesquina semicircularis* Wilson

Text figure 6, No. 2; Plate VI, figure 4

*Rafinesquina semicircularis* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 33, 1944, sec. 4, p. 185, text fig. 6, No. 2, Pl. II, fig. 4.

Outline almost semicircular; cardinal angles about 90 degrees; sides almost straight; anterior margin broadly rounded; greatest width near the hinge line and continuing for a short distance anterior to it; convexity not great for the size of the shell; geniculation semicircular in line, closely following the anterior margin and only 1.2 mm. to 2 mm. distant from it, resulting in a very large, gently convex posterior part; width, length, and thickness averaging: 25 mm., 20 mm., and 4.5 mm., respectively; striæ of two sizes over the whole shell, 1 to 4 finer ones between two coarser; very fine concentric growth lines; no crenulations seen; punctæ 5 to 6 in 2 mm. at the region of geniculation, less numerous posterior to it, more numerous anterior to it.

Brachial valve gently concave.

Interiors not known.

*R. semicircularis* is closely related to *R. deerensis* Salmon, but it is more circular in outline, has a relatively larger posterior part, and is proportionately considerably less convex. It is larger than *R. semicircularis minor*.

*Occurrence.* Hull beds, localities 44, 50, 51, 60; Sherman Fall beds, localities 50, 57, 84, 181, 186, 279; Cobourg beds, localities 95, 101, 121, 134, 208, 284.

*Type.* Holotype, G.S.C. No. 8794, Sherman Fall beds, from 'Dump', Hull, Quebec.

*Rafinesquina semicircularis minor* Wilson

Text figure 6, No. 1; Plate VI, figure 3

*Rafinesquina semicircularis minor* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 33, 1944, sec. 4 p. 186, text fig. 6, No. 1, Pl. II, fig. 3.

Small; U-shaped, almost subcircular in outline; cardinal angles non-auriculate; sides almost parallel; greatest width at the hinge line; geniculation not very sharp, centring about 12 mm. from the beak; anterior part about one-third length of the posterior part, but not increasing the total length to that degree because of its angle of 90 to 100 degrees to the plane of the posterior part; width, length, and thickness averaging: 18 mm., 14 mm., and 4.5 mm., respectively, though the holotype does not quite attain that thickness; radial striæ more or less of one size except near the median part and on the deflected anterior part; very fine concentric growth lines; punctæ very fine and numerous on the anterior, more widely spaced on the posterior.

Brachial valve not known.

Interiors not known.

The variety is very like the Norwegian form *R. parva* Høltedahl. The posterior surface, however, is more evenly convex without the ridge-like longitudinal elevation, and *R. semicircularis minor* averages larger. The radial striæ appear to be similar, though the Canadian variety lacks the concentric crenulations of the Norwegian form, shown in the illustration but not mentioned in the text. Only one pedicle valve and a few broken valves of *R. parva* have been found. It may be that the valve was slightly distorted. If so, and there should prove to be one, not two, species, the name *R. parva* will have preference.

The species has a less transverse appearance than *R. salmoni*, though the measurements are very similar, because the centre of geniculation is 12 mm., as compared with 9 mm. from the beak.

*Rafinesquina semicircularis minor* might be considered a variety of *R. declivis*. The measurements are very similar, but the sides in *R. semicircularis minor* are less abruptly geniculate than in *R. declivis*, giving the specimens a less elongated, more subcircular appearance. The illustrated holotype has not attained the maximum thickness, but the average thickness is greater than that of *R. declivis*.

The species differs from *R. miodeltoidea* in being subcircular rather than subtriangular, and the angle of the plane of the posterior to that of the anterior is somewhat sharper than in that species.

*Rafinesquina semicircularis minor* differs from *R. deerensis* Salmon in being consistently smaller and in having the posterior part longer in proportion to its width. The latter characteristic gives the species an appearance of greater length than that of *R. deerensis*, in which the posterior part is wider in proportion to its length. The species is consistently smaller than *R. laurentina*. A few specimens are transitional between *R. semicircularis minor* and most of the other smaller species.

*Occurrence.* Leray-Rockland beds, locality 17; Sherman Fall ? beds, locality 6; Cobourg beds, localities 3, 85, 88, 90, 93, 100, 105, 115, 119, 121, 133, 162, 168, 175-177, 183, 188, 191, 225, 229, 237, 241, 248, 249, 251, 257, 280, 281, 283, 287, 292, 300, 305, 306.

*Type.* Holotype, G.S.C. No. 8975, Cobourg beds, Indian Lands, cons. VIII and IX, Cornwall tp., Ontario.

#### *Rafinesquina sinuata* Wilson

Text figure 7, No. 5; Plate VI, figure 10

*Rafinesquina sinuata* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 187, text fig. 7, No. 5, Pl. II, fig. 10.

Shell very convex, somewhat variable in size, greatest width at hinge; cardinal extremities very auriculate; sides converging to a rounded anterior, interrupted by a slight invagination; geniculation pronounced but rounded; posterior position moderately convex with a transverse outline, width to length as 12:7; anterior part deep, often longer than the posterior, its convexity broken by a wide flat area or a shallow sinus, which causes the slightly sinuate anterior margin; width from 22 mm. to 25 mm., length 17 mm. to 20 mm., thickness 9 mm. to 11 mm.; striæ slightly differentiated, 1 to 4 finer ones between two coarser; concentric growth lines becoming faintly crenulated posteriorly; punctæ large and numerous.

Brachial valve and interiors not known.

The form is characterized by its flattened anterior or broad shallow sinus.

*Occurrence.* Cobourg beds, localities 88, 96 ?, 121, 131, 133 ?, 242, 259, 275 ?.

*Type.* Holotype, G.S.C. No. 8976, Cobourg ? beds, locality unspecified, Hull, Quebec.

RAFINESQUINÆ		OTTAWA LIMESTONE						
		Pamela	Lowville	Leray	Rockland	Hull	Sherman Fall	Cobourg
LOW CONVEXITY	<i>R. alternata platys</i> Wilson		?					
	<i>R. " transversa</i> Wilson							
	<i>R. " plana</i> Wilson							
	<i>R. lennoxensis</i> Salmon							
	<i>R. alternata quadrata</i> Wilson							
	<i>R. " pota</i> Wilson							
	<i>R. " semiquadrata</i> Wilson							
	<i>R. " intermedia</i> Wilson							
	<i>R. " alata</i> Wilson							
	<i>R. alternata</i> (Conrad)							
	<i>R. carlottina</i> Wilson							
HIGH CONVEXITY	<i>R. orleansensis</i> Wilson							
	<i>R. opeongoensis</i> Wilson							
	<i>R. prestonsis</i> Salmon							
	<i>R. hullensis</i> Wilson							
	<i>R. equipunctata</i> Wilson							
	<i>R. subtrigonalis</i> Wilson							
	<i>R. esmondensis borealis</i> Wilson							
	<i>R. calderi</i> Wilson							
	<i>R. patula</i> Wilson							
	<i>R. rotunda</i> Wilson							
	<i>R. robusta</i> Wilson							
	<i>R. praecursor</i> Raymond							
	<i>R. apicalis</i> Wilson							
	<i>R. subcamerata</i> Wilson							
	<i>R. camerata</i> (Conrad)							
GENICULATE	<i>R. semicircularis</i> Wilson							
	<i>R. semicircularis minor</i> Wilson							
	<i>R. declivis</i> (James)							
	<i>R. praedeltoidea</i> Wilson							
	<i>R. normalis</i> Wilson							
	<i>R. cf. deerensis</i> Salmon							
	<i>R. laurentina</i> Wilson							
	<i>R. salmoni</i> Wilson							
	<i>R. obulitchi</i> Wilson							
	<i>R. miodeltoidea</i> Wilson							
	<i>R. normaloides</i> Wilson							
	<i>R. deltoidea</i> (Conrad)							
	<i>R. sardesoni</i> Salmon							
	<i>R. sinuata</i> Wilson							
	<i>R. ottawaensis</i> Wilson							
<i>R. gibbosa</i> Wilson								

G.S.C.

Figure 9. Comparative range of *Rafinesquina* having low convexity, high convexity, and geniculation within the Ottawa formation.

### *Öpikina* Discussion

The *Öpikinae* of the area had always been identified as *Rafinesquinae*, because of the similarity of form and the association of the two genera at some horizons. Salmon<sup>1</sup>, however, demonstrated that there are two distinct genera, differing in musculature and in type of the pores in the intermediate layer of the shell material. The muscle area, unfortunately, is not often exposed, but the pores are revealed by the slightest exfoliation and are, therefore, the more commonly used criterion for distinguishing the genera. In *Rafinesquina*, the pores are comparatively large, round, and arranged in radiating rows between the striæ. In *Öpikina* the pores are minute, irregularly shaped, irregularly arranged, and cover the exposed surface like a fine network without any relationship to the striæ. Their irregularity reflects light from various angles so that the exposed surface often has a peculiar glistening effect.

In the Ottawa-St. Lawrence Lowland there are not many brachiopods at the base of the Ottawa limestone in the Pamelia beds, and neither genus is represented in it. *Öpikina* makes its appearance and is moderately common in the Lowville beds. It is prolific in the Leray-Rockland beds, where *Rafinesquina* first appears. From there upward, *Rafinesquina* increases and diverges and *Öpikina* decreases, though it is still present at the top of the formation. As far as can be judged from its occurrence in this area, then, *Öpikina* is the older form.

#### Genus, *Öpikina* Salmon

##### Genotype, *Ö. septata* Salmon

Concavo-convex; hinge line straight; surface covered by radial striæ of several sizes, the smaller ones having a tendency to disappear toward the anterior; shell structure finely, thickly, but irregularly punctate; surface of visceral area finely pustulose.

Pedicle interior with a large muscle area extending halfway or more to the anterior margin and surrounded by a low ridge, strong posteriorly, faint anteriorly; diductors shallow, circular to broadly oval, not well defined; adductor ridge rather broad, highest anteriorly; dental plates strong, divergent 90 to 120 degrees.

Brachial interior more distinctive: cardinal process stout, with two triangular branches; 5 septa present—a median one and two pairs of laterals—median septum low posteriorly, becoming narrower and sharper anteriorly; two concentric ridges present, the inner one connecting the brachiophores, the outer one corresponding to that of the pedicle valve and enclosing the musculature (condensed from Salmon's description).

The genus is outwardly like *Rafinesquina*, and many of its species have been so described. It can be distinguished from *Rafinesquina* and *Leptaena* externally by its less regular alternation of striæ and when partly exfoliated, by its fine irregular punctæ; internally by the large muscle area, and, in the brachial valve, by its five septa.

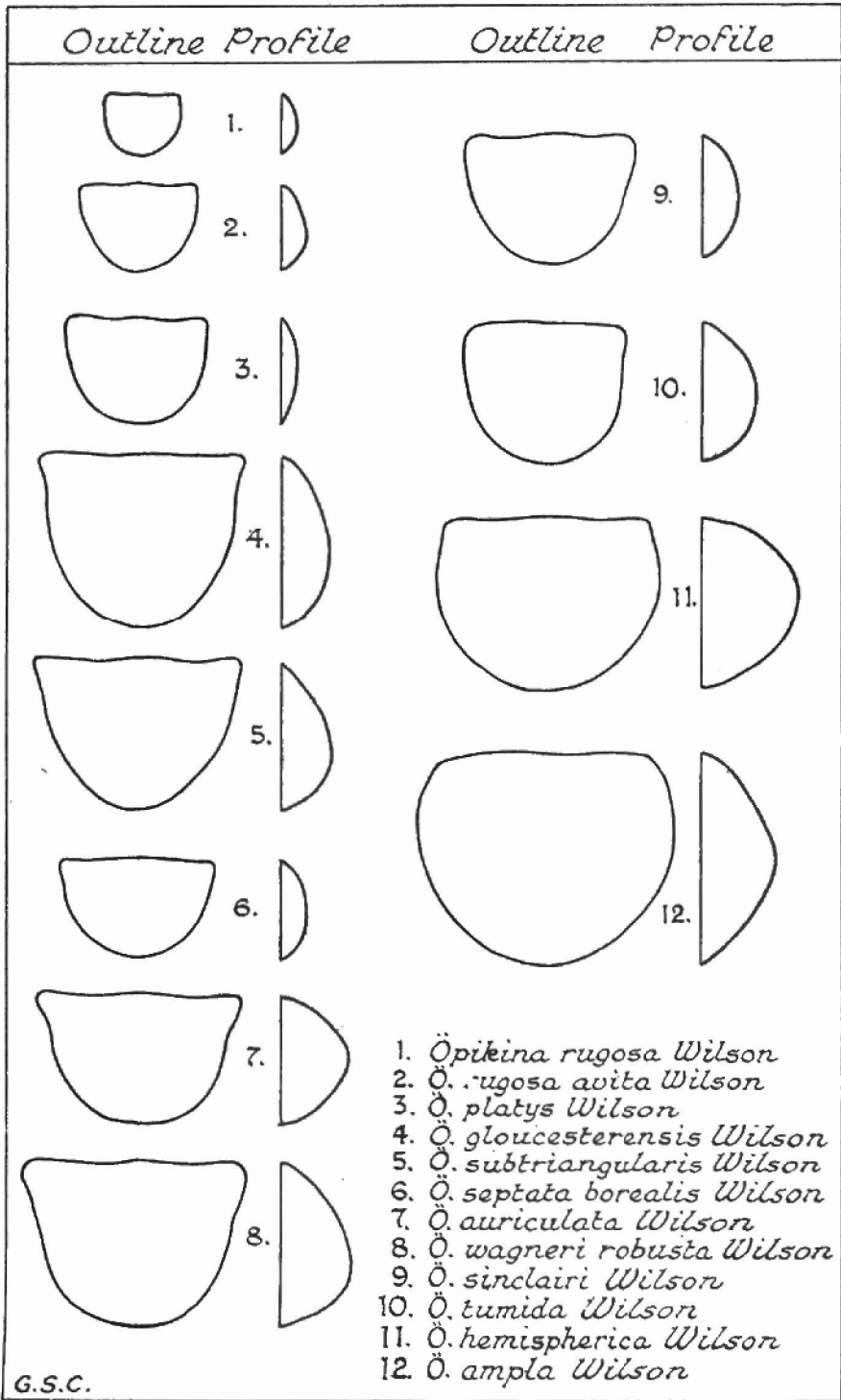
<sup>1</sup> Salmon, E. S.: Op. cit., p. 589.



*Ratio of Convexity to Length and to Width*

	Convexity	Length	Width
<i>Öpikina platys</i> Wilson.....	1	7.5	9.5
<i>Ö. sinclairi</i> Wilson.....	1	4.0	5.1
<i>Ö. gloucesterensis</i> Wilson.....	1	3.7	4.3
<i>Ö. septata borealis</i> Wilson.....	1	3.4	6.0
<i>Ö. rugosa</i> (Wilson).....	1	3.4	4.0
<i>Ö. ampla</i> Wilson.....	1	3.1	3.6
<i>Ö. subtriangularis</i> Wilson.....	1	3.0	4.0
<i>Ö. tumida</i> Wilson.....	1	2.7	3.1
<i>Ö. rugosa avita</i> (Wilson).....	1	2.5	3.75
<i>Ö. wagneri robusta</i> Wilson.....	1	2.3	3.1
<i>Ö. hemispherica</i> Wilson.....	1	2.0	2.4
<i>Ö. auriculata</i> Wilson.....	1	1.8	2.9



Figure 10. *Öpikina* species.

*Öpikina ampla* Wilson

Text figure 10, No. 12; Plate VI, figure 29

*Öpikina ampla* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 190, text fig. 10, No. 12, Pl. II, fig. 26.

Large; U-shaped outline; cardinal extremities not extended, non-auriculate; cardinal angles about 90 degrees; sides and anterior broadly convex; greatest width at the hinge or just anterior to it; convexity greatest at the centre, sloping down evenly toward all margins, slightly flattening at the wings; width, length, and thickness of holotype: 35 mm., 30 mm., and 9.5 mm., respectively; striæ poorly preserved, rather coarse, some tendency toward alternation; growth lines not well preserved, a tendency to wrinkles along the anterior of exfoliated specimens; no crenulations seen; punctæ typical.

Brachial valve and interiors not known.

*Ö. ampla* Wilson differs from other species in its size and even convexity.

*Occurrence.* Leray-Rockland beds, localities 15, 64, 77, 147, 271, 272; Hull or Sherman Fall beds, locality 210.

*Type.* Holotype, G.S.C. No. 8977, Leray-Rockland beds, lot 13, con. XII, Goulbourn tp., Ontario.

*Öpikina auriculata* Wilson

Text figure 10, No. 7; Plate VI, figure 17

*Öpikina auriculata* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, p. 190, text fig. 10, No. 7, Pl. II, fig. 17.

Much wider than long; strongly auriculate; greatest width at the hinge line; anterior broadly rounded; convexity great in proportion to length; geniculation not acute; viewed in profile greatest convexity about mid-length, rising from the hinge line and the anterior margin with similar curves; viewed from the anterior the outline is more broadly convex at the centre, flattens out and becomes definitely concave toward the cardinal extremities and to a less degree toward the lateral margins; width, length, and thickness of the holotype: 28 mm., 18 mm., and 9.5 mm., respectively; two sets of striæ, 1 or 2 finer ones between two coarser, crossed by concentric growth lines; punctæ present but indistinct on the holotype.

Brachial valve not well preserved, very concave following the curves of the pedicle valve.

Interiors not known.

The form differs from others in its auriculate cardinal extremities, its greater width in proportion to its length, and in the reversed curve of its outline from the anterior view.

*Occurrence.* Cobourg beds, locality 121.

*Type.* Holotype, Cobourg beds, Research Council Laboratories, Sussex street, Ottawa, in the private collection of G. W. Sinclair.

*Öpikina gloucesterensis* Wilson

Text figure 10, No. 4; Plate VI, figure 20

*Öpikina gloucesterensis* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 191, text fig. 10, No. 4, Pl. II, fig. 19.

Broadly U-shaped, but with slightly narrowed anterior; cardinal extremities extended, auriculate; cardinal angles less than 90 degrees; sides broadly curved; anterior margin with a narrower curve than the sides; greatest width at hinge line; convexity greatest about 18 mm. from beak; no true geniculation, but the anterior part making an angle of 120 degrees and flattening out toward the sides, leaving a wide, broadly rounded, slightly convex posterior part; width, length, and thickness of the holotype: 28 mm., 24 mm., and 6.5 mm., respectively; striæ fine, with some tendency

to develop one or two very fine interstriae; growth lines very fine; crenulations broad, short, well developed near the cardinal extremities; punctae typical.

Brachial valve not well preserved. One brachial valve supposed to belong to this species has three median septa preserved.

The species differs from *Ö. transitionalis* (Okulitch) in the lack of geniculation, in being broader in proportion to its length, in having a less convex posterior part, and in having crenulations. It differs from *Ö. clara* (Okulitch) in being more convex and less transverse in outline. It differs from *Ö. subtriangularis* Wilson in having ears, and in its less oblique sides and broader anterior margin.

*Occurrence.* Leray-Rockland beds, localities 41, 79, 109, 146-148, 285.

*Type.* Holotype, G.S.C. No. 8978, Leray-Rockland beds, lots 3-5, con. III, R.F., Gloucester, tp., Ontario.

#### *Öpikina hemispherica* Wilson

Text figure 10, No. 11; Plate VI, figure 21

*Öpikina hemispherica* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 192 text fig. 10, No. 11, Pl. II, fig. 20.

Almost half a hemisphere; cardinal extremities not extended, non-auriculate; cardinal angles greater than 90 degrees; sides and anterior making a continuous curve; greatest width near the middle; convexity evenly distributed, except that a small triangular area is abruptly flattened at the cardinal extremities; width, length, and thickness of holotype: 29 mm., 24 mm., 12 mm.; striae not well preserved, coarse on the exfoliated surface; growth lines not preserved; no crenulations; punctae typical.

Pedicle valve partly exfoliated, showing a typically large muscle scar on the interior.

The species is characterized by its almost hemispherical shape and its size.

*Occurrence.* Leray-Rockland beds, localities 148, 273.

*Type.* Holotype, G.S.C. No. 8979, Leray-Rockland beds, lot 13, con. III, Goulbourn tp., Ontario.

#### *Öpikina ovalis* (Wilson)

Plate VIII, figures 20, 21

*Rafinesquina* sp. undtd. Wilson, Geol. Surv., Canada, Mus. Bull. 33, p. 52, Pl. III, figs. 10, 11.

*Öpikina ovalis* Wilson, Roy. Soc., Canada, 3rd ser. 38, 1944, sec. 4, p. 192.

A re-examination of the forms has shown by the punctae that the species belongs to Salmon's genus *Öpikina*. The lack of the two outer septa is probably due to poor preservation.

Near oval in outline; cardinal extremities not preserved in any of the specimens, but apparently not extended; cardinal angles apparently not sharp; sides very slightly curved; anterior margin broadly rounded; greatest width at the hinge line or a little anterior to it; greatest convexity anterior to the middle; average width and length 25 mm. (?) and 20 mm., respectively; thickness not known; striae very fine, alternation of two sizes present but not distinct on the brachial valves; crenulations faint along the hinge line; punctae typical.

Interior showing three long septa, the outer pair probably obliterated by poor preservation.

*Öpikina ovalis* Wilson belongs to a low-convexity group, but it differs from *Ö. platys* in its broader anterior margin, and the outline is more transverse.

*Occurrence.* Leray-Rockland beds, localities 30, 133; Rockland beds, locality 157.

*Type.* Cotypes, G.S.C. Nos. 6222 and 6222a, Rockland beds, from loose slabs at top of Stewart quarry, Rockland, Ontario.

*Öpikina platys* Wilson

Text figure 10, No. 3; Plate VI, figures 22, 23

*Öpikina platys* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 193, text fig. 10, No. 3, Pl. II, figs. 21, 21b.

Low, small, almost semicircular; cardinal extremities not extended, non-auriculate; cardinal angles about 90 degrees; sides almost straight for some distance, then gently curved into the rounded anterior margin; greatest width at the hinge line; convexity greatest at the umbo; width, length, and thickness of holotype: 19 mm., 15 mm., and 2 mm., respectively; some specimens larger and a few slightly smaller; striæ not well preserved, very fine, a few irregular coarser ones, and a tendency toward alternation near the median region; fine growth lines; crenulations fairly prominent along the hinge line; punctæ typical.

Brachial valve not known.

Interiors only partly preserved.

The species is almost a homomorph of *Rafinesquina alternata plana* Wilson. It is readily distinguished from other *Öpikina* by its size and flatness.

*Occurrence.* Leray-Rockland beds, localities 7, 16, 30, 77, 79, 109, 143, 146, 147, 152, 271, 274; Rockland beds, locality 157.

*Type.* Holotype, G.S.C. No. 8980, Leray-Rockland beds, lots 3-5, con. III, R.F., Gloucester tp., Ontario; paratype, No. 8981, Leray-Rockland beds, Merivale road, southeast of Carlington, Ottawa, Ontario.

*Öpikina rugosa* (Wilson)

Text figure 10, No. 1; Plate VIII, figures 22, 23

*Rafinesquina rugosa* Wilson, Geol. Surv., Canada, Mus. Bull. 33, 1921, p. 51, Pl. III, figs. 8, 9.

*Öpikina rugosa* (Wilson), Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 194, text fig. 10, No. 1.

The species is distinguished from most other forms by its small size. Of the smaller *Öpikinae* it is more convex than *Ö. platys* Wilson and its rugose surface differentiates it from that species and its variety *Ö rugosa avita* (Wilson).

*Occurrence.* Leray-Rockland beds, locality 311; Rockland beds, localities 157, 289; Sherman Fall? beds, locality 63.

*Type.* Holotype, G.S.C. No. 6221; paratype, No. 6221a; Rockland beds, upper 10 feet of Stewart quarry, Rockland, Ontario.

*Öpikina* (?) *rugosa avita* (Wilson)

Text figure 10, No. 2; Plate VIII, figures 15-19

*Rafinesquina rugosa* Wilson, Can. Field Nat., 46, No. 6, 1932, p. 138, Pl. II, figs. 6-13.

*Öpikina* (?) *rugosa avita* (Wilson), Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, ser. 4, p. 195, text fig. 10, No. 2.

The variety like the species has the punctæ of the genus *Öpikina*. The interiors are not well shown. Several specimens show three septa, the median one straight, the first laterals with a slight sigmoid curve. One specimen shows a trace of one septum of the second pair of laterals.

*Ö. rugosa avita* is most closely allied to *Ö. rugosa*, from which it can be distinguished by its lack of rugose ornamentation.

*Occurrence.* Leray-Rockland beds, localities 77, 79, 109, 143, 146, 147, 226, 270, 289.

*Type.* Holotype, G.S.C. No. 6813, Leray-Rockland beds, lot 10, con. VIII, N. Crosby tp., Ontario; paratypes in private collection of G.W. Sinclair.

*Öpikina septata borealis* Wilson

Text figure 10, No. 6; Plate VI, figure 15

*Öpikina septata borealis* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 195, text fig. 10, No. 6, Pl. II, fig. 15.

Broadly U-shaped; cardinal extremities extended, slightly auriculate; cardinal angles a little less than 90 degrees; sides rounding into the anterior margin, which is almost sub-parallel to the hinge; greatest width at the hinge; greatest convexity anterior to the middle; width, length, and thickness, 21 mm., 13.5 mm., and 3.5 mm., respectively; striæ very fine, an occasional coarser one; growth lines fine, faint crenulations along the hinge line; punctæ typical.

Brachial valve not known.

Interiors not known.

The variety differs from the species in its less oblique sides and broad, sub-parallel anterior margin. It is slightly larger than the typical species according to the measurements given and considerably larger than the paratype illustrated. The typical species has been reported both from the Chazy, considerably below, and from the Upper Ordovician, considerably above, the horizon of the variety here described.

*Occurrence.* Leray-Rockland beds, locality 19.*Type.* Holotype, G.S.C. No. 8982, Leray-Rockland beds, hill above Sand Point, northwest of Arnprior, Ontario.*Öpikina sinclairi* Wilson

Text figure 10, No. 9; Plate VI, figures 18, 19

*Öpikina sinclairi* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 196, text fig. 10, No. 9, Pl. II, figs. 18a, b.

Medium size; U-shaped outline; cardinal extremities not extended, non-auriculate; cardinal angles a little less than 90 degrees; greatest width at the hinge line and in many specimens maintained for a short distance anterior to it; sides curving in to a broadly rounded anterior margin; greatest convexity anterior to the middle, with the sides flattening out; no geniculation, but the anterior part slightly more convex and shorter than the posterior part; holotype measuring: width, length, and thickness 23 mm., 18 mm., and 4.5 mm., respectively; striæ rather coarse for the size of the shell, having an irregular alternation with finer ones; fine growth lines with occasional irregular broad concentric undulations; punctæ typical.

Brachial valve not known.

Interiors not known.

Compared with *Ö. platys* Wilson it is rounded, considerably more convex, and the convexity is greater anteriorly. Compared with *Ö. ovalis* Wilson it is smaller, and the length and width are more nearly equal.

*Occurrence.* Lowville beds, locality 139; Leray-Rockland beds, localities 9, 15, 41, 77, 143, 146, 273, 310; Hull beds, locality 152; Cobourg beds, localities 90, 103, 123, 249.*Type.* Holotype, G.S.C. No. 8983, Leray-Rockland beds, Merivale road southeast of Carlington, Ottawa, Ontario; paratype, No. 8984, Leray-Rockland beds near corner of Navan and Montreal roads, east of Ottawa, Ontario.*Öpikina subtriangularis* Wilson

Text figure 10, No. 5; Plate VI, figure 24

*Öpikina subtriangularis* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 196, text fig. 10, No. 5, Pl. II, fig. 22.

Outline roughly triangular; cardinal extremities extended, non-auriculate, slightly resupinate; cardinal angles less than 90 degrees; sides oblique but slightly convex; anterior margin rather narrowly rounded, varying somewhat in degree;

greatest width at the hinge line; convexity low and regular over the posterior part, greatest anterior to the middle; no definite geniculation, but the curve increases about 17 mm. from the beak, and the sides are slightly depressed anteriorly, thereby contributing to the subtriangular appearance of the outline and to the concentration of the convexity near the anterior; holotype measuring: width, length, and thickness, 28 mm., 21 mm., and 7 mm., respectively; striæ rather coarse, a few smaller ones irregularly alternating; very fine growth lines; no crenulations; punctæ typical.

Brachial valve closely following the curvature of the pedicle; a few interiors show the septa.

*Ö. subtriangularis* Wilson is characterized by its subtriangular outline, and its convexity made prominent by the sloping sides. Forms with more sharply rounded anterior margin are almost homomorphs of *Rafinesquina praeursor* Raymond.

*Occurrence.* Lowville beds, locality 139; Leray-Rockland beds, localities 41, 143, 147, 162, 274, 285; Rockland beds, locality 187.

*Type.* Holotype, G.S.C. No. 8985, Leray-Rockland beds, lots 3-5, con. III, R.F., Gloucester tp., Ontario; paratype, No. 8986, La petite Chaudière, Val Tetreau, Quebec.

### *Öpikina transitionalis* (Okulitch)

Plate VIII, figures 12 a, b

*Rafinesquina transitionalis* Okulitch, Can. Field Nat., 49, No. 6, p. 97, Pl. I, fig. 3.

*Öpikina transitionalis* (Okulitch), Salmon, Jour. Pal., 16, No. 5, p. 595, Pl. LXXXVII, figs. 15-18.

The species is readily distinguished by its large size combined with its definite geniculation about halfway between the beak and the anterior.

*Occurrence.* Lowville beds, locality 139; Leray-Rockland beds, localities 139, 143, 147.

*Type.* Holotype, not from Ottawa-St. Lawrence Lowland but from Lowville-Leray beds, Pointe Claire, Montreal Island, in the Redpath Museum, McGill University, Montreal, Quebec.

### *Öpikina tumida* Wilson

Text figure 10, No. 10; Plate VI, figure 16

*Öpikina tumida* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 197, text fig. 10, No. 10, Pl. II, fig. 16.

Small; semicircular; cardinal extremities slightly extended, but cardinal angles blunt, almost a right angle; sides almost straight for half the length, then curving into a broadly rounded anterior margin; greatest width at or near the hinge; convexity greatest just anterior to the middle, steep on all sides, lessening but not flat toward the cardinal extremities; holotype measuring: width length, and thickness, 22 mm., 19 mm., and 7 mm., respectively; specimens from the lower beds are slightly larger and more tumid; striæ fine, occasionally a few finer ones but not regularly alternating; growth lines not preserved; no crenulations; punctæ typical.

Brachial valve not known.

Interiors not known.

The form is almost a homomorph of *Rafinesquina rotunda* Wilson. It is proportionately more convex than any other known *Öpikinae* except *Ö. hemispherica*, but is smaller, the wings are less flattened, and the change from the steep slope to the flattened cardinal extremities is less abrupt. It is larger and more tumid than *Ö. minnesotensis* (Winchell).

*Occurrence.* Lowville beds, locality 143; Lowville-Leray beds, locality 109; Leray-Rockland beds, localities 147, 268; Sherman Fall beds, locality 200.

*Type.* Holotype, G.S.C. No. 8987, Leray-Rockland beds, Mechanicsville, Ottawa, Ontario.

*Öpikina wagneri* (Okulitch) (?)

Plate VIII, figures 14 a, b

*Rafinesquina wagneri* Okulitch, Can. Field Nat., 49, No. 6, 1935, p. 98, Pl. I, fig. 5.*Öpikina wagneri* (Okulitch) Salmon, Jour. Pal., 16, No. 5, p. 596, Pl. LXXXVII, figs. 19-27.

The species is characterized by its quadrate form. The two specimens referred to this species may be a variety of it. The length is greater and the convexity is less than the holotype described, but until more material is available they are left in this species.

*Occurrence.* Leray-Rockland beds, localities 41, 147.

*Type.* Holotype, not from the Ottawa-St. Lawrence Lowland but from Leray beds, St. Vincent de Paul, Quebec, in the Redpath Museum, McGill University, Montreal, Quebec.

*Öpikina wagneri robusta* Wilson

Text figure 10, No. 8; Plate VI, figures 27, 28

*Öpikina wagneri robusta* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 198, text fig. 10, No. 8, Pl. II, figs. 25a, 25b.

Narrowly U-shaped; cardinal extremities extended, slightly auriculate; cardinal angles less than 90 degrees; sides a little oblique; anterior margin rather narrowly rounded; greatest width at the hinge line; convexity greatest anterior to the centre, where it culminates in a sharp curve, posterior and anterior only slightly convex; width, length, and thickness averaging: 30 mm., 22 mm., and 9.5 mm., respectively; striae coarse, with an occasional finer one; fine growth lines not seen, a few coarser ones in the region of greatest curve; no crenulations seen; punctæ typical.

Interior of pedicle valve not seen.

Brachial valve following the curvature of the pedicle valve; ridges and adventitious shell material coarsely developed.

The variety has approximately the same outline and profile as the species, but it is larger and coarser in every respect.

*Occurrence.* Leray-Rockland beds, localities 151, 165, 271, 274; Rockland beds, localities 148, 157.

*Type.* Holotype, G.S.C. No. 8988, Leray-Rockland beds, Huntley tp., Ontario; paratype, No. 8989, Rockland beds, north of Orleans, Ontario.

*Öpikina williamsi* (Okulitch)

Plate VIII, figures 13 a, b

*Rafinesquina williamsi* Okulitch, Can. Field Nat., 49, No. 6, 1935, p. 98, Pl. I, fig. 6.

*Öpikina williamsi* (Okulitch), Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 199.

The very fine irregular pores indicate that this species is an *Öpikina* rather than a *Rafinesquina*. It is rather prolific in the Ottawa-St. Lawrence Lowland, but the specimens add no new feature to the original description.

Salmon<sup>1</sup> considers *Ö. williamsi* (Okulitch) a synonym of *Ö. wagneri* (Okulitch) and illustrates a much smaller specimen. A form occurs in the Ottawa-St. Lawrence area that is closer to Okulitch's description and illustration of *Ö. williamsi*.

The species is very similar to *Ö. inquassa* (Sardeson), but the angle of geniculation is sharper and the convexity is less and situated farther toward the anterior than in the specimen illustrated by Sardeson.

*Occurrence.* Leray-Rockland beds, localities 5, 77, 143, 146, 147, 156, 266, 271, 273.

*Type.* Holotype, not from the Ottawa-St. Lawrence Lowland but from the Leray beds at St. Vincent de Paul, Quebec, in the Redpath Museum, McGill University, Montreal, Quebec.

<sup>1</sup> Salmon, E. S.: Op. cit., p. 596.



Genus, *Öpikinella* WilsonGenotype, *Öpikinella affinis* Wilson

The genus is known only from the interiors of two brachial valves, which show a stout cardinal process with two more or less triangular branches. The outstanding characteristic is the septal system. Three ridges lie between the brachio-phores. The central ridge divides at a short distance from the beak, and the 4 continue for more than half the distance to the anterior margin, the central pair being longer than the lateral pair. As in *Öpikina*, the ridges become sharper and more prominent anteriorly.

*Öpikinella* is similar to *Öpikina* in the presence and disposition of the adventitious shell matter, the pore system, and in having strong vascular markings, but it differs from *Öpikina* in having 4 ridges instead of 5, and in the forming of the central pair by bifurcation.

*Öpikinella affinis* Wilson

## Plate VI, figure 25

*Öpikinella affinis* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 199, Pl. II, fig. 23.

The species is known from the interior of the brachial valve only. U-shaped, very flat; cardinal extremities not extended; non-auriculate; cardinal angles approximately 90 degrees; greatest width at the hinge line; holotype measuring: width and length, 18 mm. and 15 mm., respectively; thickness, convexity, striation, and growth lines not known; punctæ as in *Öpikina*, very fine and irregular, and pustulose in the interior.

Brachial interior typical of the genus, the median ridge dividing 2.5 mm. from the beak. The species is characterized by 3 broad, low inter-elevations between the 4 typical ridges, and by the delicacy of the whole interior.

*Occurrence.* Cobourg beds, locality 91.

*Type.* Holotype, G.S.C. No. 8990, Cobourg beds, south end of LeBreton street, Ottawa, Ontario.

*Öpikinella salmoni* Wilson

## Plate VI, figure 26

*Öpikina salmoni* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 38, 1944, sec. 4, p. 200, Pl. II, fig. 24.

The species is known from the interior of the brachial valve only. U-shaped; cardinal extremities not extended; cardinal angles blunt, approximately a right angle; sides straight near hinge, then curving in to a broadly rounded anterior margin; greatest length slightly anterior to the hinge line; holotype measuring: width and length, 24 mm., and 17 mm., respectively; thickness, convexity, striation, and growth lines not known; punctæ very fine and irregular, pustulose in the interior as in *Öpikina*.

Brachial interior deeply impressed; vascular markings prominent; median ridge dividing at 3.5 mm. from the beak; all ridges close together, strongly defined; inter-elevations almost obliterated, the few traces showing being very fine.

*Ö. salmoni* differs from *Ö. affinis* in its size, in the deeply impressed interior mechanism, and in the closeness of the ridges.

*Occurrence.* Cobourg beds, locality 119.

*Type.* Holotype, G.S.C. No. 8991, Cobourg beds, Steamboat landing, Sussex street, Ottawa, Ontario.

*Rafinesquina-Strophomena* Development

Just as the homomorphs of *Rafinesquina* have been described as *Rafinesquina* species until recently, so a close examination of *Strophomena* within the Ottawa-



St. Lawrence Lowland has revealed a number of homomorphs that have been described as *Strophomena* species. Persistent characteristics distinguish the homomorphs from *Strophomena*, restricted: a difference in the arrangement of the punctæ in the intermediate shell layer, a constant difference in the size of the pedicle muscle scar, and a difference in the form of the brachial scar.

*Rafinesquina*, *Öpikina*, *Öpikinella*, *Strophomena*, *Trigrammaria*, and *Microtrypa* undoubtedly had a common ancestry, but the order of the lines of development is not clear. The reversal of the valves as between *Rafinesquina* and *Strophomena* has long been established. *Öpikina* and *Öpikinella*, like *Rafinesquina*, have a convex pedicle valve and a concave or flat brachial valve. *Trigrammaria* and *Microtrypa*, like *Strophomena*, begin with a convex pedicle valve, which in maturity becomes concave. The *Rafinesquina* group continued along the parent line, but the *Strophomena* group diverged from it in this respect. Therefore, it would seem the *Strophomena* group was the later to appear.

The *Rafinesquina* and *Strophomena* groups developed along related but not parallel lines, particularly in changes in muscle scar, geniculation, and punctæ. The *Rafinesquina* group preserved the pedicle muscle scar, so far as known, but the muscle scar of the brachial valve, and the punctæ of both valves were altered. In the *Strophomena* group the pedicle muscle scar followed two lines, either developing a large flabellate type or a small round type. This group like the *Rafinesquina* group differentiated in the brachial valve. The brachial valve of *Trigrammaria*, so far as seen, has the main median septum of *Strophomena*, but it is longer and there is an additional lateral pair. *Microtrypa*, also, has the main median septum, but it is forked anteriorly and there is the additional pair of laterals. Thus as it stands the *Strophomena* group presents three lines of development, comparable to the three lines of the *Rafinesquina* group—*Rafinesquina*, *Öpikina*, and *Öpikinella*—but with the convexity of the valves reversed.

The punctæ of *Rafinesquina* restricted are coarser and farther apart than those of *Strophomena* restricted, and both are arranged radially between the striæ, but those of *Öpikina* and *Öpikinella* of the *Rafinesquina* group are similar to the punctæ of *Trigrammaria* and *Microtrypa* of the *Strophomena* group—a fine, irregularly arranged network.

The accompanying table shows the relationship of the genera as they exist, without reference as to which is the older form.

TABLE V

*Relationship of Rafinesquina and Strophomena groups*

	Convexo-concave	Anterior margin		Punctæ	Geniculation		Pedicle muscle	Brachial septa
		Rounded	Angular		Present	Absent		
<i>Rafinesquina</i>	a	b	b <sub>1</sub>	c	d	d <sub>1</sub>	e	1
<i>Öpikinella</i>	a	b		c <sub>1</sub>	d	d <sub>1</sub>	e	4
<i>Öpikina</i>	a	b		c <sub>1</sub>	d	?	e? <sub>1</sub>	5
<i>Strophomena</i>	o/a	b	b <sub>1</sub> ?	c <sub>2</sub>		d <sub>1</sub>	o/e	1
<i>Trigrammaria</i>	o/a		b <sub>1</sub>	c <sub>1</sub>	d		o/e <sub>1</sub>	3
<i>Microtrypa</i>	o/a	b		c <sub>1</sub>		d <sub>1</sub>	o/e <sub>1</sub>	4

The muscle scar of the pedicle valve of the *Rafinesquina* group is essentially stable. Was the development of the brachial valve from the complex to the simple, from the five septa of *Öpikina* and the four septa of *Öpikinella* to the strong central septum of *Rafinesquina*? And was the punctæ development from the fine, irregular, unorganized network to the large, regularly arranged, radial arrangement?

In the lower beds of the Ottawa limestone *Öpikina* is much more common than *Rafinesquina*, both in numbers and in species. *Rafinesquina* is much more common in numbers and in species in the upper beds. Reasoning from this evidence, development was from the more complex and disorganized to the more simple.

On the other hand *Strophomena*, with its simple brachial valve scar and its regular, radially arranged punctæ, is more common in the lower beds than *Trigrammaria* and *Microtrypa*. And, as mentioned previously, because the *Strophomena* group in its early stages recapitulates the convex pedicle and concave brachial valves of the *Rafinesquina* group, the ancestor of the *Strophomena* group was probably the later development. In that case the large simple punctæ of *Rafinesquina* have become the small numerous punctæ of *Strophomena*, though the system of arrangement has been maintained, and the fine, irregular network of punctæ of *Trigrammaria* and *Microtrypa* has developed from the small radial punctæ of *Strophomena*.

Reasoning from this evidence, it would appear that the development was from the more simple to the more complex.

There are two possible explanations for the contradictory evidence of these two groups within the Ottawa limestone.

If, as is often the case in contemporary life, development was from the more complex to the simple, then *Rafinesquina* during the time of the Ottawa limestone deposition followed the direct trend. *Strophomena* and its homomorphs were a reversion. Having in earlier time developed from the more complex ancestor to the more ordered form, as seen in *Strophomena*, the line tended to revert to the complex *Trigrammaria* and *Microtrypa* of the upper beds, and the reversion was along the lines of the development of *Rafinesquina*.

If, on the other hand, development was from the more simple to the more complex, then, during the period of its paucity in the lower beds of the Ottawa formation, *Rafinesquina* must have continued its development elsewhere, only a few representatives entering this basin during this time of disposition, although its homomorphs thrived, to be replaced largely by the *Rafinesquina* when they did appear.

Considerable weight to the possibility of development elsewhere is given by the fact that many of the *Rafinesquina* had developed a greater convexity and geniculation when they did appear in great numbers within this basin, during deposition of the upper beds.

Meanwhile the *Strophomena*, having separated earlier from the parent stock, had become prolific in the lower beds and had given rise to its homomorphs.

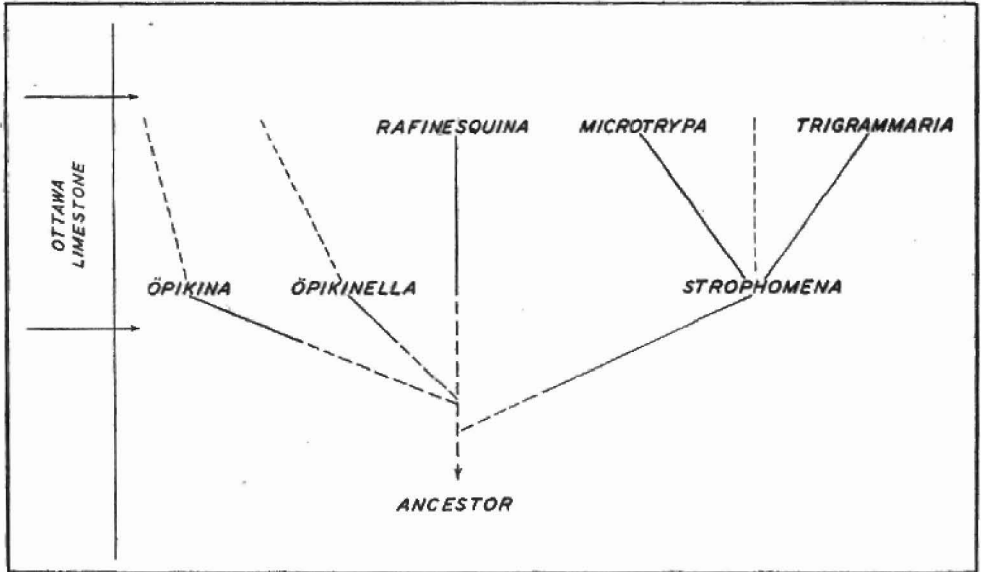


Figure 11. Suggested development of the arrangement of punctæ in the *Rafinesquina* and *Strophomena* groups.

Until the appearance of Salmon's<sup>1</sup> paper in 1942 there was no attempt to separate *Rafinesquina* from its homomorphs. Until the appearance of the paper on *Strophomena* and its homomorphs<sup>2</sup> no attempts had been made to separate *Strophomena* from its homomorphs. The study is not completed. A revision of the Chazy and Richmond *Rafinesquina* and *Strophomena* would be necessary to establish the lines of development conclusively.

<sup>1</sup> Salmon, E. S.: Jour. Pal. 16 No. 5, 1942.

<sup>2</sup> Wilson A. E.: Roy. Soc., Canada, 3rd ser. 39, 1945, sec 4; pp 121-147.

RAFINESQUINA GROUP							
SPECIES	OTTAWA LIMESTONE						
	PAMELIA	LOWVILLE	LEFAY	ROCKLAND	HULL	SHERMAN FALL	COBBOURGE
<b>RADIAL ARRANGEMENT</b>							
<i>RAFINESQUINA ALTERNATA</i> (CONRAD)							
<i>R. ALTERNATA ALATA</i> WILSON							
<i>R. ALTERNATA INTERMEDIA</i> WILSON							
<i>R. ALTERNATA PLANA</i> WILSON							
<i>R. ALTERNATA PLATYS</i> WILSON		?					
<i>R. ALTERNATA QUADRATA</i> WILSON							
<i>R. ALTERNATA POTA</i> WILSON							
<i>R. ALTERNATA SEMIQUADRATA</i> WILSON							
<i>R. ALTERNATA TRANSVERSA</i> WILSON							
<i>R. APICALIS</i> WILSON							
<i>R. CALDERI</i> WILSON							
<i>R. CAMERATA</i> WILSON							
<i>R. CARLOTTINA</i> WILSON							
<i>R. DECLIVIS</i> (JAMES)							
<i>R. CF. DEERENSIS</i> SALMON							
<i>R. DELTOIDEA</i> (CONRAD)					?		
<i>R. EQUIPUNCTATA</i> WILSON							
<i>R. ESMONDENSIS BOREALIS</i> WILSON				?			
<i>R. GIBBOSA</i> WILSON							
<i>R. HULLENSIS</i> WILSON							
<i>R. LAURENTINA</i> WILSON							
<i>R. LENNOXENSIS</i> SALMON							
<i>R. MIDDLELTOIDEA</i> WILSON							
<i>R. NORMALIS</i> WILSON							
<i>R. NORMALOIDES</i> WILSON						?	
<i>R. OKULITCHI</i> WILSON							
<i>R. OPEONGENSIS</i> WILSON							
<i>R. ORLEANENSIS</i> WILSON							
<i>R. OTTAWAENSIS</i> WILSON							
<i>R. PATULA</i> WILSON							
<i>R. PRAECURSOR</i> RAYMOND							
<i>R. PRAEDELTOIDEA</i> WILSON							
<i>R. PRESTONENSIS</i> SALMON							
<i>R. ROBUSTA</i> WILSON							
<i>R. ROTUNDA</i> WILSON							
<i>R. SALMONI</i> WILSON						?	
<i>R. SARDESONI</i> WILSON							
<i>R. SINUATA</i> WILSON							
<i>R. SEMICIRCULARIS</i> WILSON						?	
<i>R. SEMICIRCULARIS MINOR</i> WILSON						?	
<i>R. SUBCAMERATA</i> WILSON						?	
<i>R. SUBTRIGONALIS</i> WILSON							
<b>NETWORK ARRANGEMENT</b>							
<i>OPIXINA AMPLA</i> WILSON							
<i>Ö. AURICULATA</i> WILSON							
<i>Ö. GLOUCESTERENSIS</i> WILSON							
<i>Ö. HEMISPHERICA</i> WILSON							
<i>Ö. INOUASSA</i> (SARDESON)							
<i>Ö. OVALIS</i> WILSON							
<i>Ö. PLATYS</i> WILSON							
<i>Ö. RUGOSA</i> WILSON						?	
<i>Ö. RUGOSA AVITA</i> WILSON							
<i>Ö. SEPTATA BOREALIS</i> WILSON							
<i>Ö. SINCLAIRI</i> WILSON							
<i>Ö. SUBTRIANGULARIS</i> WILSON							
<i>Ö. TRANSITIONALIS</i> (OKULITCH)							
<i>Ö. TUMIDA</i> WILSON							
<i>Ö. WAGNERI</i> (OKULITCH)?							
<i>Ö. WAGNERI ROBUSTA</i> WILSON							
<i>Ö. WILLIAMSII</i> (OKULITCH)							
<i>ÖPIKINELLA AFFINIS</i> WILSON							
<i>Ö. SALMONI</i> WILSON							

Figure 12. Comparative range of forms of *Rafinesquina* group having radial and network arrangement of punctæ.

<i>STROPHOMENA</i> GROUP	
SPECIES	OTTAWA LIMESTONE
	PAMELIA LOWVILLE LERAY ROCKLAND MULL SHERMAN FALL COBOURG
<b>RADIAL ARRANGEMENT</b>	
<i>STROPHOMENA BILLINGSI</i> W. AND S.	-----
<i>S. DELICATULA</i> FENTON	--
<i>S. CF. DIGNATA</i> FENTON	--
<i>S. EXTENSA</i> WILSON	-----
<i>S. FILITEXTA</i> HALL	-----
<i>S. FILITEXTA CRENULATA</i> WILSON	--
<i>S. FILITEXTA OBESA</i> WILSON	-----
<i>S. IRREGULARIS</i> WILSON	-----
<i>S. MAGNA</i> WILSON	-----
<i>S. MILLIONENSIS AFFINIS</i> WILSON	-----
<i>S. MINUTA</i> WILSON	-----
<i>S. MOLLIS</i> WILSON	-----
<i>S. PLANUMBONA PRAECIPITA</i> WILSON	-----
<i>S. ROTUNDA</i> WILSON	-----
<i>S. THALIA</i> BILLINGS	-----
<i>S. VENUSTULA</i> WILSON	-----
<i>STROPHOMENA</i> SP.	-----
<b>NETWORK ARRANGEMENT</b>	
<i>TRIGRAMMARIA PULCHRA</i> WILSON	-----
<i>T. TRIGONALIS</i> WILSON	-----
<i>T. TRIGONALIS PARVA</i> WILSON	-----
<i>T. TRIGONALIS PRIMA</i> WILSON	-----
<i>T. TRIGONALIS TUMIDA</i> WILSON	-----
<i>MICROTRYPA ALTILIS</i> WILSON	-----
<i>M? MODESTA</i> WILSON	-----
<i>M? NASUTA</i> WILSON	-----
<i>M? NITIDA</i> WILSON	-----
<i>M? PLANA</i> WILSON	-----
<i>M? TERSA</i> WILSON	-----

Figure 13. Comparative range of forms of *Strophomena* group having radial and network arrangement of punctæ.

### Range

Figures 12 and 13, like Table II, are made to scale, showing as nearly as possible the relative maximum thickness of the rocks of the various beds as they have been described in the past. It is felt that the constant use of the "formation" names has given an impression that they have a more or less equal value, which is far from the case. The whole, as stated above, is the result of uninterrupted sedimentation. It is known that the thickness of some, probably of all, of these "formations" varies laterally, due to the continuance of local conditions longer in one place than in another.

Genus, *Strophomena* (Rafinesque) de BlainvilleGenotype, *S. rugosa* de Blainville

Transversely subcircular; concavo-convex, the pedicle valve slightly convex at the umbo, becoming concave; brachial valve flat or concave at the umbo, becoming convex; greatest width at the hinge line; cardinal area conspicuous; pedicle area deep with a wide triangular delthyrium partly or completely covered by a deltidial plate; brachial area narrow; striæ radial, fine, equal or alternate in size; some specimens exhibiting wrinkles on the cardinal extremities; punctæ very definite but fine, occurring in radiating rows between the striæ.

Pedicle interior having strong teeth widely divergent, dental plates produced into ridges surrounding a relatively short subcircular or flabellate muscle scar, which is deeply excavated and divided by a median ridge.

Brachial interior with deep sockets; crural plates extended laterally; short, bilobed cardinal process; muscle scar divided by a low median ridge; vascular markings well defined.

The genus most closely resembles *Rafinesquina* in form, but the concavo-convex profile of the valves is reversed, and the punctæ are much smaller and more numerous. It differs from *Opikina* also in the reversal of the profile of the valves, and in the punctæ, which in the latter genus are finer and are not radially arranged but form a network over the whole shell. It differs from *Trigrammaria* and *Microtrypa* in having a larger flabellate pedicle muscle scar, and in the regular radial arrangement of the pore system.

*Strophomena billingsi* Winchell and Schuchert

Plate XI, figures 14 a, b

*Strophomena recta* Billings (non Conrad), Geol. Surv., Canada, Pal. Foss., 1, 1865, p. 130, fig. 108.

*Strophomena billingsi* Winchell and Schuchert, Minnesota, 3, 1893, p. 397, fig. 32.

Semi-elliptical; greatest width at the hinge line; brachial valve only gently convex; Billings' largest specimen measuring 1 inch and  $\frac{3}{4}$  inch in width and length respectively; anterior margins uniformly rounded; cardinal extremities a right angle or less; cardinal area  $\frac{1}{4}$  inch in height; striæ fine, rounded, of different sizes, 4 to 5 finer ones between two coarser; some specimens slightly crenulated; fine concentric striæ.

Brachial valve very depressed for the genus, slightly resupinate at the cardinal extremities, with a barely perceptible mesial depression extending from the beak to mid-length.

Pedicle valve, gently convex in umbonal region, flat or gently concave elsewhere.

Interiors not known.

The species is characterized by its semi-elliptical outline and lack of convexity, particularly in the brachial valve. Both these features distinguish it from *S. filitexta*, the species nearest to it. It differs from *S. venustula* Wilson in being shorter, more transverse, and flatter.

*Occurrence.* Leray-Rockland beds, locality 76; Sherman Fall beds, locality 186.

*Type.* Billings type of *Strophomena recta* is lost, and a neotype should be chosen from Minnesota material.

*Strophomena delicatula* Fenton

Plate XI, figures 19-21

*S. delicatula* Fenton, Amer. Mid. Nat., 11, 1929, p. 155, Pl. IX, figs. 4-6.

Pedicle valves only have been recognized. The species is somewhat quadrate in outline, smaller than the typical *S. filitexta*; the muscle scar is more delicate, less

impressed, but extending one-half the distance from the beak to the anterior margin as compared with approximately one-third the distance in *S. filitexta*.

*Occurrence.* Leray beds, locality 77.

*Strophomena cf. dignata* Fenton

Plate XI, figures 17, 18

*S. dignata* Fenton, Amer. Mid. Nat., 11, 1929, p. 151, Pl. X, figs. 3-5.

Only brachial valves were recognized.

In his description of *S. dignata* Fenton made no mention of the strongly nasute outline shown in his illustration. It constitutes another characteristic in which it differs from *S. musculosa*, with which he compared it. It is because of this feature and the general agreement in size that these brachial valves are compared to *S. dignata* Fenton. The striæ are not well preserved, but they do not show the alternation as described in that species.

*Occurrence.* Leray beds, locality 17.

*Strophomena extensa* Wilson

Plate XI, figures 22, 23

*S. expansa* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 26, 1932, sec. 4, p. 398, Pl. VI, figs. 1 and 2; 39, 1945, sec. 4, p. 131.

Semi-elliptical in outline; greatest width at the hinge line; very large, averaging: width, length, and thickness, 65 mm., 40 mm., and 8 mm., respectively; anterior margin broadly rounded; cardinal extremities extended, acute, but not definitely auriculate; cardinal area not seen; striæ alternating, 1 to 5 finer ones between two coarser; fine concentric growth lines; punctæ typical.

Brachial valve evenly convex; no fold or sinus; interior not known.

Pedicle valve resupinate at the cardinal extremities, slightly concave, flatter than the brachial valve; no sinus; interior showing only a poor outline of the flabellate diductor muscle scar enclosing a pair of long adductor scars.

The form is so much larger than any other described species that it is readily distinguished.

*Occurrence.* Cobourg beds, localities 208, 241, 257, 342.

*Type.* Holotype, G.S.C. No. 6658; paratype, No. 6658a; Cobourg beds, lot 21, con. VIII, Cornwall tp., Ontario

*Strophomena filitexta* Hall

Plate IX, figure 13

*Leptaena filitexta* Hall, Pal. New York, 1, 1847, p. 111, Pl. XXXIB, fig. 3a-c.

*Strophomena filitexta* Hall, Hall and Clarke, Pal. New York, 8, pt. 1, 1892, p. 251, Pl. IXA, fig. 11; C. L. Fenton, Amer. Mid. Nat., 11, 1929, p. 501, Pl. XXXVIII, figs. 1-5.

Shell large, pedicle valve projecting beyond the brachial valve by the height of its cardinal area, making the ratio of length to width greater than in the more transverse brachial valve, the latter appearing still shorter because of its anterior convexity; resupinate; cardinal angles almost auriculate; cardinal area wide, that of the pedicle valve high, with a prominent deltidium; striæ round, alternate, several finer ones between two coarser ones, all crossed by concentric growth lines. Fenton, in re-defining Hall's types states that there is no crenulation present. Nevertheless, there are specimens in the Ottawa-St. Lawrence area that have a few faint crenulations at the hinge line and almost at right angles to it. These when present are easily distinguished from the marked crenulations of *S. filitexta crenulata* Wilson.

Pedicle interior having the muscle scar elevated; diductors striated, lobed, divided by a broad, low septum, upon which lie the linear adductors.

Brachial interior typical of the genus.

The species differs from others in its size, and in being longer in proportion to its width than other large species.

*Occurrence.* Pamelia beds, locality 32; Lowville beds, localities 139, 339; Leray beds, localities 7-9, 12, 36, 38, 41, 71, 74, 77-79, 109, 137, 139, 140, 143, 146, 147, 159, 264, 316, 317, 320, 322, 326, 334, 337, 339; Leray-Rockland beds, localities 20, 315; Rockland beds, localities 136, 156; Hull beds, locality 140; Sherman Fall beds, locality 10; Cobourg beds, locality 232.

*Type.* Plesiotype, G.S.C. No. 7583, Leray-Rockland beds, La petite Chaudière, Val Tetreau, Quebec.

*Strophomena filitexta crenulata* Wilson

Plate IX, figures 14, 15 a, b

*S. musculosa* Fenton, Amer. Mid. Nat., 11, 1929, Pl. VIII, figs. 6 and 7 (non 1-5).

*S. plattinensis* Fenton, *ibid.*, Pl. X, fig. 9 (non 7 and 8).

*S. filitexta crenulata* Wilson, Roy. Soc., Canada, 3rd ser. 39, 1945, sec. 4, p. 132, Pl. I, figs. 16-18.

Semicircular in outline; the largest specimen seen, a pedicle valve, measuring: width 44 mm., length 28 mm., holotype somewhat smaller; striae rather coarser than usual, not always alternating in size. The outstanding feature is the crenulation composed of three or four large low-angled folds at the cardinal extremities of the brachial valve, and four or five complementary folds on the pedicle valve. Those of the brachial valve arise in the posterior third of the shell about one-third of the total width apart on either side of the median line; in the initial stages these are directed almost at right angles to it, then gently curve upward and outward to end, one anterior to the cardinal angle, one approximately at the angle, and one near it on the hinge line. The fourth smaller fold of the pedicle valve ends on the hinge close to the preceding one.

*S. filitexta crenulata* differs from the species in being more transverse, and in having the crenulations long, curving, pronounced, and regular, and in their low angle to the hinge line.

*Occurrence.* Leray beds, localities 20, 41, 109, 147.

*Type.* Holotype, G.S.C. No. 7573, Leray beds, lot 3, con. III, Gloucester tp., Ontario; paratype, No. 7574, Leray beds, La petite Chaudière, Val Tetreau, Quebec.

*Strophomena filitexta obesa* Wilson

Plate IX, figures 17 a, b, 18

*Strophomena filitexta obesa* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 39, 1945, sec. 4, p. 133, Pl. I, figs. 20, 21.

Large, holotype measuring: width, length, and thickness, 40 mm., 31 mm., and 13 mm., respectively; outline having a tendency to be subtriangular; convexity great; line of profile in a mature specimen rising almost perpendicularly from the hinge, making a narrow curve, not a geniculation, and becoming gently convex in the anterior part. The pedicle valve is more concave than that of the species, but the difference in degree is far less than that between the convexity of the brachial valve of the variety and that of the species. Striae as in the species.

Exfoliated brachial valves show a narrow but definite depression in the position of the wide median ridge.

The variety is not a result of old age as shown by the fact that smaller specimens have the gibbous umbonal region, and many of the large specimens of the species proper have the low umbonal region.

Compared with the species the variety is more obese, and on this account the wings are smaller, flatter, and less resupinate.



*Occurrence.* Leray beds, localities 7, 15, 83, 109, 139, 143, 152, 154, 313, 319; Rockland beds, locality 157; Sherman Fall beds, locality 13; Cobourg beds, locality 95.

*Type.* Holotype, G.S.C. No. 7651, Leray beds, Paquette Rapids, Ottawa River, Ontario; paratype, No. 7570, Leray beds, southeast of Cumberland, Ontario.

*Strophomena irregularis* Wilson

Plate XI, figures 15, 16

*S. irregularis* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 26, 1932, sec. 4, p. 398, Pl. V, figs. 11, 12.

The most striking characteristics of the species are the sharpness of the striae, and the fragility of the margin shown by the fact that all specimens found have had their edges broken away.

*Occurrence.* Cobourg beds, localities 185, 191, 208, 223, 233, 241, 257, 259, 280, 305, 341.

*Type.* Holotype, G.S.C. No. 6656; paratype, No. 6657; from Cobourg beds at lot 21, con. VIII, Cornwall tp., and lot 22, con. III, Roxborough tp., Ontario.

*Strophomena magna* Wilson

Plate IX, figures 11, 12

*Strophomena magna* Wilson, Roy. Soc., Canada, 3rd ser. 39, 1945, sec. 4, p. 134, Pl. I, figs. 13, 14.

Semicircular in outline; greatest width at the hinge; large; holotype measuring: width, length, and thickness, 44 mm., 32 mm., and 9.5 mm., respectively; cardinal extremities extended, slightly auriculate; cardinal area at right angles to the plane of the shell, 2.5 mm. in height; striae alternating, 3 to 6 finer ones between two coarser; fine growth lines, some specimens having a few larger lines near the anterior and lateral margins; punctae characteristic of the genus.

Brachial valve having its greatest convexity at the middle or anterior to it, then rounding off steeply to the anterior; no fold; interior not seen.

Pedicle valve very concave, following the convexity of the brachial valve; no sinus. Two pedicle interiors associated with brachial valves are assumed to belong to the species, muscle scar long, compared to its width, and coarsely striated.

The species is more pronounced than others in every feature. Compared with *S. filitexta* the plane of the cardinal area is more erect and the muscle of the pedicle valve is more elongate. Compared with *S. filitexta obesa* the position of the greatest convexity and concavity is farther forward, and the cardinal extremities are more auriculate. Compared with *S. thalia* the anterior is more broadly rounded, the wings more auriculate, the concavity of the pedicle valve greater and farther forward, and the cardinal area is flatter and higher.

*Occurrence.* Rockland beds, localities 156, 329.

*Type.* Holotype, G.S.C. No. 7579, Rockland beds, Stewart quarry, Rockland, Ontario; paratype, in private collection of G. W. Sinclair.

*Strophomena ? millionensis affinis* Wilson

Plate IX, figure 5

*Strophomena ? millionensis affinis* Wilson, Roy. Soc., Canada, 3rd ser. 39, 1945, sec. 4, p. 135, Pl. I, fig. 5.

Elliptical in outline; small, thin, with greatest width at the hinge line, measurements averaging: width, length, and thickness, 20 mm., 13 mm., and 3 mm., respectively; anterior margin slightly sinuate because of a small fold and sinus beginning about two-thirds the length from the beak; cardinal extremities almost a right

angle, and slightly resupinate; cardinal area low, making a right angle with the plane of the shell; striæ very fine, irregularly alternating, 3 to 5 between two coarser; growth lines very fine; punctæ not seen.

Brachial valve very gently and evenly convex, with a small low fold on the anterior third; interior not known.

Pedicle valve with a gentle concavity following the curve of the convexity of the brachial valve; a shallow sinus on the anterior third; interior not seen.

Neither pedicle muscle scar nor punctæ have been observed, therefore, the genus *Strophomena* is queried.

The size of the shell is similar to that of *S. millionensis* Foerste, which also has a short, shallow fold and sinus, but this form differs in being very finely striate. It also occurs at a considerably lower horizon.

*Occurrence.* Leray-Rockland beds, locality 16.

*Type.* Holotype, G.S.C. No. 7586, Leray-Rockland beds, from an unspecified locality on the Cobden-Eganville road, Ontario.

### *Strophomena minuta* Wilson

Plate IX, figures 1-3

*Strophomena minuta* Wilson, Roy. Soc., Canada, 3rd ser. 39, 1945, sec. 4, p. 135, Pl. I, figs. 1-3,

Semicircular in outline; greatest width at hinge line; rather thin for the genus; width, length, and thickness averaging: 15 mm., 11 mm., and 3 mm., respectively; anterior margin broadly rounded; cardinal extremities a little less than a right angle; cardinal area not high, delthyrium very wide at the base on the hinge line; striæ exceedingly fine, 12 to 14 in 2 mm., at the anterior margin, two sizes, 5 to 8 finer ones between two coarser; fine growth lines, in some specimens forming piled up, heavier growth lines near the margins; punctæ very fine.

Brachial valve having a gentle convexity, greatest about mid-length, evenly rounded towards the margins; interior not known.

Pedicle valve with its concavity more shallow than the corresponding convexity of the brachial valve; interior not known.

In size the species is close to *S. millionensis* Foerste or *S. scofieldi* W. and S., but it differs from both in lacking the fold and sinus near the median anterior margin, and in the alternation of the striæ. It differs also from *S. millionensis* in being less transverse, and in the fineness of the striæ. It differs from *S. scofieldi* in lacking the reflex of the cardinal extremities.

*Occurrence.* Pamela beds, localities 30, 324, 331, 335, 336; Leray beds, localities 15, 19, 29, 38, 41, 76, 147, 318, 321; Rockland beds, locality 157.

*Type.* Holotype, G.S.C. No. 7616, Leray beds, Stewart quarry, Rockland, Ontario; paratypes, No. 7617, Leray beds, La petite Chaudière, Val Tetreau, Quebec, and No. 7618, Rockland beds, upper 10 feet of Stewart quarry, Rockland, Ontario.

### *Strophomena mollis* Wilson

Plate IX, figure 4

*Strophomena mollis* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 39, 1945, sec. 4, p. 136 Pl. I, fig. 4.

Semi-elliptical or subtriangular in outline; greatest width at the hinge line; measurements averaging: width, length, and thickness, 24 mm., 16 mm., and 5 mm., respectively; anterior margin rounded or subangular; cardinal extremities extended but not auriculate; cardinal area not seen; striæ sharply distinct, 1 to 3 finer ones between two coarser; only fine growth lines seen; punctæ normal but very numerous.

Brachial valve having its greatest convexity concentrated at the middle or anterior to it; no fold; interior not known.

Compared with *S. venustula* n.sp., the form is smaller, more elliptical, and has a more extended hinge line and a more centralized convexity. In outline it is very similar to *Microtrypa ? plana*, but is readily distinguished from that species by its pore system, and it is larger.

*Occurrence.* Lera y beds, locality 147.

*Type.* Holotype, G.S.C. No. 7588, Lera y beds, lots 3-5, con. III, R. F., Gloucester tp., Ontario.

*Strophomena planumbona praecipita* Wilson

Plate IX, figures 9 a, b

*Strophomena planumbona praecipita* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 39, 1945, sec. 4, p. 136, Pl. I, figs. 9, 10.

Semicircular or subquadrate in outline; moderate size; holotype measuring: width 29 mm., length 21 mm.; another specimen slightly larger; greatest width at the hinge line; cardinal angles acute, in some specimens slightly extended; anterior margin almost parallel to hinge; greatest concavity of pedicle valve about three-fifths length from the beak; striae uneven but not alternating; fine corrugations on the side of the teeth flush with the pedicle cardinal area and on the face of the area just along the outer edge of the deltidium.

Brachial valve not recognized.

Pedicle muscle scar stout, extending almost half length, deeply excavated; median ridge prominent, extending slightly beyond the border of the muscle scar, bearing linear adductor scars on either side; ovarian markings prominent.

The variety is almost the same as the species, but none of the descriptions of the species refers to the presence of the fine corrugations on the teeth and on the cardinal area margining the deltidium, and the species seems to lack these finer striations.

*Occurrence.* Lera y beds, localities 20, 109.

*Type.* Holotype, G.S.C. No. 1156a, Lera y beds, above Mechanicsville, Ottawa, Ontario.

*Strophomena rotunda* Wilson

Plate IX, figure 8

*Strophomena rotunda* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 39, 1945, sec. 4, p. 137, Pl. I, fig. 8.

Semicircular in outline; greatest width at the hinge line; width, length, and thickness, averaging: 28 mm., 25 mm., and 8 mm., respectively; anterior margin almost semicircular; cardinal extremities slightly extended; cardinal area not seen; striae alternating, 2 to 4 smaller ones between two coarser; fine growth lines, the coarse growth lines common to many species near the margins are lacking in this; punctae typical.

Brachial valve very convex; without fold or sinus; interior not known except for the septal depression in exfoliated specimens.

Pedicle valve only known from one poor specimen, which shows the exterior concavity to be considerably less than the corresponding convexity of the brachial valve; interior not known.

The specimen is unlike any other described because of its compact, rotund profile.

*Occurrence.* Lera y-Rockland beds, localities 29, 73, 74, 147, 316, 322.

*Type.* Holotype, G. S.C. No. 7589, Lera y-Rockland beds, on hillock on road east from Skead road, east of Ottawa.

*Strophomena thalia* Billings

Plate IX, figures 10 a, b

*Strophomena thalia* Billings, Geol. Surv., Canada, Pal. Foss. 1, p. 125, fig. 103.

Subtriangular; greatest width at hinge line; holotype measuring: width, length, and thickness, 40 mm., 29 mm., and 8 mm., respectively; pedicle valve most strongly concave at two-thirds length; brachial valve most convex about half length, and greatest convexity along the median region of the holotype and largest specimen; other, smaller specimens proportionately less convex; cardinal wings resupinate; cardinal area very low in both valves considering the size of the shell; the plane between the edges of the cardinal area at right angles to the length of the shell, not projecting at an angle as in *S. filitexta*; striæ rather coarse, one or at most two finer ones irregularly between two coarser.

Interiors not seen.

*S. thalia* differs from *S. filitexta* Hall in its subtriangular outline, in the concentration of the convexity in the median region, in the angle of the cardinal areas to the plane of the shell, and in having fewer fine striæ, which are irregularly arranged.

*Occurrence.* Leray beds, localities 20, 147; Cobourg ? beds, locality 133.

*Type.* Holotype, G.S.C. No. 1607b; paratypes, Nos. 1607, 1607a, and 1607c; Cobourg ? beds from an unspecified locality at Ottawa, Ontario.

*Strophomena venustula* Wilson

Plate IX, figures 6, 7

*Strophomena venustula* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 39, 1945, sec. 4, p. 138, Pl. I, figs. 6, 7.

Semicircular in outline; greatest width at hinge line or slightly anterior to it; width and length averaging: 25 mm. and 18 mm., respectively; cardinal angles blunt; cardinal area not seen; anterior margin broadly rounded; striæ very fine, alternating, several fine between two coarser; concentric wrinkles more pronounced near the anterior and side margins.

Brachial valve moderately convex, averaging 3.5 mm.; convexity greatest just posterior to the central region, and gradually decreasing on all sides; cardinal angles narrowly flattening out, in some specimens becoming slightly resupinate at the cardinal angle.

Brachial interior not seen except that some partly exfoliated specimens show a shallow median depression in the position of the median septum.

A considerable number of pedicle valves are associated with some of the brachial valves. They appear to belong to this species. They average slightly longer than the brachial valves, but that is common in the genus, the degree of difference depending upon the angle and height of the cardinal area, which has not been seen in this species. In outline, width, and radial and concentric striation they correspond.

The form is very close to *S. inconsueta* Fenton and may be a local variety of that species, but it averages larger and is more transverse. Compared with *S. trentonensis* W. and S. it is less transverse and of more than sixty specimens none shows wrinkles common to that species. It is longer, less wide, and more convex than *S. billingsi*.

*Occurrence.* Pamela beds, localities 325, 331; Lowville beds, locality 324; Leray beds, localities 40, 73, 77, 139, 147, 337, 339; Leray-Rockland beds, localities 109, 314; Rockland beds, localities 29, 211, 323.

*Types.* Holotype, G.S.C. No. 7591, Leray-Rockland beds, lot 24, con. VII, Allumette, Quebec; paratype, No. 7599, Leray-Rockland beds, Mechanicsville, Ottawa, Ontario.

*Strophomena* sp.

## Plate IX, figure 16

*Strophomena* sp. Wilson, Roy. Soc., Canada, Trans., 3rd ser. 39, 1945, sec. 4, p. 139, Pl. I, fig. 19.

Only brachial valves are known.

Subtriangular or semicircular in outline; greatest width at the hinge line; largest and smallest specimen measuring: width, length, and thickness, 41 mm., 22 mm., 27 mm., and 17 mm., 7 mm., and 5 mm., respectively; anterior margin irregularly prolonged; cardinal extremities less than a right angle, slightly resupinate, in some cases having wrinkles; striae irregularly alternating; growth lines fine, occasionally larger coarser ones; punctae normal. The outstanding characteristic is the nature of the anterior margin, which is pinched up into one or more narrow sharp folds, giving some specimens a somewhat frilled edge. When only one fold is present it is near the central region. One specimen has as many as five small folds.

Brachial valve having its greatest convexity about the centre, disregarding the prolongation of the fold, sloping down rather abruptly to all edges and flattening out at the wings; interior not known.

Pedicle valve not known.

This form is so variable in size and number of sharp folds that the specimens may not all belong to one species. For that reason it is not named here, though it is felt that the sharp folds are worthy of notice.

*Occurrence.* Leray beds, locality 41; Rockland beds, locality 211.

*Type.* Holotype, G.S.C. No. 7612, Leray beds, La petite Chaudière, Val Tetreau, Quebec.

Genus, *Trigrammaria* WilsonGenotype, *T. trigonalis* Wilson

The species and its varieties, like *Strophomena*, have a resupinate pedicle valve, concave anteriorly, and a convex brachial valve. They are triangular in outline; the brachial valve being more or less sharply geniculate with a broad anterior fold prolonged beyond the general contour, and a corresponding sinus in the pedicle valve; a small pedicle muscle scar and three septa in the brachial valve; the median septum is prolonged and two lateral ones added, both curving inward towards the median septum; punctae forming a fine irregular network.

The genotype of *Strophomena*, *S. rugosa* de Blainville, cannot now be examined. The first *Strophomena* described and illustrated from North America was *Producta incurvata* Shepard, 1838, now recognized as *S. filitexta* Hall. This species illustrates the typical form, the deeply sculptured pedicle muscle scar and a single strong median septum, and the radial arrangement of the punctae, and it is here regarded as typical of the genus *Strophomena*.

Several score of *S. filitexta* were examined, none of them complete, but all showed one stout median septum or its impression. *Trigrammaria* differs, then, from *Strophomena* in having three septa in the brachial valve, in its small pedicle muscle scar, and in the irregular network arrangement of the punctae. It differs from the following genus *Microtrypa* in being triangular in outline and in being convex and more or less geniculate. In addition, the median septum of *Microtrypa* divides anteriorly making 4 septa in all.

The name is derived from tria (three) and gramme (a line) and refers to the three fine septa.

*Trigrammaria pulchra* Wilson

## Plate X, figures 1, 2

*Trigrammaria pulchra* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 39, 1945, sec. 4, p. 140, Pl. II, figs. 1, 2.

Subtriangular in outline; greatest width at the hinge line; holotype measuring: width, length, and thickness, 20 mm., 19 mm., and 6 mm., respectively; anterior

margin sharply rounded; cardinal extremities acute; cardinal area not seen; striae apparently coarse; almost all specimens are exfoliated, and the finer striae, if any, are removed; growth lines fine; punctae typical.

Brachial valve with its greatest convexity about mid-length, narrowly rounded, but not a true geniculation; anterior central region having a low indefinite fold; interior showing the characteristic three septa.

A number of pedicle valves have been assigned to this species because of their outline. They are less concave than the brachial valves are convex, and, consequently, the anterior narrowing of a sinus is less marked than the fold of the brachial valve; no interiors seen.

*T. pulchra* differs from *T. trigonalis* in size, in having the fold and consequent anterior prolongation less marked, in having the angle of geniculation greater than 90 degrees, and, therefore, the convexity is more rounded. It differs from *T. trigonalis parva* in its less acute geniculation and less prolonged fold. It approaches *Microtrypa modesta* in outline and convexity, but is smaller; the greatest convexity is more anterior, and the central anterior part is more narrowly rounded.

*Occurrence.* Cobourg beds, localities 89, 162, 168, 194, 235, 238, 257, 294, 344.

*Type.* Holotype, G.S.C. No. 7652, Cobourg beds, about 2 miles west of McAlpine, Ontario; paratype, No. 7653, Cobourg beds, east of boundary of Cornwall tp., con. IX, Charlottenburgh tp., Ontario.

### *Trigrammaria trigonalis* Wilson

Plate X, figures 7-9

*Trigrammaria trigonalis* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 39, 1945, sec. 4, p.141, Pl. II, figs. 7-9.

Triangular in outline; greatest width at the hinge line, measurements averaging: width, length, and thickness, 28 mm., 24 mm., and 9 mm., respectively; a more or less sharply rounded geniculation at about 12 mm. from the beak along the median line, the posterior part being subtriangular, flat, and when exfoliated having a small pronounced concavity at the beak; the anterior part sloping down at an angle of 110 to 120 degrees; anterior margins pinched into a fold and prolonged beyond the regular outline; cardinal extremities extended, slightly auriculate; cardinal area not seen; striae coarse, one specimen showing a few finer ones between the coarser; growth lines fine, with coarser ones near the margins; a few short crenulations along the hinge line present in some specimens; punctae typical of the group.

Brachial valve very convex, greatest convexity in the median line in the region of geniculation; fold in the anterior part quite characteristic; a few exfoliated specimens show part of the interior; comparatively deep dental sockets; diverging brachiophores; 3 very fine septa apparently arising close together near the beak, and ending in the region of geniculation, the two lateral ones being slightly concave towards the median one.

Pedicle valve not as deeply concave as the brachial is convex; an anterior sinus corresponding to the brachial fold; one poorly preserved interior shows a part of the pedicle muscle scar.

The species differs from others in its size, its triangular outline, its anterior fold and sinus, and its pronounced geniculation.

The outline and profile suggest *Strophomena fluctuosa*. Unfortunately the type of that species is missing. Other specimens examined show by the punctae that the *Strophomena fluctuosa* is a true *Strophomena*, so that *Trigrammaria trigonalis* is readily distinguished from it. It also differs in being smaller, in having a less crenulated posterior part, a less prolonged anterior part, and a more distinct fold and sinus.



*Occurrence.* Cobourg beds, localities 85, 86, 116, 134, 168, 249, 257, 259, 280, 333, 340.

*Type.* Holotype, G. S.C. No. 7614, Cobourg beds, west end of Fifth avenue, Ottawa, Ontario; paratypes, Nos. 7614a, 7614b, and 7637, Cobourg beds, corner Fifth avenue and Percy street, Ottawa, Ontario.

*Trigrammaria trigonalis parva* Wilson

Plate X, figures 3, 4

*Trigrammaria trigonalis parva* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 39, 1945, sec. 4, p. 142, Pl. II, figs. 3, 4.

The variety is almost a small replica of the species; averaging: width, length, and thickness, 24 mm., 18 mm., and 9 mm., respectively; angle of geniculation equal to or less than a right angle, like that of *T. trigonalis tumida*; fold on the anterior part like the species but more variable, continuing to grow in gerontic specimens and, in many cases, curving inward.

Brachial valve showing the three septa, with the two lateral ones close to the median one and curving towards it. The illustrated paratype shows a faint indication of the right hand septum of a second lateral pair, not seen on any other brachial valve. It is possible that this individual specimen has a tendency, not established, to follow the line of variation of *Öpikina*, a homomorph of *Rafinesquina*, which has five septa so arranged.

Pedicle valve showing the typical small muscle scar. The scar of the specimen illustrated is slightly obliterated anteriorly.

*T. trigonalis parva* differs from the species in being smaller, proportionately thicker, and in the tendency to inroll.

*Occurrence.* Cobourg beds, localities 69, 85, 86, 134, 162, 189, 208, 243, 244, 258, 294, 300, 305.

*Type.* Holotype, G.S.C. No. 7656; paratype, No. 7657. Both from Cobourg beds, Lalonde quarry, west of Alfred, and from Casselman, Ontario.

*Trigrammaria trigonalis prima* Wilson

Plate X, figure 20

*Trigrammaria trigonalis prima* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 39, 1945, sec. 5, p. 143, Pl. II, fig. 21.

Subtriangular in outline; greatest width anterior to the hinge; holotype, a brachial valve, measuring: width, length, and thickness, 33 mm., 25 mm., and 7 mm., respectively; geniculate at about 10 mm. from the beak along the median line, sloping down towards the cardinal margin so that the posterior part forms an almost flat triangular space of approximately the same proportions as the outline of the whole specimen, and its plane stands at an angle of about 20 degrees to the plane of shell. The anterior part is gently convex, prolonged in the median region, with an indistinct fluting-like irregularity on the surface; cardinal extremities blunt, cardinal area not seen; striæ alternating, 5 or 6 finer ones between two coarser; in exfoliated specimens the finer ones are not always preserved, so that the coarser striæ have rather broad, irregular spaces between them.

Brachial valve the only one known.

The variety is larger than any of the others. It differs from the species in being larger, in having its greatest width anterior to the hinge line, and in having a proportionately smaller area posterior to the geniculation.

*Occurrence.* Leray beds, locality 41.

*Type.* Holotype, G.S.C. No. 7658, Leray beds, La petite Chaudière, west of Hull, Quebec.

*Trigrammaria trigonalis tumida* Wilson

Plate X, figure 15

*Trigrammaria trigonalis tumida* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 39, 1945, sec. 4, p. 143, Pl. II, fig. 15.

The variety is essentially the same as the species. It differs in rising more abruptly from the hinge line; in having the outline of geniculation rounded rather than triangular; in the smaller angle of geniculation, often attaining 90 degrees or less; in lacking the fold on the anterior part or having a suggestion of it; and, in consequence, in having a more rounded anterior margin.

*Occurrence.* Cobourg beds, localities 85, 162, 177, 188, 191, 208, 243, 245, 281, 300.

*Type.* Holotype, G.S.C. No. 7659, Cobourg beds, Industrial school, Alfred, Ontario.

*Microtrypa* gen. nov.Genotype, *Microtrypa altilis* Wilson

*Microtrypa* is semicircular or subtriangular in outline; has a low evenly convex brachial and a resupinate pedicle valve, concave on the anterior part; a small round pedicle muscle scar and four septa in the brachial valve. The median septum is forked anteriorly and two laterals added, which do not curve as in *Trigrammaria*. The two limbs of the bifurcated median septum are subparallel, the two lateral septa are divergent. Thus the brachial interior arrives at the same septal system as *Öpikinella* of the *Rafinesquina* group, though the convexity of the valve is reversed. The punctæ of the intermediate shell layer form a fine, unorganized network.

Only one well preserved brachial valve has been found, and only that species can be assigned with absolute certainty to *Microtrypa* rather than to the preceding genus *Trigrammaria*. Other species are here assigned to *Microtrypa* because of their low even convexity, their general lack of prolongation of a fold, and because the musculature of the brachial valve is covered whereas the three septa of the brachial valve of *Trigrammaria* are evident on almost all specimens seen.

The species of this group, like those of *Trigrammaria* have, heretofore, been identified as *Strophomena* and both might be regarded as a subgenus of it.

*Microtrypa*, like *Strophomena*, has a convex brachial valve and a resupinate pedicle valve. It differs, however, in having a small round pedicle muscle scar instead of a large flabellate one; in having a fine, unorganized network of punctæ; and in having 4 septa instead of 1 in the brachial valve.

*Microtrypa* differs from *Trigrammaria* in its low, even convexity, its general lack of a fold in the brachial valve, and in having 4 subparallel septa in the brachial valve instead of 3.

*Microtrypa altilis* Wilson

Plate X, figures 10-12

*Microtrypa altilis* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 39, 1945, sec. 4, p. 144, Pl. II, figs. 10-12.

Semi-oval in outline, greatest width at the hinge; width, length, and thickness averaging: 23 mm., 17 mm., and 3.5 mm., respectively; anterior margin broadly rounded; cardinal extremities at approximately a right angle; cardinal area not seen; striæ irregularly alternating in size; concentric striæ fine, a few coarser ones near the margin.

Brachial valve very gently convex, curving gradually towards the anterior region, flattening or even reflexed towards the cardinal extremities; brachial interior having deep sockets, cardinal process double, stout, projecting a little beyond the hinge plate, with corrugated muscle scars on the inner sides of the shafts.



Pedicle valve with its concavity very slight; no sinus; delthyrium very broad; two poor interiors show diverging dental plates and a small flabellate muscle scar that extends less than one-third the length of the shell.

Compared with *M. nasuta* it is more transverse and lacks the anterior fold. Compared with *M. trigonalis prima* it is much less convex and lacks any geniculation. It might have developed into *M. nitida*, which is much larger.

*Occurrence.* Lowville-Leray beds, locality 156; Leray beds, locality 20; Rockland beds, localities 148, 211.

*Type.* Holotype, G.S.C. No. 7649; paratypes, Nos. 5649a and 7650. All from Leray beds, Stewart quarry, Rockland, Ontario.

*Microtrypa ? modesta* Wilson

Plate X, figures 16 a, b, 17

*Microtrypa ? modesta* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 39, 1945, sec. 4, p. 145, Pl. II, figs. 16-18.

Subtriangular in outline; greatest width at the hinge line; measurements of the holotype and paratype: width, length, and thickness, 24 mm., 18 mm., and 5 mm., respectively; anterior margin angular but not produced; cardinal extremities acute, slightly reflexed; cardinal area low, at right angles to the plane of the shell; striae fine, of two sizes, 2 to 4 between two coarser; growth lines very fine.

Brachial valve having its greatest convexity posterior to the centre, rising somewhat abruptly from the hinge area; no geniculation and no fold; interior not seen.

Pedicle valve following the curve of the brachial valve; muscle scars not seen.

*M. ? modesta* Wilson is characterized by its subtriangular outline, its shortness in proportion to its length, and the abruptness of its convexity. It differs from *M. ? nasuta* Wilson in being larger, in lacking the fold, and in its finer striations. It is larger than *M. ? nasuta*, but less robust, and it lacks the pronounced prolongation of the anterior of that species.

*Occurrence.* Cobourg beds, localities 69, 224, 249, 294, 300, 343, 345.

*Type.* Holotype, G.S.C. No. 7643, Cobourg beds, dam west of Alexandria, Ontario; paratype, Cobourg beds, about 2 miles west of McAlpine, Ontario, in the private collection of G. W. Sinclair.

*Microtrypa ? nasuta* Wilson

Plate X, figures 13, 14

*Microtrypa ? nasuta* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 39, 1945, sec. 4, p. 146, Pl. II, figs. 13, 14.

Triangular in outline; greatest width at the hinge line; width, length, and thickness approximately 23 mm., 19 mm., and 3.5 mm., respectively; anterior margin slightly nasute; cardinal extremities acute; cardinal area not seen; striae irregularly alternating, 1 to 4 finer ones between two coarser; fine growth lines, in some cases coarser ones nearer the margins; a fine network of punctae.

Brachial valve gently convex, with the convexity maintained to the margin forming a fold in the anterior half; sides sloping fairly steeply near the fold but more gradually to the wings and hinge line; interior not known.

Pedicle valve less concave than the brachial valve is convex, and having a sinus less pronounced than the fold of the brachial valve; interior not known.

The outline is suggestive of *Strophomena nutans*, but the convexity is more evenly distributed along the median ridge and the form lacks the geniculations of that species. It also resembles *S. millionensis* in outline, but the anterior fold and sinus are more pronounced and more prolonged. The network of punctae show that it is not a true *Strophomena*.

*Occurrence.* Leray-Rockland beds, locality 29; Rockland beds, locality 211.

*Type.* Holotype, G.S.C. No. 7641; paratype, No. 7641a. Both from Rockland beds, Ange gardien road, 4 miles west of L'Orignal, Ontario.

*Microtrypa ? nitida* Wilson

Plate X, figures 21, 22

*Microtrypa ? nitida* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 39, 1945, sec. 4, p. 146, Pl. II, figs. 22, 23.

Bluntly subtriangular in outline; greatest width at the hinge line; measurements of the holotype, a pedicle valve: 38 mm., 24 mm., and 4 mm.; anterior margin narrowly rounded; cardinal extremities extended, acute but not auriculate; cardinal area not seen; striæ irregularly alternating, 1 to 3 finer ones between two coarser; small crenulations along the hinge line near the beak in some specimens; fine growth lines; punctæ typical.

Brachial valve slightly and evenly convex; greatest convexity just posterior to the middle; interior not known.

Pedicle valve with concavity following the convexity of the brachial valve; muscle scars not preserved.

*Microtrypa ? nitida* is very similar to *Strophomena filitexta* in size and outline, though it is less convex, but can be distinguished from it by its characteristic punctæ. It is considerably larger than any other species of *Microtrypa* yet found.

*Occurrence.* Cobourg beds, localities 95, 116, 283, 292.

*Type.* Holotype, G.S.C. No. 7644; paratype, No. 7645. Both from Cobourg beds, top of hill, lot 8, between cons. VI and VII, Cumberland tp., and La Salle Academy, Ottawa, Ontario.

*Microtrypa ? plana* Wilson

Plate X, figures 5, 6

*Microtrypa ? plana* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 39, 1945, sec. 4, p. 147, Pl. II, figs. 5, 6.

Semi-oval in outline; greatest width at the hinge line; measurements averaging: width, length, and thickness, 20 mm., 14 mm., and 5 mm., respectively; anterior margin broadly rounded; cardinal extremities a little less than a right angle, slightly reflexed; cardinal area not high, not so oblique as in *Strophomena filitexta*; striæ alternating, 1 to 3 finer between two coarser, all comparatively coarse for the size of the specimen; growth lines very fine, occasional larger ones; punctæ typical.

Brachial valve only slightly and evenly convex; no fold or anterior prolongation; only poor interiors preserved showing widely divergent brachiophores.

Pedicle valve slightly concave, following the form of the brachial valve; interiors showing the small muscle scar.

The species is characterized by its delicateness, its rounded anterior, and its comparative flatness.

*M. ? plana* differs from *Trigrammaria trigonalis* and its varieties in having a rounded, not a protruding, anterior margin. It is smaller and more delicate than any other described species.

*Occurrence.* Sherman Fall beds, localities 200, 259; Cobourg beds, localities 91, 95, 110, 121, 223, 232, 238, 258, 300.

*Type.* Holotype, G.S.C. No. 7646; paratype, No. 7646a. Both from Cobourg beds, at the foot of Sussex street, Ottawa, Ontario.

*Microtrypa ? tersa* Wilson

Plate X, figures 18, 19

*Microtrypa ? tersa* Wilson, Roy. Soc., Canada, Trans., 3rd ser. 39, 1945, sec. 4 p. 147, Pl. II, figs. 19, 20.

Semicircular in outline; greatest width at the hinge line; measurements averaging: width, length, and thickness, 30 mm., 23 mm., and 3.5 mm., respectively; anterior margin rounded; cardinal extremities not very acute; cardinal area high, at about the same angle as in *Strophomena filitexta*; striae fine, alternating, 2 to 4 finer ones between two coarser; fine concentric growth lines with coarser ones near the margins; a tendency towards crenulations in the cardinal region, not always evident.

Brachial valve gently convex; convexity more confined to the centre than in some species, leaving the wings comparatively flat, resulting in a more narrowly rounded anterior margin.

Pedicle valve slightly concave, muscle scar small, extending about one-third the length of the shell and having the surrounding thickened tissue projected anteriorly a short distance so that it makes a sigmoid curve.

The form is characterized by its length in proportion to its width, and the position and moderateness of its convexity. It is intermediate between *M. ? plana* and *M. ? nitida*. It differs from *M. ? plana* in being larger and in having a more narrowly rounded anterior margin. It differs from *M. ? nitida* in being smaller and in having less acute cardinal angles.

*Occurrence.* Sherman Fall beds, locality 263; Cobourg beds, localities 91, 103, 116, 119, 131, 224, 228, 232, 233, 238, 243, 249, 330, 338.

*Type.* Holotype, G.S.C. No. 7647; paratype, No. 7648. Both from Cobourg beds, corner Booth and Elm streets, and Rideau Hall grounds, Ottawa, Ontario.

Genus, *Clitambonites* PanderGenotype, *Pronites adscendens* Pander

Semi-elliptical, hinge line less than the greatest width, outline biconvex or concavo-convex; ventral valve subpyramidal, ventral area very erect, often sloping forward beyond the perpendicular; deltidium and chilidium well developed, dorsal area shorter than pedicle area, and not erect beyond the perpendicular; surface with many radii, often spinose, crossed by concentric growth lines. The interior is similar to that of the following genus *Vellamo*.

Schuchert and Cooper<sup>1</sup> place all the American species under *Vellamo* and distinguish *Clitambonites* and *Vellamo* by the greater forward slope of the pedicle area of the former, its rugose ornamentation, and the fact that usually the ventral spondylium is longer than wide instead of wider than long as in *Vellamo*.

*Clitambonites ottawaensis* n.sp.

Plate III, figures 33, 34

Semicircular in outline; greatest width anterior to the hinge line; holotype measuring: hinge, width, length, and thickness, 18 mm., 21 mm., 17 mm., and 12 mm., respectively; thickness and width of the deltidium at the base 2.5 mm. and 7 mm., respectively; cardinal area of the pedicle valve sloping forward at an angle of 20 to 30 degrees from the perpendicular striae, and growth lines not well preserved except in one spot, which shows a rugose ornamentation.

Pedicle interior not well preserved, but showing the spondylium of about equal length and width.

<sup>1</sup>Schuchert and Cooper: Peabody Mus. Nat. Hist., Mem. 4, pt. 1, 1932, pp. 113-114.

Brachial valve flat or slightly concave with a typical interior.

The forward leaning cardinal area and the rugose ornamentation show that this is a *Clitambonites* not a *Vellamo*.

*Occurrence.* Sherman Fall beds, locality 186; Cobourg beds, localities 43 and 121.

*Type.* Holotype and paratype from Cobourg beds, Research Council Laboratories, Sussex street, Ottawa, Ontario, in the private collection of G. W. Sinclair.

### Genus, *Vellamo* Öpik

Genotype, *Orthis verneuili* Eichwald

Semi-elliptical; hinge straight, as wide or wider than greatest width of shell; profile plane or concavo-convex; ventral area elevated, projecting and slightly twisted; margin straight or broadly sulcate; deltidium and chilidium well developed; surface covered by rather coarse, slightly flexuous striæ crossed by fine concentric lines; shell impunctate.

Ventral cavity deep; teeth strong; fossettes shallow; having a spondylium and a median septum reaching nearly to anterior margin.

Dorsal cavity small, cardinal process linear; brachiophores orthid, supported by extensions from the cavity platform; median ridge thick and broad.

The distinctions between *Vellamo* and *Clitambonites* are given under the genus *Clitambonites*.

#### *Vellamo sinclairi* n.sp.

Plate III, figure 30

Subquadrate in outline; greatest width anterior to the hinge; holotype measuring: hinge, width, length, and height, 19 mm., 23 mm., 17 mm., and 5 mm., respectively; cardinal area flat, with a slight posterior slope; delthyrium of pedicle valve 3.5 mm. in width at the base; striæ, fine and numerous; fine growth lines not preserved, but several specimens show coarse concentric lines near the margin.

Interiors not seen.

The species differs from *Vellamo trentonensis* in being larger, proportionately not so thick, and in having a narrower pedicle delthyrium and more numerous striæ.

It is difficult to compare the species with *V. americanus* and *V. diversa* from the Richmond, because those two species have not been clearly distinguished from one another, but the delthyrium of the pedicle valve of *Vellamo sinclairi* is narrower in proportion to the cardinal area, though not so high as in *V. ruedemanni*.

The species is named after G. W. Sinclair, who has loaned his private collection for this study.

*Occurrence.* Sherman Fall beds, locality 56; Cobourg beds, locality 102.

*Type.* Holotype, Cobourg beds, from cliff at the west end of Sparks street, Ottawa, Ontario, in the private collection of G. W. Sinclair.

#### *Vellamo trentonensis* (Raymond)

Plate III, figures 31, 32

*Clitambonites trentonensis* Raymond, Geol. Surv., Canada, Mus. Bull. 31, 1921, p. 27, Pl. 8, figs. 6, 7.

*Vellamo trentonensis* Raymond, Schuchert and Cooper, Peabody Mus. Nat. Hist., Mem. 4, pt. 1, 1932, p. 114, Pl. VII, figs. 14, 18, 28.

The simple striæ and the angle of the pedicle cardinal area show this to be a *Vellamo*. The species has been amply described and illustrated.

*Occurrence.* Leray-Rockland beds, locality 13; Sherman Fall beds, localities 42, 186; Cobourg beds, localities 43, 121, 128, 133.

*Type.* Holotype, G.S.C. No. 1612b (missing), from Leray-Rockland beds, Jessop Rapids, Bonnechère River, Ontario; plesiotype, No. 6413, from Sherman Fall beds, Castor River, about 1 mile east of Embrun, Ontario.

Genus, *Triplecia* Hall

Genotype, *Atrypa extans* Emmons

Trilobed, transverse, biconvex; greatest width about the middle or anterior to it; hinge line straight and short; anterior margin either invaginate or prolonged; cardinal extremities rounded; cardinal area low, erect; delthyrium narrow; deltidium convex or flat, with a circular perforation; brachial area narrow and beak incurved; obscure concentric striæ; impunctate.

Pedicle valve shallow, depressed anteriorly by a broad, deep sinus; teeth well developed; short dental plates; two lateral muscle diductor scars with long central adductors.

Brachial valve very convex with a strong median fold; cardinal process erect, deeply bifurcated, with a single groove at the end of each branch supported by a callosity bearing two short crural points.

Shimer and Shrock<sup>1</sup> have adopted the original form of the name *Tripllesia*, but Hall and Clark<sup>2</sup> state that the name was pre-occupied and adopt the term *Triplecia*, which is the form used here.

*Triplecia cuspidata* (Hall)

Plate VIII, figures 3, 4

*Atrypa cuspidata* Hall, Pal. New York, 1, 1847, p. 138, Pl. XXXIII\*, fig. 1.

Gibbous, pedicle valve convex, brachial valve very convex; length and width sub-equal; hinge line short; anterior margin almost straight, interrupted by the backward curve of the fold and sinus, which is not so produced as in *T. extans*. Fold narrow and subangular, delimited from the sides by a shallow narrow groove; sinus having an angular floor.

The species is distinguished by its gibbosity, which is greater than in *T. extans*, by the subangular narrow fold and sinus, and by its more squared anterior margin.

*Occurrence.* Rockland beds, locality 156; Cobourg ? beds, locality 228 (loose).

*Type.* Plesiotypes, G.S.C. Nos. 6414, 6414a, from Rockland beds, Rockland, Ontario.

*Triplecia extans* (Emmons)

Plate VIII, figure 2

*Atrypa extans* (Emmons), Geol. New York, Rept. 2nd District 1842, p. 395, fig. 6; Hall, Pal. New York, 1, 1847, p. 137, Pl. XXXIII, fig. 1.

*Triplecia extans* (Emmons), Hall and Clarke, Pal. New York, 8, pt. 1, 1892, p. 270, Pl. XIc, figs. 1-7.

Gibbous, pedicle valve somewhat convex, brachial valve very convex; hinge line shorter than the greatest width, but more extended than in *T. cuspidata*; width greater than length; anterior margin produced by the prolongation of a broad, rounded fold on the brachial valve, delimited from the lateral part by a shallow groove; a broad sinus with a rounded floor.

The species differs from *T. cuspidata* in having the front produced, in having a wider, subangular fold and sinus as compared with the more rounded type, and in being more transverse.

*Occurrence.* Rockland beds, localities 106, 148, 156; Sherman Fall beds, locality 129; Cobourg beds, localities 228, 257, 259.

*Type.* Plesiotype, G.S.C. No. 6415, from Rockland beds, north of Orleans, Ontario.

<sup>1</sup> Index Fossils of North America, 1944, p. 307.

<sup>2</sup> Pal. New York, 8, pt. 1, 1892, p. 269—footnote.

*Triplecia nuclea* (Hall)

Plate VIII, figures 1 a, b

*Atrypa nuclea* Hall, Pal. New York, 1, 1847, p. 138, Pl. XXXIII, fig. 2.*Triplecia nucleus* (Hall), Hall and Clarke, Pal. New York 8, pt. 1, 1892, p. 270, Pl. XIc, figs. 8, 9.

Small, average specimen measuring: width, length, and thickness, 12 mm., 8 mm., and 8 mm., respectively; hinge line very short; anterior not produced; fold on brachial valve very high and narrow, bearing a subangular crest and comprising the greatest thickness of the shell, and separated from the lateral sections by a definite narrow groove; sinus on the pedicle valve correspondingly deep, having a narrow subangular groove on its floor and two shallow, lateral grooves marking the separation from the down-curving sides. The fold and sinus form at least one-third of the whole shell.

The species is readily distinguished by its small size, its three equal sections, the upward turn of the fold causing a greater thickness, not a greater length as in *T. extans*, and its three sub-equal parts.

*Occurrence.* Cobourg beds, locality 43.

*Type.* Plesiotype, from Cobourg beds, Philemon Island, Hull, Quebec, in the private collection of G. W. Sinclair.

Genus, *Triplecella* WilsonGenotype, *T. diplicata* Wilson

"A very small brachiopod, only one valve known which appears to be the pedicle valve. The tip of the beak is buried. Convex, hinge very short. A faint sinus broadens anteriorly. Within the sinus lie broad round plications. The surface . . . . . is crossed by concentric growth lines which periodically become undulating wrinkles."

"Interior not known."

A further examination of the specimen reveals that what were at first thought to be very fine striae covering the whole are probably due to the fibrous nature of the shell material.

The genus was named *Triplecella* because its form is suggestive of a small *Triplecia*.

Schuchert<sup>1</sup> did not believe the genus or species valid, but had no other suggestion as to its relationship. As it is one of the few forms with a limited range, and as it does not fit in with anything else, it is recorded here until further specimens are found.

*Triplecella diplicata* Wilson (?)

Plate VIII, figure 5

*T. diplicata* Wilson, Roy. Soc., Canada, 26, 1932, sec. 4, p. 400, Pl. V, fig. 13.

As there is only one species known and it is not certain which characteristics are generic the description of the genus corresponds to the description of the species.

*Occurrence.* Cobourg beds, locality 252.

*Type.* Holotype, G.S.C. No. 6659, from Cobourg beds, lot 35, con. IX, Charlottenburgh tp., Ontario.

Genus, *Camerella* BillingsGenotype, *C. volborthi* Billings

Subglobular, sub-elliptical, or pentagonal in outline; biconvex, the convexity of the dorsal valve being the greater; cardinal extremities rounded; cardinal area minute or non-existent; delthyrium open, often filled by the beak of the dorsal

<sup>1</sup> Schuchert, Chas.: Personal communication.



valve; posterior part smooth and unbroken, anterior with a fold and sinus; surface smooth or having coarse, rounded plications on the anterior part; shell fibrous and impunctate.

Ventral valve with strong teeth; angular spondylium; the supporting median septum prolonged anteriorly a short distance.

Brachial valve with deep elongate cavity, the supporting plates uniting anteriorly and forming the median septum.

*Camerella hemiplicata* (Hall)

Plate XI, figure 4

*Atrypa hemiplicata* Hall, Pal. New York, 1, 1847, p. 144, Pl. XXXIII, fig. 1.

*Camerella hemiplicata* (Hall), Billings, Geol. Canada, 1863, p. 168, fig. 154.

*Parastrophia hemiplicata* (Hall), Hall and Clarke, Pal. New York, 8, pt. 2, 1893, p. 221, Pl. LXIII, figs. 1-3; Wilson, Geol. Surv., Canada, Bull. 2, 1914, p. 131, Pl. IV.

*Camerella hemiplicata* (Hall), Schuchert and Cooper, Peabody Mus. Nat. Hist., Mem. 4, 1932, p. 168, Pl. XXV, fig. 24.

Outline variable, sub-elliptical or subpentangular; width usually greater than height; greatest width about the middle; size variable, but averaging considerably larger than either of the succeeding species; cardinal extremities rounded; cardinal area minute or absent; fold and sinus distinct on the anterior third and having two strong delimiting striæ at the edge; number of striæ exceedingly variable, 0-6 on the fold, 0-5 in the sinus, those of the fold arising just anterior to the beak, those of the sinus just where the fold and sinus begin to differentiate; none, one, or two short striæ on each side, arising a short distance from the margin; specimens with no striæ or with only a few tend to be thinner and more transverse than those with many.

This species differs from *C. panderi* and *C. volborthi* in being larger and more alate, in having fold and sinus more defined, and, in the typical form, having more and longer striæ.

In the Ottawa-St. Lawrence Lowland *C. hemiplicata* is much more prolific than the other two species, being more widespread and having a longer range.

For many years Hall's species *Atrypa hemiplicata* was considered as a *Camerella*. In 1892 Hall and Clarke<sup>1</sup> referred it to their new genus *Parastrophia*. Schuchert and Cooper<sup>2</sup> again place it in *Camerella*. It is an exceedingly variable form and externally it is often difficult to separate some of the more gibbous specimens of *C. hemiplicata* from *C. volborthi*. Internally *C. hemiplicata* has the typical duplex spondylium and the æ of the cruralium belonging to *Camerella*.

*Occurrence.* Leray beds, localities 7, 30, 41, 163, 209, 210; Rockland beds, localities 29, 68, 106, 135, 165; Hull beds, localities 51, 53, 60, 82, 210, 215; Hull or Sherman Fall beds, locality 48; Sherman Fall beds, localities 56, 129, 265; Cobourg beds, localities 43, 86, 90, 91, 92, 98, 103, 108, 110, 119, 122, 123, 130, 133, 176, 189, 192, 242, 244, 250, 252, 258.

*Type.* Plesiotype, G.S.C. No. 6416, from Rockland beds, Rockland, Ontario.

*Camerella panderi* Billings

Plate XI, figure 2

*C. panderi* Billings, Can. Nat. Geol., 4, 1859, p. 302; Geol. Canada, 1863, p. 143, fig. 78;

Hall and Clarke, Pal. New York, 8, pt. 2, 1892, p. 220, Pl. LXII, figs. 19, 21-23;

Wilson, Can. Field Nat., 46, No. 6, 1932, Pl. II, figs. 1-3 and 5 (non fig. 4).

Small, subglobular; gibbous, no cardinal area; fold and sinus beginning on anterior quarter, shallow, turning upward abruptly, interfering but little with the circular outline; striæ, non-existent, or only faint indications along the anterior margin; concentric growth lines fine but quite marked in some specimens.

<sup>1</sup> Hall and Clarke: Pal. New York, 8, pt. 2, 1892, p. 221.

<sup>2</sup> Schuchert and Cooper: Peabody Mus. Nat. Hist., Mem. 4, p. 168.

Pedicle and brachial interiors typical.

The species differs from the genotype *C. volborthi* in its smaller size and lack of striae. The faint indications of striae on the occasional specimen are quite distinguishable from the definite striae of *C. volborthi*.

Schuchert and Cooper<sup>1</sup> do not recognize *C. panderi*, but its small round form is much more prolific than that of *C. volborthi* at the type locality.

*Occurrence.* Pamela beds, localities 66, 79; Leray-Rockland beds, localities 2, 7-9, 11, 23, 30, 77, 106, 142, 156, 165; Rockland beds, locality 29.

*Type.* Cotypes, G.S.C. Nos. 1149, a-e, from Leray-Rockland beds, Allumette Island, Ottawa River, Quebec; plesiotype, in the private collection of G. W. Sinclair.

### *Camerella volborthi* Billings

#### Plate XI, figure 3

*C. volborthi* Billings, Can. Nat. Geol., 4, 1859, p. 301; Geol. Canada, 1863, p. 143, fig. 77; Hall and Clarke, Pal. New York, 8, pt. 2, 1892, p. 220, Pl. LXII, figs. 11-18; Schuchert and Cooper, Peabody Nat. Hist. Mus., Mem. 4, 1932, Pl. XXV, figs. 5, 20-22, 27-30.

Subglobular or pentagonal from the pedicle side; no cardinal area; fold and sinus beginning on the anterior third, shallow but turning up abruptly; striae short and broad, 2 to 4 on the fold, 1 to 3 in the sinus, and 1 or 2 on each side; concentric growth lines very fine.

Brachial valve very convex with the typical interior.

Pedicle valve not so convex, and pedicle beak not so incurved.

The species is distinguished from *C. panderi* by its larger size and definite striae. It differs from *C. hemiplicata* in being smaller, and in its fewer, less pronounced striae, those on the fold and sinus not beginning at so early a stage as in *C. hemiplicata*.

*Occurrence.* Leray-Rockland beds, locality 7.

*Type.* Cotypes, G.S.C. Nos. 1148, a, b; plesiotype, No. 6417; from Leray-Rockland beds, Allumette Island, Ottawa River, Quebec, and from Paquette Rapids, Ontario.

### Genus, *Eichwaldia* Billings

#### Genotype, *E. subtrigonalis* Billings

Subtriangular; biconvex, pedicle valve usually a little more convex than the brachial; greatest width anterior to the middle; length and width sub-equal; specimens measuring: from very small to width, length, and thickness, 27 mm., 27 mm., and 8 mm. (pedicle valve only); anterior margin broadly rounded, hinge line quite short; shoulders sloping; cardinal area of the pedicle valve curved high, triangular, extending well beyond the curved-in brachial beak. Billings describes a perforation on the back of the beak through which the pedicle protruded. All specimens known are silicified and they all show a break in the same position, but none of the perforations, if that is the nature of the break, is round. One tiny specimen shows a silicified tube that is supposed to be the protruding pedicle. Concentric growth lines, but no radiating striae, present.

Brachial interior showing a prominent septum extending almost to the anterior margin.

<sup>1</sup>Schuchert and Cooper: Peabody Nat. Hist. Mus., Mem. 4, p. 168.



*Eichwaldia subtrigonalis* Billings

Plate VIII, figures 6-9

*E. subtrigonalis* Billings, Geol. Surv., Canada, Rept. of Prog. 1857, 1858, p. 192, fig. 24; Can. Nat. Geol., 3, 1858, p. 443, fig. 24; Hall and Clarke, Pal. New York, 8, pt. 2, 1893, p. 310, figs. 241, 242, Pl. LXXXIII, figs. 1-4.

The species is the only known member of the genus, so that the generic description covers it.

*Occurrence.* Leray-Rockland beds, locality 7.

*Type.* Holotype, G.S.C. No. 1145a; paratypes, Nos. 1145b-1145g; plesiotype, No. 6418; all from Leray-Rockland beds, Allumette Island, Ottawa River, Quebec.

Genus, *Rhynchotrema* HallGenotype, *Rhynchonella capax* Conrad

Subtriangular in outline; a definite fold in the brachial valve and sinus in the pedicle valve; coarse, simple striæ from the beak to the margins; fine growth lines, zigzagging over the striæ and at more or less irregular intervals developing a lamellose structure. In certain lights and certain conditions of exfoliation the fine growth lines intersecting the fibrous shell matter give an impression of minute punctæ.

Pedicle valve projecting beyond the brachial; delthyrium generally covered. Interior having strong teeth; two concave dental plates; muscle area large for the size of the shell.

Brachial valve having deep dental sockets; a linear cardinal process lying at the base of the crural cavity; a pair of slender brachidia and a median septum.

The genus differs from *Camerella* externally in having striæ. It is often difficult to distinguish it externally from *Camarotoechia*. Usually the beak of *Rhynchotrema* is less sharp. Internally the differences are readily recognized.

*Rhynchotrema ainsliei* N. H. Winchell

Plate XI, figure 7

*Rhynchonella ainsliei* N. H. Winchell, 14th Ann. Rept. Geol. Nat. Hist. Surv., Minnesota, 1886, p. 315, Pl. II, figs. 5, 6.

*Rhynchotrema ainsliei* N. H. Winchell, Winchell and Schuchert, Geol. Minnesota, 3, 1893, p. 459, Pl. XXXIV, figs. 1-8.

*Rhynchotrema ainsliei* is essentially the same as *R. increbescens* and the main description is given under that species.

It differs from *R. increbescens* in being more transverse, in having a lower fold and more shallow sinus, and in having more striæ, from 5 to 7 of which are in the sinus and correspondingly 6 to 8 on the fold.

It is found at a lower level than *R. increbescens* and its range is more limited.

*Occurrence.* Lowville beds, locality 156; Leray beds, locality 74.

*Type.* Plesiotype, G.S.C. No. 6419, from Lowville beds, Rockland, Ontario.

*Rhynchotrema increbescens* (Hall)

Plate XI, figures 12 a, b, 13

*Atrypa increbescens* Hall (pars), Pal. New York, 1, 1847, pp. 146 and 289, Pl. XXXIII, figs. 3a-3h.

*Rhynchotrema increbescens* (Hall), Hall and Clarke, Pal. New York, 8, pt. 2, 1893, pp. 183 and 185; Wilson, Geol. Surv., Canada, Bull. 44, 1926, Pl. IV, fig. 5.

Subtriangular in outline; small, averaging 10 mm. to 12 mm. in width; having from 16 to 22 striæ, of which 4 are usually on the fold of the brachial valve and 3 in the sinus of the pedicle valve, though there is some variation.

Pedicle valve not so convex as the brachial. Interior typical of the genus.

Brachial valve very convex; interior showing the typical double crural plates, linear cardinal process, and a pair of long, slender brachidia, bifid at the extremities and striated at the base, protruding into the visceral region.

*Occurrence.* Lowville-Leray beds, locality 163; Leray beds, localities 15, 19, 38, 41, 63, 64, 71, 74, 77, 79, 109, 139, 143, 146, 150, 216, 220, 264; Leray-Rockland beds, localities 7, 8, 20, 147; Rockland beds, localities 22, 29, 129; Hull beds, localities 36, 49, 60, 208, 217; Hull or Sherman Fall beds, localities 48, 50; Sherman Fall beds, localities 10, 11, 42, 56, 84, 129, 137, 180, 186, 188, 198-201, 203, 263; Sherman Fall or Cobourg beds, locality 6; Cobourg beds, localities 3, 43, 85, 90, 91, 95, 99, 103, 104, 112, 114-117, 120-123, 128, 133, 141, 176, 177, 189, 191, 208, 225, 237, 242, 244.

*Type.* Plesiotypes, G.S.C. No. 1146f, from Leray-Rockland beds, Paquette Rapids, Ontario, and No. 6420, from Leray beds, Merivale road, southwest of Ottawa, Ontario.

*Rhynchotrema intermedia* Wilson

Plate XI, figures 8 a-c

*Rhynchotrema intermedia* Wilson, Roy. Soc., Canada, 26, 1932, sec. 4, p. 400, Pl. 5, figs. 8-10.

This form has been described as completely as can be without interiors. The illustration is slightly foreshortened. The average width, length, and thickness: 19 mm., 16 mm., and 10.5 mm., respectively.

The species is larger than the typical *R. increbescens*, has fewer and coarser plications, and a more strongly marked fold and sinus. There are gradations between it and *R. increbescens*. It is smaller than *R. capax* and usually has more sloping shoulders, though there are gradations also between it and *R. capax*.

*Occurrence.* Leray beds, locality 163; Sherman Fall beds, localities 13, 39, 55, 56, 84, 186, 188, 200; Cobourg beds, localities 69, 86-88, 91, 101, 112, 114, 121, 123, 133, 175, 185, 189, 191, 208, 231, 243, 248, 257.

*Type.* Holotype, G.S.C. No. 6660, from Cobourg beds, lot 32, con. III, Kenyon tp., Ontario.

*Rhynchotrema ? ottawaensis* Billings

Plate XI, figures 9-11

*Porambonites ? ottawaensis* Billings, Geol. Surv., Canada, Pal. Foss., 1, 1865, p. 140, fig. 117.

*Rhynchotrema ottawaense* (Billings), Schuchert, U.S. Surv., Bull. 87, 1897, p. 369.

Subtriangular; biconvex; greatest width anterior to the middle; most specimens averaging: width, length, and thickness, 12 mm., 13 mm., and 8 to 10 mm., respectively, though a few specimens are larger; shoulders sloping; pedicle valve having a shallow sinus, and brachial valve a shallow fold extending from the umbo to the anterior margin where it interrupts the evenness of the curve; both beaks incurving, that of the pedicle valve being slightly the longer; delthyrium of both valves large, no trace of a covering; 3 large plications on the fold, 2 on the sinus, and 3 to 5 on each side, none arising at the beak, those on the fold begin at the umbo, those on the sides about the middle; concentric striae, in places almost rugose.

The pedicle interior having strong teeth, supported by two thin sub-parallel dental plates.

Brachial interior showing deep sockets in the two discrete plates of the cruralium; each cruralium plate gives rise to a long slender brachidium, which curves posteriorly, no septum visible.

*R. ottawaense* is about the same size as *R. increbescens*, but is more triangular in outline and has fewer and coarse plications and these do not begin at the beak; three plications on the fold and two in the sinus as compared with four on the fold

and three in the sinus; the brachidia curve posteriorly as compared with the straight brachidia of *R. increbescens*.

The genus is queried because no trace of the linear median septum has been seen.

*Occurrence.* Leray-Rockland beds, locality 7.

*Type.* Cotypes, G.S.C. Nos. 1143b, c, g, h, from Leray-Rockland beds, Paquette Rapids, Ottawa River, Ontario.

### Genus, *Zygospira* Hall

#### Genotype, *Atrypa modesta* Hall

Small, subcircular or transversely oval in outline; biconvex; hinge line short and straight; cardinal extremities rounded; elongated foramen; a narrow prominent umbo on the pedicle valve culminating in a ridge; brachial umbo depressed convex, with a shallow sinus; surface sharply striate.

Teeth of pedicle valve lacking dental plates.

Brachial valve with stout bilobed cardinal process; spires small, loosely coiled, directed towards the centre; jugum a straight band.

This is the earliest known spire-bearing brachiopod.

#### *Zygospira deflecta* (Hall)

##### Plate XI, figures 5 a, b

*Atrypa deflecta* Hall, Pal. New York, 1, 1847, p. 140, Pl. XXXIII, fig. 4.

*Zygospira deflecta* (Hall), Hall and Clarke, Pal. New York, 8, pt. 2, 1893, p. 157.

The species has been well described and illustrated. It is similar to *Z. recurvirostris* in all essential features. It differs in being smaller, for the most part, in having a less curved pedicle beak, and in that the sides become flattened and then deflected at the lateral margins making the ridge more prominent as compared with the effect of the convex sides of *Z. recurvirostris*.

*Occurrence.* Leray beds, locality 41; Cobourg beds, localities 86-88, 90, 102, 103, 121, 130, 242.

*Type.* Plesiotype, G.S.C. No. 6421, from Cobourg beds, Booth street, Ottawa, Ontario.

#### *Zygospira recurvirostris* (Hall)

##### Plate XI, figures 6 a, b

*Atrypa recurvirostris* Hall, Pal. New York, 1, 1847, p. 140, Pl. XXXIII, fig. 5.

*Zygospira recurvirostris* (Hall), Chamberlin, Geol. Wisconsin, 1, 1883, p. 155, fig.; Winchell and Schuchert, Geol. Minnesota, 3, 1893, p. 466, Pl. XXXIV, figs. 38-41.

Small, elliptical or subpentagonal; length a little greater than width; about 24 regular striae, which arise at the beak.

The species differs from *Z. modesta* in its smaller size and more compact form. It differs from *Z. deflecta* in its convex lateral parts.

*Occurrence.* Lowville beds, locality 77; Leray beds, localities 1, 18, 30, 139, 142, 204-206; Leray-Rockland beds, localities 7, 8; Rockland beds, localities 30, 129, 140, 156, 210; Hull beds, localities 37, 44, 61, 213, 215; Hull or Sherman Fall beds, locality 50; Sherman Fall beds, localities 13, 42, 43, 54, 56, 84, 129, 186, 198, 203, 218, 260, 263; Cobourg beds, localities 43, 84, 86, 90, 91, 103, 105, 112, 114, 118, 123, 130, 134, 194, 238, 241, 243, 246, 247, 252, 257.

*Type.* Plesiotype, G.S.C. No. 6424, from Hull or Sherman Fall beds, Brewery Creek, Hull, Quebec.

Genus, *Cyclospira* Hall and ClarkeGenotype, *Orthis bisulcata* Emmons

Small, biconvex, the pedicle valve very convex, the brachial valve depressed convex; beak of the pedicle valve incurved over the brachial and over the delthyrium; umbo of the pedicle valve prominent, having a fold that anteriorly becomes a sinus; lateral slopes broad, convex, and smooth until interrupted by the short fold on either side; brachial valve with a shallow sinus within which a low fold develops anteriorly, corresponding to the sinus of the pedicle valve; concentric striæ near the margins.

Pedicle interior having a thickened platform posteriorly upon which lie the muscle scars.

Brachial interior with a low median septum, spirals coiled in planes nearly parallel to the vertical axis of the shell, apices slightly turned towards the median ridge.

The only genus of comparable size and shape found in these rocks is *Zygospira*, from which *Cyclospira* is readily distinguished by its lack of radial plications.

*Cyclospira bisulcata* (Emmons)

## Plate XI, figures 1 a, b

*Orthis bisulcata* Emmons, Geol. New York, Rept. 2nd Dist., 1842, p. 396, fig. 4.

*Cyclospira bisulcata* (Emmons), Hall and Clarke, Pal. New York, 8, pt. 2, 1893, p. 147, figs. 133-136, Pl. LIV, figs. 38-40.

The generic description is practically the description of the species. Only one other species has been doubtfully referred to the genus.

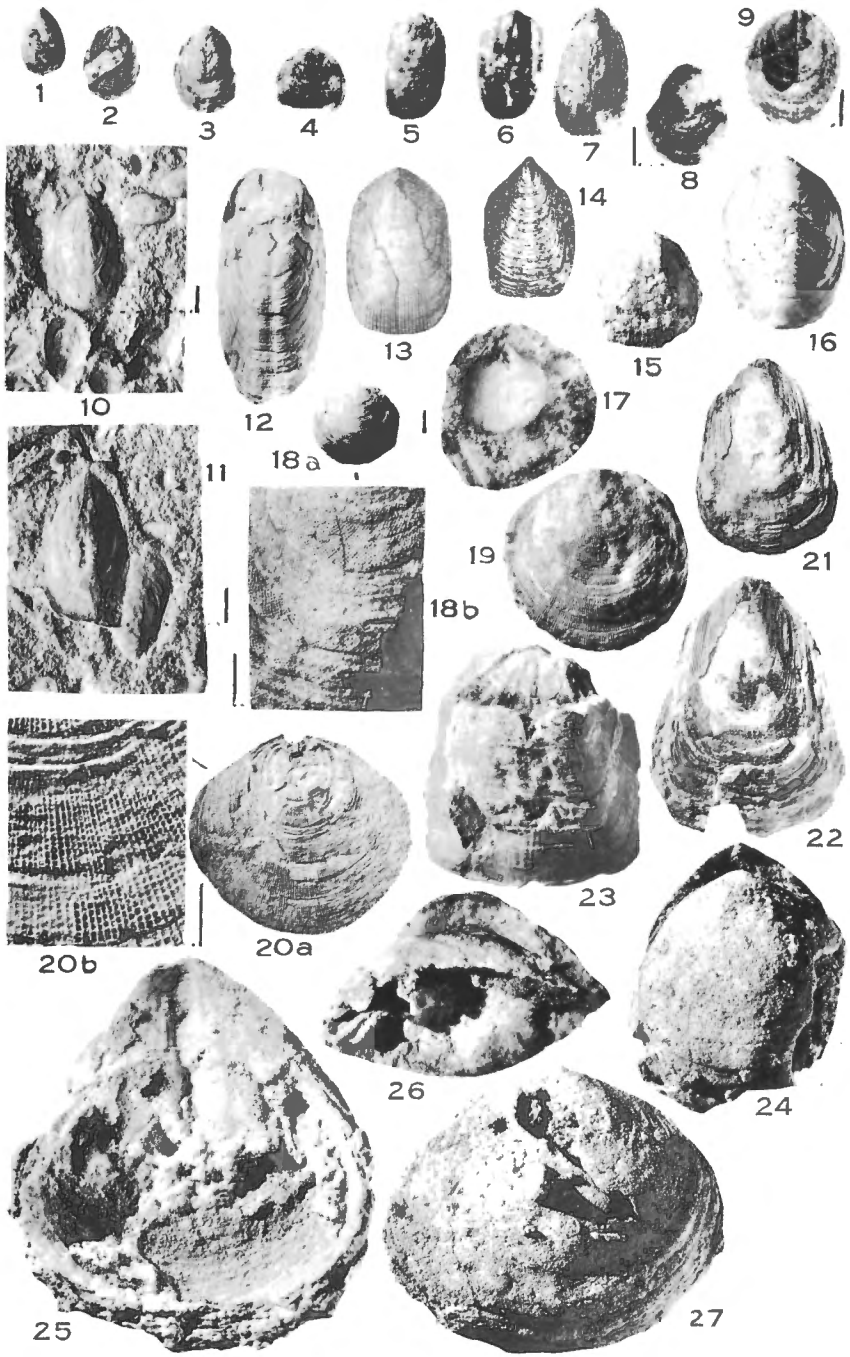
*Cyclospira* in this region is limited to one level near the top of the Cobourg beds of Ottawa limestone.

*Occurrence.* Cobourg beds, localities 47, 86-89, 91, 92, 100, 101, 119, 121, 126, 133, 134, 185, 208, 241, 252, 259.

*Type.* Plesiotype, G.S.C. No. 6422, from Sherman Fall beds, behind the axe factory, Hull, Quebec.

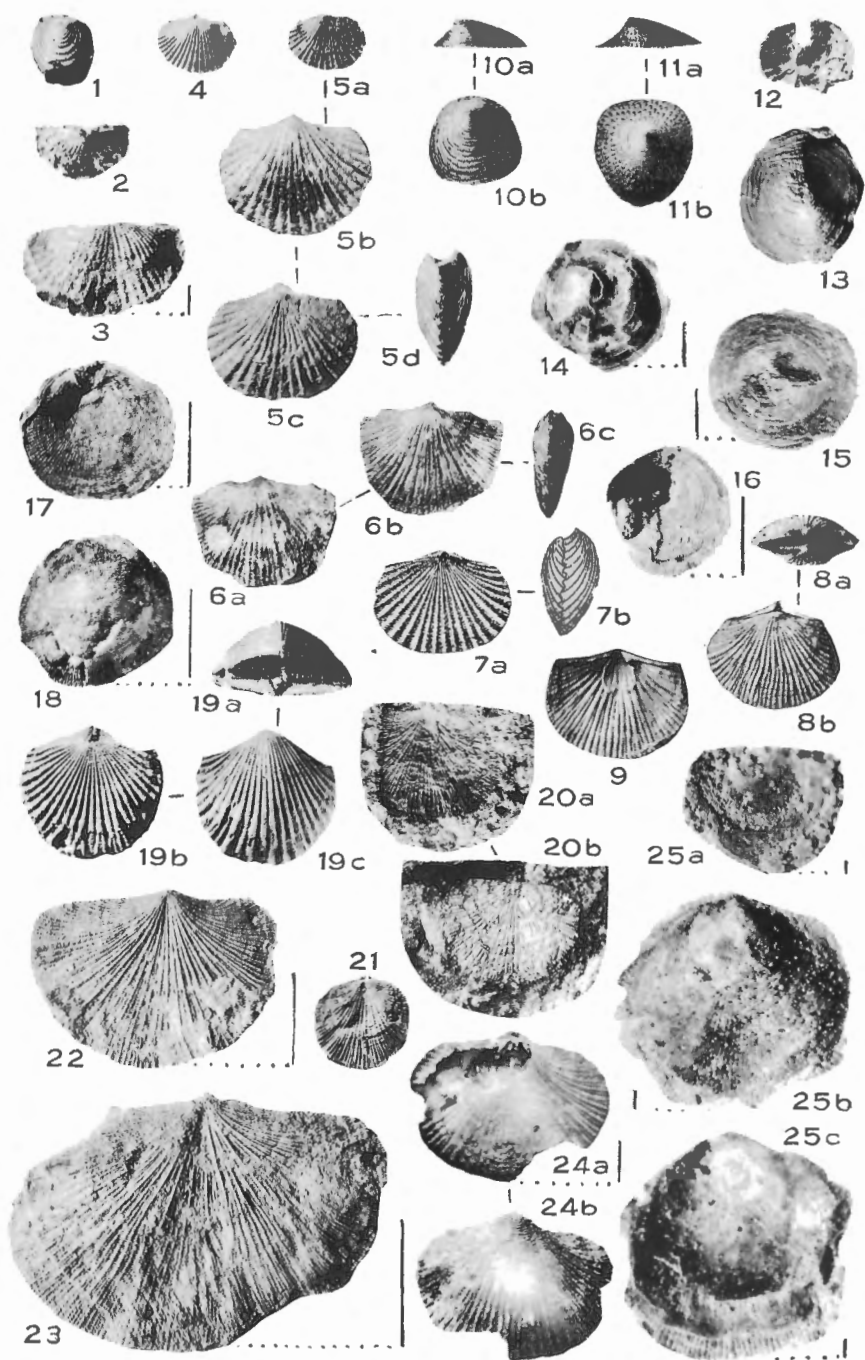
## PLATE I

- Figure 1. *Lingula trentonensis* Conrad. Pedicle valve, showing small acute beak. Plesiotype, G. W. Sinclair collection. (Page 21.)
- Figure 2. *Lingula riciniformis* Hall. Pedicle valve, showing the rounded anterior margin and the beak obtuse as in *L. obtusa*, but the species is shorter and proportionately broader. Plesiotype, G.S.C. No. 6324. (Page 20.)
- Figure 3. *Lingula obtusa* Hall. Pedicle valve, showing the rounded anterior margin and the bluntness of the beak. Plesiotype, G.S.C. No. 6323. (Page 19.)
- Figure 4. *Lingula curta* Conrad. Pedicle valve, slightly broken on the anterior margin. Plesiotype, G.S.C. No. 6304. (Page 18.)
- Figure 5. *Lingula elongata* Hall. Pedicle valve, showing the blunt beak, and almost parallel sides. Plesiotype, G.S.C. No. 6314. (Page 18.)
- Figure 6. *Lingula hullensis* n.sp. Pedicle valve, showing the wide shoulders and narrow anterior. Holotype, G.S.C. No. 6318. (Page 19.)
- Figure 7. *Lingula briseis* Billings. Pedicle valve, showing the sloping shoulders and almost squared anterior margin. Cotype, G.S.C. No. 1643e. (Page 18.)
- Figure 8. *Lingula sinclairi* n.sp. Brachial valve, having the tip of the beak broken. Paratype, x 3. G. W. Sinclair collection. (Page 20.)
- Figure 9. *Lingula sinclairi* n.sp. Pedicle valve, x 3. Holotype, G. W. Sinclair collection. (Page 20.)
- Figures 10 and 11. *Lingula narrawayi* Wilson. Pedicle valves, x 6. Holotype and paratype, Royal Ontario Museum. (Page 19.)
- Figure 12. *Lingula philomela* Billings. Pedicle valve, showing the long, narrow outline. Paratype, G.S.C. No. 1641. (Page 20.)
- Figure 13. *Lingula rectilateralis major* Ruedemann. Reprint. (Page 20.)
- Figure 14. *Lingula huronensis* Billings. Reprint of Billings' original figure of the holotype.
- Figure 15. *Lingula huronensis* Billings. Pedicle valve, broken at the anterior but showing the three flat surfaces on the top and sides. Plesiotype, G.S.C. No. 6319. (Page 19.)
- Figure 16. *Lingula cobourgensis* Billings. Pedicle valve, showing gently rounded sides and anterior margin. Holotype, G.S.C. No. 1635a. (Page 18.)
- Figure 17. *Cornwallia minuta* Wilson (?). Parasitical form. Holotype, G.S.C. No. 6609, x 4. (Page 22.)
- Figure 18. *Trematis terminalis* (Emmons). 18a, brachial valve, natural size; 18b, the same x 4, to show the ornamentation. Plesiotype, G.S.C. No. 6327. (Page 23.)
- Figure 19. *Trematis ottawaensis* Billings. Holotype, G.S.C. No. 1651. (Page 22.)
- Figure 20. *Trematis ottawaensis* Billings. 20a, another specimen; 20b, the same x 3½, to show ornamentation. Plesiotype, G.S.C. No. 6326.
- Figure 21. *Lingulasma eva* (Billings). A rather small specimen. Holotype, G.S.C. No. 1160a. (Page 21.)
- Figure 22. *Lingulasma eva* (Billings). An average sized specimen. Paratype, G.S.C. No. 1160b.
- Figure 23. *Lingulasma eva* Billings. Pedicle valve with part of the tip broken away revealing part of the interior. Plesiotype, G.S.C. No. 6325.
- Figure 24. *Dinobolus canadensis* Billings. Brachial valve, showing the pedicle area projecting beyond it. Holotype, G.S.C. No. 1150. (Page 16.)
- Figure 25. *Dinobolus erectus* n.sp. Brachial valve showing the high, erect area of the pedicle valve projecting beyond it. Holotype, G.S.C. No. 6301. (Page 17.)
- Figure 26. *Dinobolus magnificus* (Billings). Parts of both brachial and pedicle valve, showing the height and shape of the pedicle area. Paratype, G.S.C. No. 1161a.
- Figure 27. *Dinobolus magnificus* (Billings). Brachial valve, showing the transverse outline. Holotype, G.S.C. No. 1161. (Page 17.)



## PLATE II

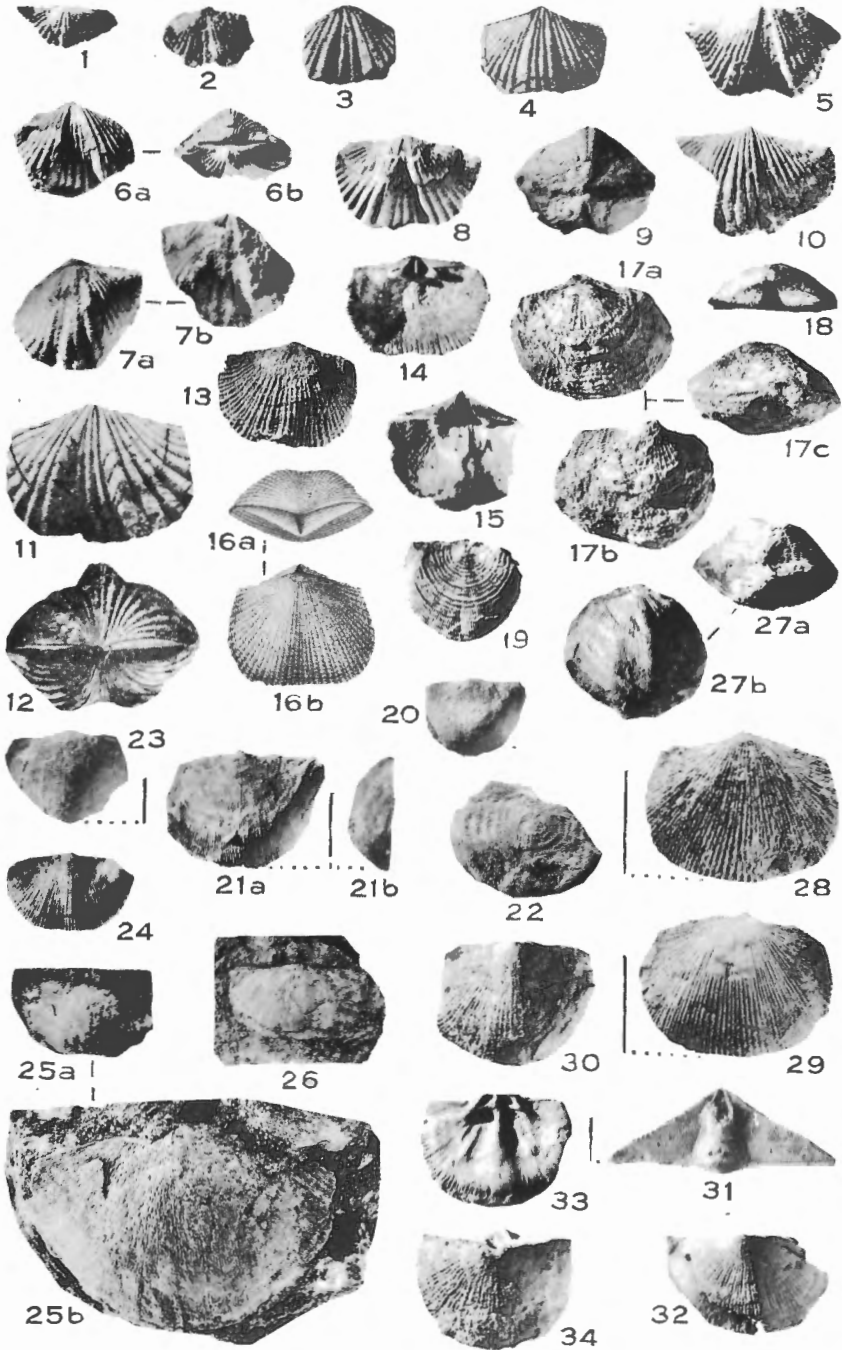
- Figure 1. *Pholidops trentonensis* Hall. Plesiotype, G.S.C. No. 6374, x 2. (Page 26.)
- Figure 2. *Skenidiodes ? merope* (Billings). Pedicle valve, showing the erect cardinal area. Neotype, G.S.C. No. 6326, x 3. (Page 34.)
- Figure 3. *Skenidiodes ? merope* (Billings). Brachial valve, showing the broad shallow depression. Neoparatype, G.S.C. No. 6385, x 3. (Page 34.)
- Figure 4. *Plectorthis plicatella laurentina* n.var. Brachial valve. Holotype, G. W. Sinclair collection. (Page 28.)
- Figure 5. *Plectorthis ottawaensis* n.sp. 5a, Pedicle valve; 5b and 5c, pedicle and brachial valves, x 2, to show striæ implantations; 5d, profile, to show degree of convexity. Holotype, G.S.C. No. 6375, x 2. (Page 28.)
- Figure 6. *Plectorthis pulchella* n.sp. 6a, Pedicle valve; 6b, brachial valve; 6c, profile having the pedicle valve on the right. Holotype, G. W. Sinclair collection. (Page 28.)
- Figure 7. *Plectorthis plicatella trentonensis* Foerste. 7a, brachial valve; 7b, profile. Reprints. (Page 28.)
- Figure 8. *Plectorthis neglecta* (James). 8a, hinge line; 8b, brachial valve. Reprint. (Page 27.)
- Figure 9. *Plectorthis neglecta* (James). Interior of pedicle valve. Reprint. (Page 27.)
- Figure 10. *Crania trentonensis* Hall, x 2. Reprint. (Page 26.)
- Figure 11. *Crania setigera* Hall, x 2. Reprint. (Page 26.)
- Figure 12. *Orbiculoidea lamellosa* d'Orbigny. Pedicle valve, broken. Plesiotype, H. W. Sinclair collection. (Page 24.)
- Figure 13. *Orbiculoidea lamellosa* d'Orbigny. Brachial valve. Plesiotype, G. S. C. No. 6372.
- Figure 14. *Schizotreta canadensis* n.sp. Pedicle valve. Holotype, G.S.C. No. 6373, x 2½. (Page 25.)
- Figure 15. *Schizotreta canadensis* n.sp. Brachial valve. Paratype, G.S.C. No. 6373a, x 2½.
- Figure 16. *Schizotreta pelopea* (Billings). Pedicle valve, looking into the concave side. Plesiotype, G.S.C. No. 1655a, x 1½. (Page 25.)
- Figure 17. *Schizocrania filosa* Hall. Pedicle valve. Plesiotype, G.S.C. No. 6329, x 1½. (Page 23.)
- Figure 18. *Schizocrania filosa* Hall. Brachial valve. Plesiotype, G.S.C. No. 6328, x 1½. (Page 23.)
- Figure 19. *Hesperorthis tricenaria* (Conrad). 19a, hinge line; 19b, brachial valve; 19c, pedicle valve. Plesiotype, G.S.C. No. 1151c. (Page 34.)
- Figure 20. *Dalmanella millepunctata* Wilson. 20a, pedicle valve; 20b, brachial valve. Both on one slab. Holotype, G.S.C. No. 6610. (Page 37.)
- Figure 21. *Dalmanella rogata* (Sardeson). Brachial valve. Plesiotype, G.S.C. No. 6390. (Page 38.)
- Figure 22. *Dalmanella whittakeri* Raymond. Brachial valve. Paratype, G.S.C. No. 3240a, x 2.
- Figure 23. *Dalmanella whittakeri* Raymond. Brachial valve. Holotype, G.S.C. No. 3240, x 2. (Page 38.)
- Figure 24. *Dalmanella paquettensis* (Sinclair). 24a, brachial valve; 24b, pedicle valve. Holotype, G. W. Sinclair collection. (Page 37.)
- Figure 25. *Schizocrania minuscula* n.sp. 23a, pedicle valve, opening a little obscure because of magnification, but outline can be seen on left side; 23b, brachial valve; 23c, another brachial valve. All on one slab. Cotypes, G.S.C. No. 6371, x 16. (Page 24.)





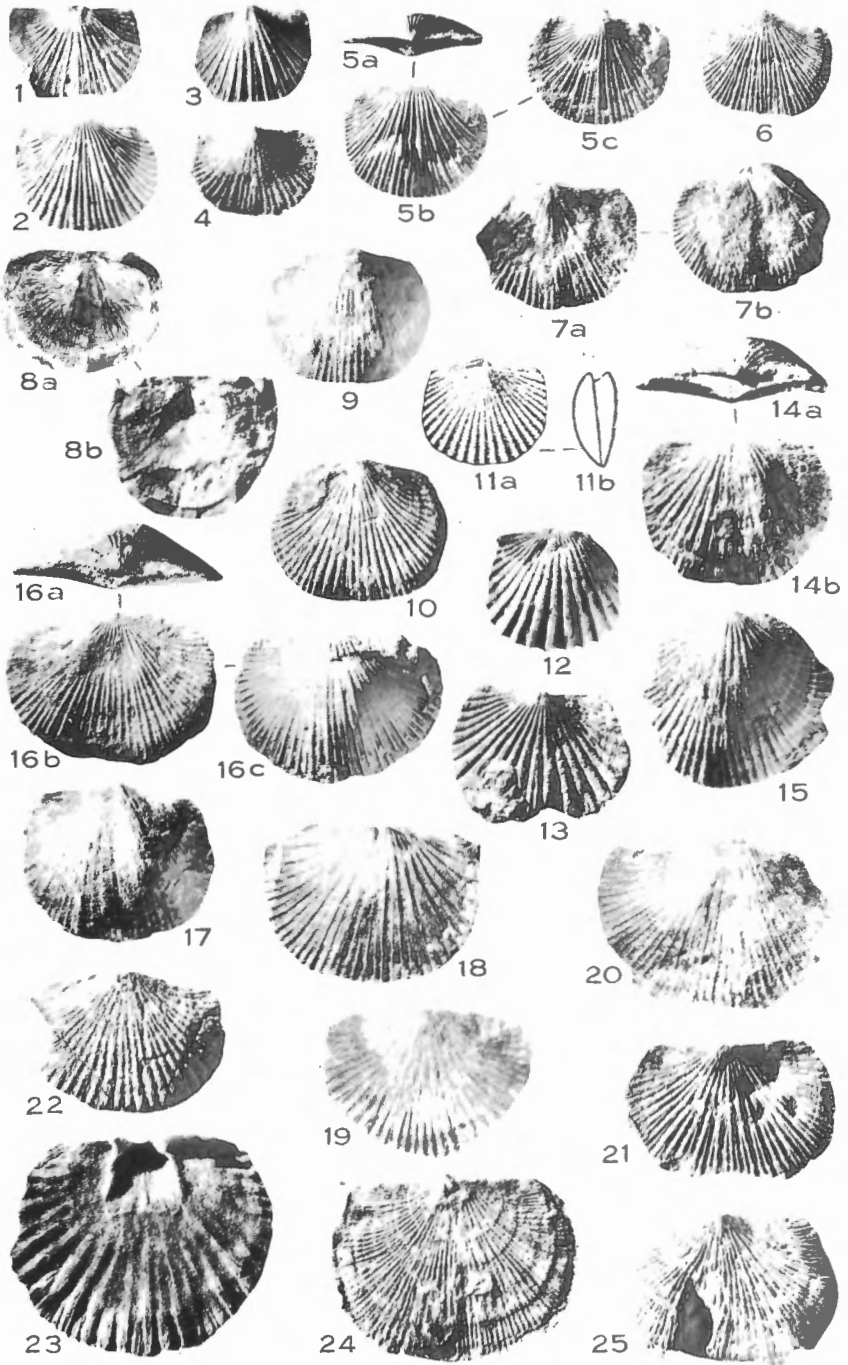
## PLATE III

- Figure 1. *Platystrophia uniplicata* McEwan. Brachial valve, broken at anterior margin, but showing the 2 plications on the fold. Plesiotype, G.S.C. No. 6378. (Page 31.)
- Figure 2. *Platystrophia uniplicata* McEwan. Pedicle valve, showing one plication in the sinus. Plesiotype, G.S.C. No. 6376.
- Figure 3. *Platystrophia precedens* McEwan. Pedicle valve. Reprint. (Page 31.)
- Figure 4. *Platystrophia trentonensis* McEwan. Brachial valve. Reprint. (Page 31.)
- Figure 5. *Platystrophia hermitagensis* McEwan. Pedicle valve, showing the 5 plications in the sinus. Plesiotype, G. W. Sinclair collection. (Page 31.)
- Figure 6. *Platystrophia elegantula* McEwan. 6a, pedicle valve, showing the 3 plications in the sinus increasing to 5; 6b, posterior view, showing the short hinge line. Plesiotype, G.S.C. No. 6384. (Page 33.)
- Figure 7. *Platystrophia amoena* McEwan. 7a, brachial valve, showing 4 plications on the fold; 7b, pedicle valve, showing 3 plications in the sinus. Plesiotype, G.S.C. No. 6381. (Page 32.)
- Figure 8. *Platystrophia amoena longicardinalis* McEwan. Pedicle valve, showing 3 plications in the sinus, and hinge line longer than in the species. Plesiotype, G.S.C. No. 6382. (Page 32.)
- Figure 9. *Platystrophia amoena robusta* McEwan. Hinge line, showing the beginning of the *P. amoena* type of striation on fold and sinus, and the robust form. Plesiotype, G.S.C. No. 6383. (Page 33.)
- Figure 10. *Platystrophia extensa* McEwan. Brachial valve, showing its wide width in proportion to its length. Plesiotype, G.S.C. No. 6380. (Page 32.)
- Figure 11. *Platystrophia preponderosa* McEwan. Pedicle valve, showing the large size and coarse plications. Reprint. (Page 33.)
- Figure 12. *Platystrophia preponderosa* McEwan. Hinge line, showing high fold. Reprint.
- Figure 13. *Glyptorthis bellarugosa* (Conrad). Brachial valves, showing the rugose striae. Plesiotype, G. W. Sinclair collection. (Page 35.)
- Figure 14. *Glyptorthis bellarugosa* (Conrad). Brachial interior. Plesiotype, G. W. Sinclair collection.
- Figure 15. *Glyptorthis bellarugosa* (Conrad). Pedicle interior. Plesiotype, G. W. Sinclair collection.
- Figure 16. *Glyptorthis inscupta* (Hall). 16a, hinge line, showing the relation of the two valves; 16b, brachial valve, showing the fine numerous striae. Reprint. (Page 36.)
- Figure 17. *Eridorthis rocklandensis* n.sp. 17a, brachial valve; 17b, pedicle valve; 17c, anterior margin. Holotype, G.S.C. No. 6387. (Page 36.)
- Figure 18. *Eridorthis rocklandensis* n.sp. Hinge view of pedicle valve. Paratype, G.C.S. No. 6389.
- Figure 19. *Leptaena affinis* n.sp. Holotype, G. W. Sinclair collection. (Page 53.)
- Figure 20. *Leptaena ? diminuta* n.sp. Pedicle valve. Paratype, G.S.C. No. 6412.
- Figure 21. *Leptaena ? diminuta* n.sp. 21a, Pedicle valve, x 1½; 21b, profile of the same, x 1½. Holotype, G. W. Sinclair collection. (Page 53.)
- Figure 22. *Leptaena trentonensis* Wilson. Pedicle valve. Holotype, G.S.C. No. 6636. (Page 53.)
- Figure 23. *Sowerbyella ? minuta* n.sp. Pedicle valve, x 2. Holotype, G. W. Sinclair collection. (Page 50.)
- Figure 24. *Sowerbyella punctostriata* Mather. Reprint. (Page 51.)
- Figure 25. *Sowerbyella subovalis* Wilson. 25a, pedicle valve, showing the convex pedicle area; 25b, the same, x 4, to show the punctae. Holotype, G.S.C. No. 6612. (Page 52.)
- Figure 26. *Sowerbyella sericea* (Sowerby). Pedicle valve, showing the outline. Plesiotype, G.S.C. No. 6613. (Page 51.)
- Figure 27. *Doleroides gibbosus* (Billings). 27a, the hinge line, showing the gibbosity; 27b, brachial valve of the same specimen. Plesiotype, G.S.C. No. 6409. (Page 49.)
- Figure 28. *Doleroides pervetus ottawanus* Wilson. Pedicle valve, showing the characteristic outline. Paratype, G.S.C. No. 6727a, x 1½.
- Figure 29. *Doleroides pervetus ottawanus* Wilson. Brachial valve. Holotype, G.S.C. No. 6727, x 1½. (Page 49.)
- Figure 30. *Vellamo sinclairi* n.sp. Pedicle valve, showing the obliquely forward inclination of beak. Holotype, G. W. Sinclair collection. (Page 115.)
- Figure 31. *Vellamo trentonensis* (Raymond). Cardinal area, showing the width and height. Holotype, G.S.C. No. 1612b, x 2. (Page 115.)
- Figure 32. *Vellamo trentonensis* (Raymond). Pedicle valve, showing the perpendicular cardinal area. Plesiotype, G.S.C. No. 6413.
- Figure 33. *Clitambonites ottawaensis* n.sp. Interior of the brachial valve. Paratype, G. W. Sinclair collection.
- Figure 34. *Clitambonites ottawaensis* n.sp. Pedicle valve, showing the oblique forward inclination of the cardinal area. Holotype, G. W. Sinclair collection. (Page 114.)



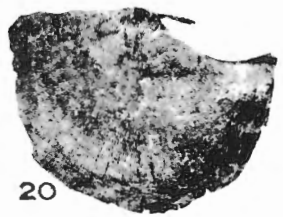
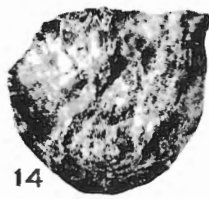
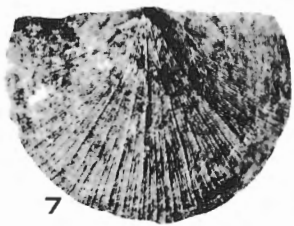
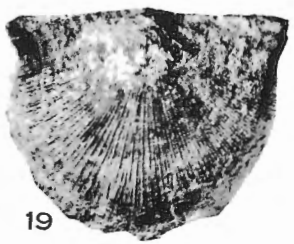
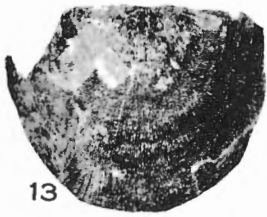
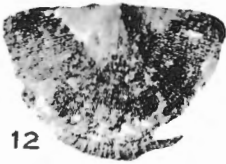
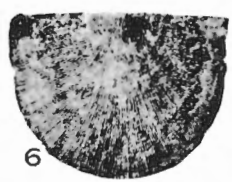
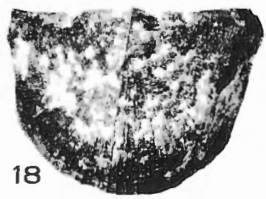
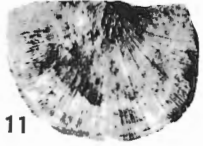
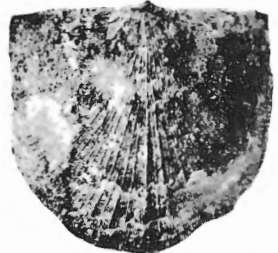
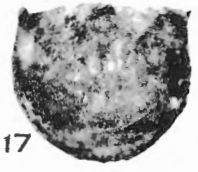
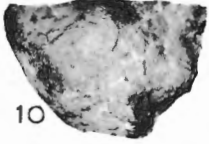
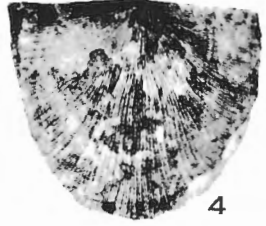
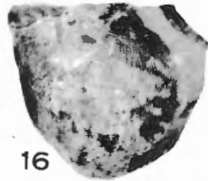
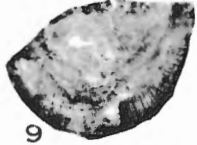
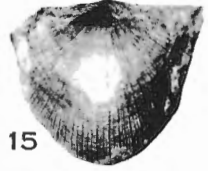
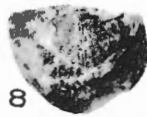
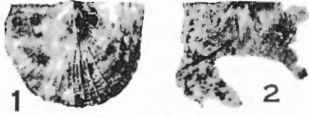
## PLATE IV

- Figure 1. *Dinorthis iphigenia media* n.var. Pedicle valve, showing the slight elevation at the umbo. Paratype, G.S.C. No. 6392a.
- Figure 2. *Dinorthis iphigenia media* n.var. Brachial valve, showing the size, the number of striæ, and the gentle convexity. Holotype, G.S.C. No. 6392. (Page 41.)
- Figure 3. *Dinorthis iphigenia minor* n.var. Brachial valve, slightly broken. Paratype, G.S.C. No. 6393a.
- Figure 4. *Dinorthis iphigenia minor*, n.var. Pedicle valve, showing its outline and flatness. Holotype, G.S.C. No. 6393. (Page 42.)
- Figure 5. *Dinorthis meedsi plana* n.var. 5a, hinge line, showing relative thickness; 5b, brachial valve with low convexity; 5c, pedicle valve showing its flatness and the striation. Holotype, G.S.C. No. 6395. (Page 43.)
- Figure 6. *Dinorthis meedsi germana* (W. and S.). Pedicle valve. Plesiotype, G.S.C. No. 6405. (Page 42.)
- Figure 7. *Dinorthis subquadrata* (Hall). 7a, pedicle valve, showing the fine striæ; 7b, pedicle valve, showing the faint median depression and the subquadrated outline. Plesiotype. G.S.C. No. 6403. (Page 45.)
- Figure 8. *Dinorthis strathmorii* Wilson. 8a, brachial valve; 8b, pedicle valve. Both on one slab. Holotype, G.S.C. No. 6611. (Page 45.)
- Figure 9. *Dinorthis iphigenia* (Billings). Brachial valve, showing a moderate convexity with a slight median flattening. Cotype, G.S.C. No. 1634a. (Page 41.)
- Figure 10. *Dinorthis iphigenia* (Billings). Pedicle valve, showing the relatively short hinge line, and relatively fine striæ. Cotype, G.S.C. No. 1634b.
- Figure 11. *Dinorthis pectinella sweeneyi* (N. H. Winchell). 11a, brachial valve; 11b, profile. Reprint. (Page 44.)
- Figure 12. *Dinorthis pectinella* (Emmons). Brachial valve, somewhat broken, showing the low convexity, and simple coarse striæ. Plesiotype, G. W. Sinclair collection. (Page 43.)
- Figure 13. *Dinorthis pectinella* (Emmons). Pedicle valve. Plesiotype, G.C.S. No. 6399.
- Figure 14. *Dinorthis subquadrata alternata* n.var. 14a, showing the degree of convexity and the erect, high cardinal area; 14b, brachial valve showing the alternation of striæ. Holotype. G.S.C. No. 1630. (Page 45.)
- Figure 15. *Dinorthis regularis* n.sp. Brachial valve, showing the subcircular outline and the regularity of the convexity and striæ. Holotype, G.S.C. No. 6402. (Page 44.)
- Figure 16. *Dinorthis calderi* n.sp. 16a, hinge line, showing the slightly resupinate wings; 16b, pedicle valve showing the broad, flat depression; 16c, brachial valve, showing the even convexity. Holotype, J. A. Calder, collection. (Page 40.)
- Figure 17. *Dinorthis ottawaensis* n.sp. Brachial valve, partly exfoliated but showing the relatively fine striæ. Holotype, G.S.C. No. 6398. (Page 43.)
- Figure 18. *Dinorthis browni* n.sp. Brachial valve, showing the evenly convex form and the method of increase of striæ. Holotype, G.S.C. No. 1620. (Page 39.)
- Figure 19. *Dinorthis browni* n.sp. Pedicle valve. Paratype, G.S.C. No. 6391.
- Figure 20. *Dinorthis dubia* n.sp. Brachial valve, with an indefinite depression imposed on its low convexity. Holotype, G. W. Sinclair collection. (Page 40.)
- Figure 21. *Dinorthis* sp. Pedicle valve, No. 3. Holotype, G. W. Sinclair collection. (Page 46.)
- Figure 22. *Dinorthis* sp. Pedicle valve, No. 2. Holotype, G.S.C. No. 6404. (Page 46.)
- Figure 23. *Dinorthis* sp. Pedicle valve No. 1. Holotype, G. W. Sinclair collection. (Page 47.)
- Figure 24. *Dinorthis* sp. Pedicle valve, No. 5. Holotype, G. W. Sinclair collection. (Page 47.)
- Figure 25. *Dinorthis* sp. Pedicle valve, No. 4. Holotype, G. W. Sinclair collection. (Page 47.)



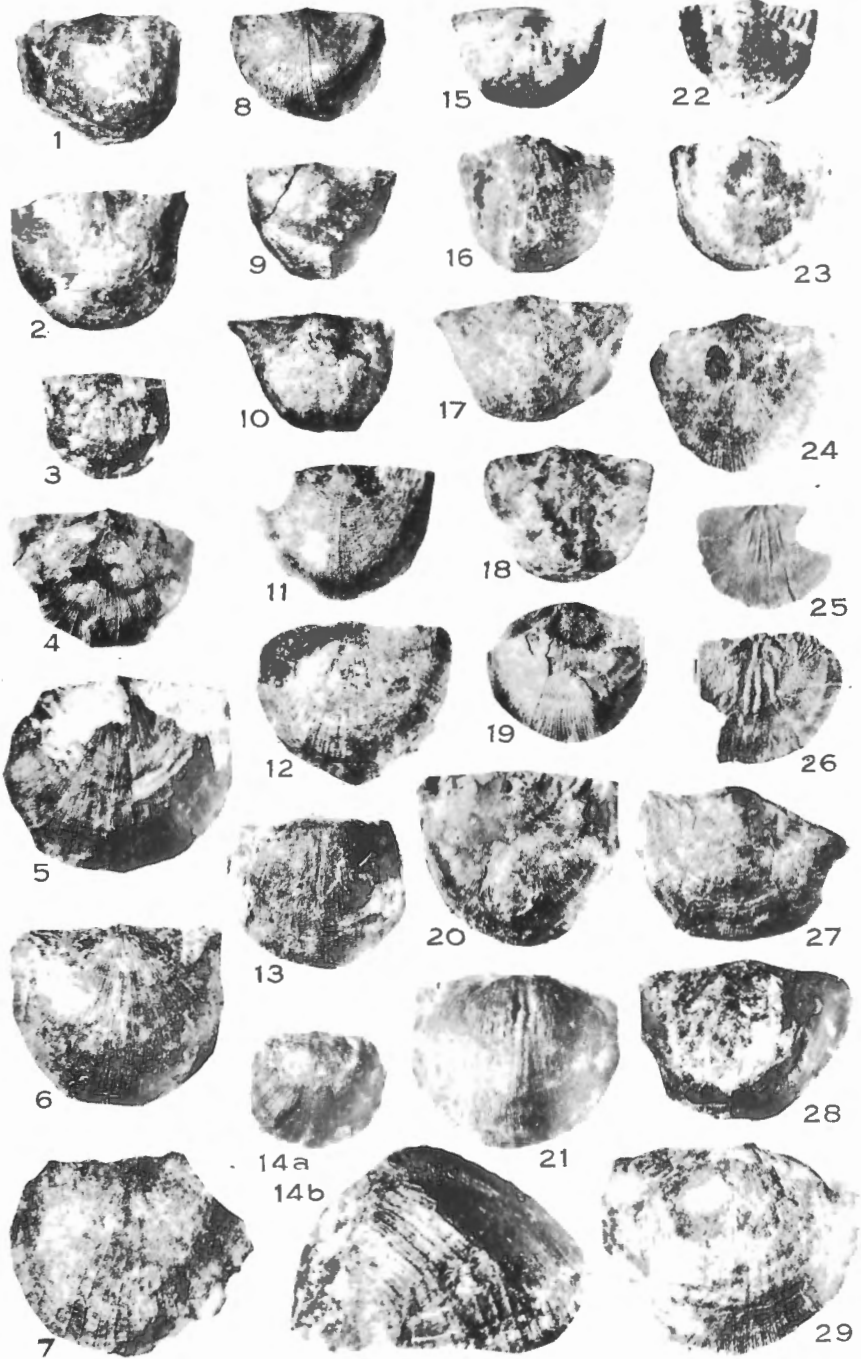
## PLATE V

- Figure 1. *Rafinesquina alternata plana* Wilson. Pedicle valve. Holotype, G.S.C. No. 8948. (Page 67.)
- Figure 2. *Rafinesquina alternata plana* Wilson. Interior of brachial valve. Paratype, G.S.C. No. 8947.
- Figure 3. *Rafinesquina alternata intermedia* Wilson. Pedicle valve. Holotype, G.S.C. No. 8946. (Page 67.)
- Figure 4. *Rafinesquina alternata* (Conrad). Pedicle valve, to show the relative size. Plesiotype, G.S.C. No. 8961. (Page 66.)
- Figure 5. *Rafinesquina lennoxensis* Salmon. Pedicle valve. Plesiotype, G.S.C. No. 8953. (Page 70.)
- Figure 6. *Rafinesquina alternata quadrata* Wilson. Holotype, G.S.C. No. 8950. (Page 69.)
- Figure 7. *Rafinesquina alternata semiquadrata* Wilson. Holotype, G.S.C. No. 8951. (Page 69.)
- Figure 8. *Rafinesquina rotunda* Wilson. Holotype, G.S.C. No. 8962. (Page 75.)
- Figure 9. *Rafinesquina esmondensis borealis* Wilson. Holotype, G.S.C. No. 8956. (Page 72.)
- Figure 10. *Rafinesquina calderi* Wilson. The specimen is worn but the left side shows the outline. Holotype, G.S.C. No. 8955. (Page 71.)
- Figure 11. *Rafinesquina alternata platys* Wilson. The view from the top does not show the extreme flatness of the species. Holotype, J. A. Calder collection. (Page 68.)
- Figure 12. *Rafinesquina alternata transversa* Wilson. Holotype, G.S.C. No. 8952. (Page 69.)
- Figure 13. *Rafinesquina patula* Wilson. Holotype, G.S.C. No. 8960. (Page 74.)
- Figure 14. *Rafinesquina orleansensis* Wilson. Holotype, G.S.C. No. 8959. (Page 74.)
- Figure 15. *Rafinesquina praecursor* Raymond. Holotype, G.S.C. No. 3259. (Page 74.)
- Figure 16. *Rafinesquina subtrigonalis* Wilson. Holotype, G.S.C. No. 8964. (Page 76.)
- Figure 17. *Rafinesquina opeongoensis* Wilson. Holotype, G.S.C. No. 8958. (Page 73.)
- Figure 18. *Rafinesquina alternata alata* Wilson. Holotype, G.S.C. No. 8945. (Page 66.)
- Figure 19. *Rafinesquina alternata pota* Wilson. Holotype, G.S.C. No. 8949.
- Figure 20. *Rafinesquina hullensis* Wilson. Holotype, G.S.C. No. 8957. (Page 73.)



## PLATE VI

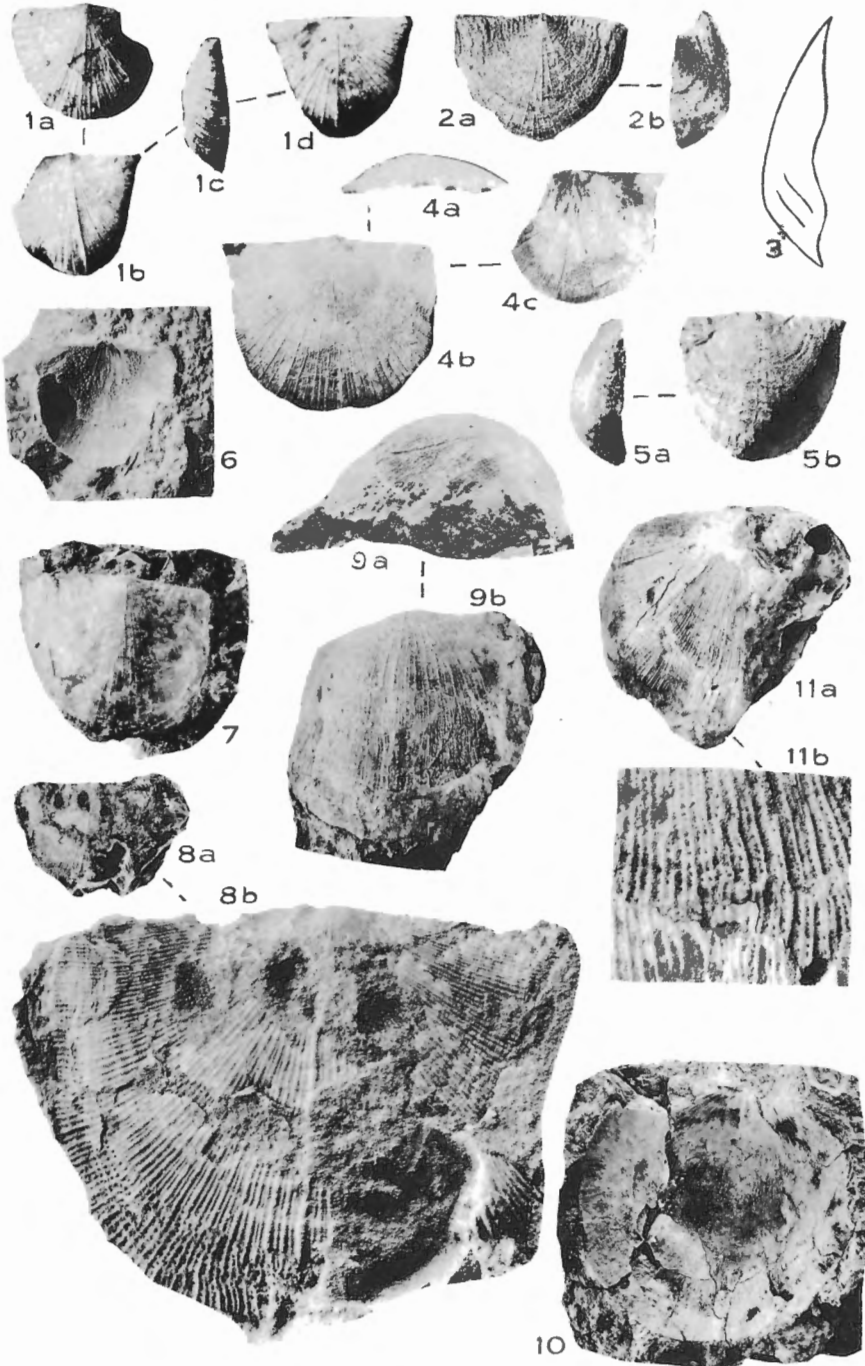
- Figure 1. *Rafinesquina subcamerata* Wilson. Holotype, G.S.C. No. 8963. (Page 76.)
- Figure 2. *Rafinesquina apicalis* Wilson. The illustration does not show the central elevation well. Holotype, G.S.C. No. 8954. (Page 71.)
- Figure 3. *Rafinesquina semicircularis minor* Wilson. Holotype, G.S.C. No. 8975. (Page 83.)
- Figure 4. *Rafinesquina semicircularis* Wilson. The upper left hand corner is slightly crushed, making the specimen wider along the hinge line. Holotype, G.S.C. No. 8974. (Page 83.)
- Figure 5. *Rafinesquina normaloides* Wilson. A slight crushing accentuates the concentric wrinkles. Holotype, G.S.C. No. 8968. (Page 80.)
- Figure 6. *Rafinesquina sardesoni* Salmon(?). Plesiotype, G.S.C. No. 8973. (Page 83.)
- Figure 7. *Rafinesquina okulitchi* Wilson. Holotype, G.S.C. No. 8969. (Page 80.)
- Figure 8. *Rafinesquina salmoni* Wilson. Outline very similar to *Opikina septata borealis*, but the pore arrangement is very different. Holotype, G.S.C. No. 8972. (Page 82.)
- Figure 9. *Rafinesquina miodeltoidea* Wilson. Holotype, G.S.C. No. 8967. (Page 79.)
- Figure 10. *Rafinesquina sinuata* Wilson. Holotype, G.S.C. No. 8976. (Page 84.)
- Figure 11. *Rafinesquina praedelloidea* Wilson. The very fine crenulations not well shown here, distinguishing this species from *R. laurentina*, which occurs in higher beds. Holotype, G.S.C. No. 8971. (Page 81.)
- Figure 12. *Rafinesquina laurentina* Wilson. (See note under Figure 11.) Holotype, G.S.C. No. 8966. (Page 78.)
- Figure 13. *Rafinesquina gibbosa* Wilson. Holotype, G.S.C. No. 8965. (Page 78.)
- Figure 14. *Rafinesquina ottawaensis* Wilson. 14a, view from top; 14b, profile, x 2½, showing geniculation, striae, and pores. Holotype, G.S.C. No. 8970. (Page 81.)
- Figure 15. *Opikina septata borealis* Wilson. Note the similarity of outline to that of *Rafinesquina salmoni*, Figure 8. Holotype, G.S.C. No. 8982. (Page 92.)
- Figure 16. *Opikina tumida* Wilson. Holotype, G.S.C. No. 8987. (Page 93.)
- Figure 17. *Opikina auriculata* Wilson. Note the similarity of outline to that of *Rafinesquina sinuata*, Figure 10. Holotype, G. W. Sinclair collection. (Page 89.)
- Figure 18. *Opikina sinclairi* Wilson. An exfoliated specimen, showing the outline. Holotype, G.S.C. No. 8983. (Page 92.)
- Figure 19. *Opikina sinclairi* Wilson. A specimen showing the striae. Paratype, G.S.C. No. 8984.
- Figure 20. *Opikina gloucesterensis* Wilson. Holotype, G.S.C. No. 8978. (Page 89.)
- Figure 21. *Opikina hemispherica* Wilson. Holotype, G.S.C. No. 8979. (Page 90.)
- Figure 22. *Opikina platys* Wilson. Holotype, G.S.C. No. 8980. (Page 91.)
- Figure 23. *Opikina platys* Wilson. A rather larger specimen than is common. Paratype, G.S.C. No. 8981.
- Figure 24. *Opikina subtriangularis* Wilson. Holotype, G.S.C. No. 8985. (Page 92.)
- Figure 25. *Opikinella affinis* Wilson. Holotype, G.S.C. No. 8990. (Page 95.)
- Figure 26. *Opikinella salmoni* Wilson. Holotype, G.S.C. No. 8991. (Page 95.)
- Figure 27. *Opikina wagneri robusta* Wilson. Broken valve, but showing the posterior part and region of geniculation. Paratype, G.S.C. No. 8989.
- Figure 28. *Opikina wagneri robusta* Wilson. Outline of the right hand side more nearly typical. Holotype, G.S.C. No. 8988. (Page 94.)
- Figure 29. *Opikina ampla* Wilson. Holotype, G.S.C. No. 8977. (Page 89.)





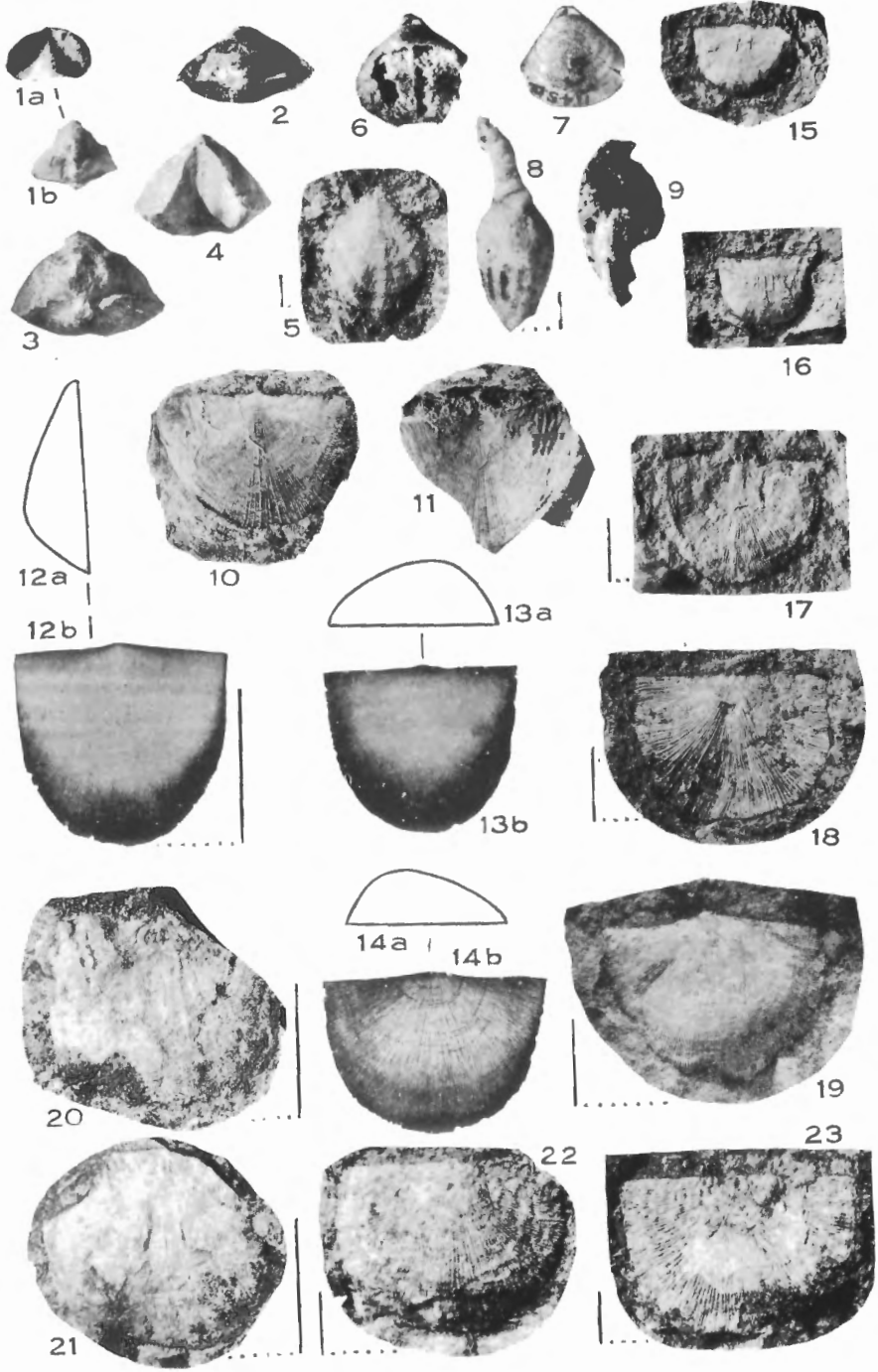
## PLATE VII

- Figure 1. *Rafinesquina declivis* (James). 1a, pedicle valve, more rounded than the average; 1b, pedicle valve, showing the elongated outline and low convex posterior part; 1c, profile; 1d, pedicle valve, showing complete hinge line. Reprint. (Page 77.)
- Figure 2. *Rafinesquina deerensis* Salmon. 2a, showing outline and rugose markings of pedicle valve; 2b, profile. Reprint. (Page 77.)
- Figure 3. *Rafinesquina normaloides* Wilson. Drawing of profile, slightly larger than normal, showing the long, flat part posterior to the geniculation. (Page 80.)
- Figure 4. *Rafinesquina prestonensis* Salmon. 4a, profile; 4b, large pedicle valve; 4c, small pedicle valve, showing prominent auriculation. Reprint. (Page 75.)
- Figure 5. *Rafinesquina deltoidea* (Conrad). 5a, profile; 5b, pedicle valve of a typical specimen. Plesiotype, G.S.C. No. 7736. (Page 77.)
- Figure 6. *Rafinesquina camerata* (Conrad). Interior of a brachial valve, not from this region. Plesiotype, G.S.C. No. 3258. (Page 71.)
- Figure 7. *Rafinesquina camerata* (Conrad). Pedicle valve of a rather large specimen, not from this region. Plesiotype, G.S.C. No. 3256a.
- Figure 8. *Rafinesquina carlottina* Wilson. 8a, pedicle valve; 8b, the same, x 4. Holotype, G.S.C. No. 8955. (Page 70.)
- Figure 9. *Rafinesquina robusta* Wilson. 9a, profile; 9b, pedicle valve, the same specimen. Paratype, G.S.C. No. 6655a.
- Figure 10. *Rafinesquina robusta* Wilson. Interior of a brachial valve. Holotype, G.S.C. No. 6655. (Page 75.)
- Figure 11. *Rafinesquina equipunctata* Wilson. 11a, pedicle valve; 11b, the same, x 4. Holotype, G.S.C. No. 6637. (Page 72.)



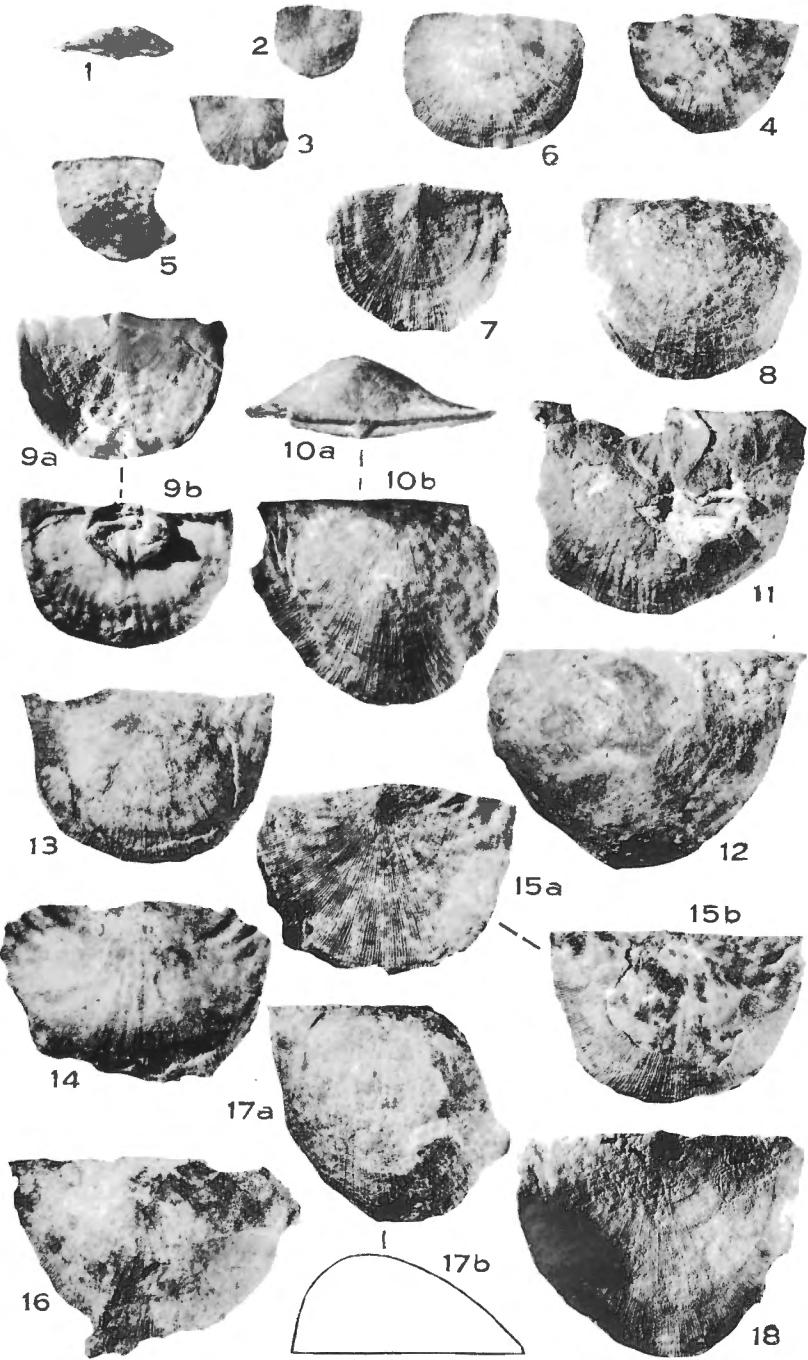
## PLATE VIII

- Figure 1. *Triplecia nuclea* (Hall). 1a, pedicle valve; 1b, posterior view, showing the elevated fold. Plesiotype, G. W. Sinclair collection. (Page 117.)
- Figure 2. *Triplecia extans* (Emmons). View from the hinge line, showing the moderate height of the fold. Plesiotype, G.S.C. No. 6415. (Page 116.)
- Figure 3. *Triplecia cuspidata* (Hall). Posterior view, showing the height of the fold and relative gibbosity of the sides. Plesiotype, G.S.C. No. 6414a. (Page 116.)
- Figure 4. *Triplecia cuspidata* (Hall). Anterior view, showing the narrowness of the fold; and the angularity of the sinus. Plesiotype, G.S.C. No. 6414.
- Figure 5. *Triplecella diplicata* Wilson (?). Pedicle valve. Holotype, G.S.C. No. 6659, x 4. (Page 117.)
- Figure 6. *Eichwaldia subtrigonalis* Billings. Brachial valve, showing the long median septum. Paratype, G.S.C. No. 1145g.
- Figure 7. *Eichwaldia subtrigonalis* Billings. Brachial valve. Holotype, G.S.C. No. 1145a. (Page 120.)
- Figure 8. *Eichwaldia subtrigonalis* Billings. Small specimen, showing a silicified tube supposed to be the pedicle. Paratype, G.S.C. No. 1145, x 4.
- Figure 9. *Eichwaldia subtrigonalis* Billings. Profile of a large specimen. Plesiotype, G.S.C. No. 6418.
- Figure 10. *Rafinesquina normalis* Wilson. Pedicle valve, showing the typical outline, and the low convexity of the posterior part. Holotype, G.S.C. No. 6653. (Page 79.)
- Figure 11. *Rafinesquina normalis* Wilson. Pedicle valve, showing some of the cardinal crenulations. Paratype, G.S.C. No. 6653a.
- Figure 12. *Öpikina transitionalis* (Okulitch). 12a, profile; 12b, pedicle valve, x 1½. Reprint. Holotype, Redpath Museum, McGill University. (Page 93.)
- Figure 13. *Öpikina williamsi* (Okulitch). 13a, profile; 13b, pedicle valve. Reprint. Holotype, Redpath Museum, McGill University. (Page 94.)
- Figure 14. *Öpikina wagneri* (Okulitch). 14a, profile; 14b, pedicle valve, x 1½. Holotype, Redpath Museum, McGill University. (Page 94.)
- Figures 15 and 16. *Öpikina rugosa avita* Wilson. Two exfoliated brachial valves showing parts of the septa. Paratype, G. W. Sinclair collection. (Page 91.)
- Figure 17. *Öpikina rugosa avita* Wilson. Brachial valve, showing the projecting cardinal process. Paratype, G.S.C. No. 6813c, x 2.
- Figure 18. *Öpikina rugosa avita* Wilson. Exterior of a brachial valve. Paratype, G.S.C. No. 6813b, x 2.
- Figure 19. *Öpikina rugosa avita* Wilson. Pedicle valve. Holotype, G.S.C. No. 6813a, x 2.
- Figure 20. *Öpikina ovalis* Wilson. Brachial valve, showing 3 of the 5 septa and the irregular network of punctæ. Cotype, G.S.C. No. 6222, x 1½. (Page 90.)
- Figure 21. *Öpikina ovalis* Wilson. Another brachial valve, showing 3 of the 5 septa and a few of the crenulations at the hinge line. Cotype, G.S.C. No. 6222, x 1½.
- Figure 22. *Öpikina rugosa* Wilson. Pedicle valve showing the rugose exterior. Holotype, G.S.C. No. 6221, x 2. (Page 91.)
- Figure 23. *Öpikina rugosa* Wilson. Brachial valve. Paratype, G.S.C. No. 6221a, x 2.



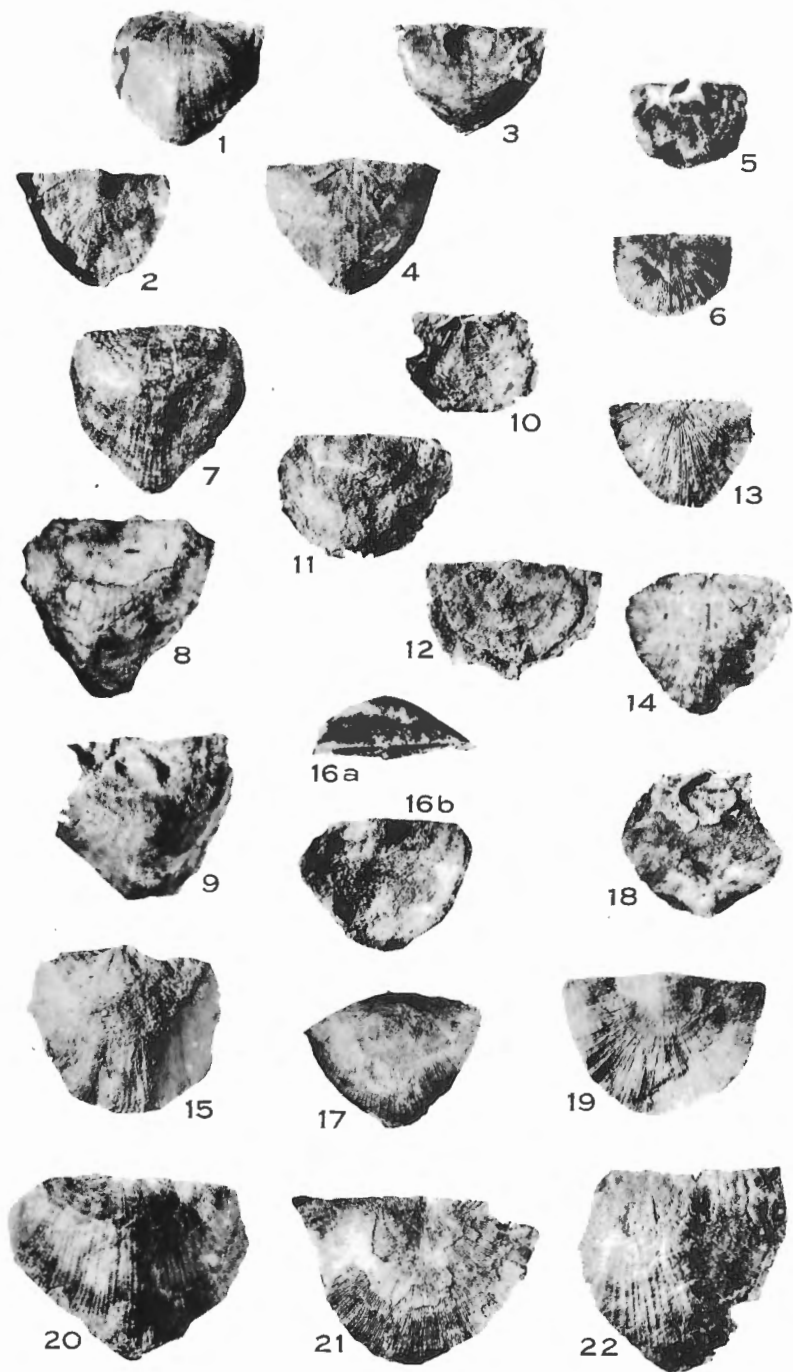
## PLATE IX

- Figure 1. *Strophomena minuta* Wilson. Hinge line, showing the thinness of the shell. Holotype, G.S.C. No. 7616. (Page 105.)
- Figure 2. *Strophomena minuta* Wilson. Brachial valve. Paratype, G.S.C. No. 7617.
- Figure 3. *Strophomena minuta* Wilson. Pedicle valve. Paratype, G.S.C. No. 7618.
- Figure 4. *Strophomena mollis* Wilson. Brachial valve. Holotype, G.S.C. No. 7538. (Page 105.)
- Figure 5. *Strophomena ? millionensis affinis* Wilson. Brachial valve. Holotype, G.S.C. No. 7586. (Page 104.)
- Figure 6. *Strophomena venustula* Wilson. Brachial valve. Holotype, G.S.C. No. 7591. (Page 107.)
- Figure 7. *Strophomena venustula* Wilson. Pedicle valve. Paratype, G.S.C. No. 7599.
- Figure 8. *Strophomena rotunda* Wilson. Brachial valve. The illustration does not make clear that the greatest convexity is at some distance from the beak, as compared with *S. filitexta obesa* in which it is near the beak. Holotype, G.S.C. No. 7589. (Page 106.)
- Figure 9. *Strophomena planumbona praecipita* Wilson. 9a, exterior of pedicle valve; 9b, interior of the same. Holotype, G.S.C. No. 1156a. (Page 106.)
- Figure 10. *Strophomena thalva* Billings. 10a, cardinal area, showing the resupinate wings; 10b, the same, brachial valve. Holotype, G.S.C. No. 1607b. (Page 107.)
- Figure 11. *Strophomena magna* Wilson. Interior of a pedicle valve. Paratype, G. W. Sinclair collection.
- Figure 12. *Strophomena magna* Wilson. Brachial valve. Holotype, G.S.C. No. 7579. (Page 104.)
- Figure 13. *Strophomena filitexta* Hall. Brachial valve, showing the faint wrinkles almost at right angles to the cardinal area. Plesiotype, G.S.C. No. 7593. (Page 102.)
- Figure 14. *Strophomena filitexta crenulata* Wilson. Brachial valve, showing the oblique crenulations. Holotype, G.S.C. No. 7573. (Page 103.)
- Figure 15. *Strophomena filitexta crenulata* Wilson. 15a, pedicle valve; 15b, brachial valve, showing the complementary position of the wrinkles. Paratype, G.S.C. No. 7574.
- Figure 16. *Strophomena* sp. Brachial valve, showing the sharp fold. Holotype, G.S.C. No. 7612. (Page 108.)
- Figure 17. *Strophomena filitexta obesa* Wilson. 17a, brachial valve; 17b, profile. Paratype, G.S.C. No. 7570. (See note under Figure 8.)
- Figure 18. *Strophomena filitexta obesa* Wilson. Pedicle valve. Holotype, G.S.C. No. 7651. (Page 103.)



## PLATE X

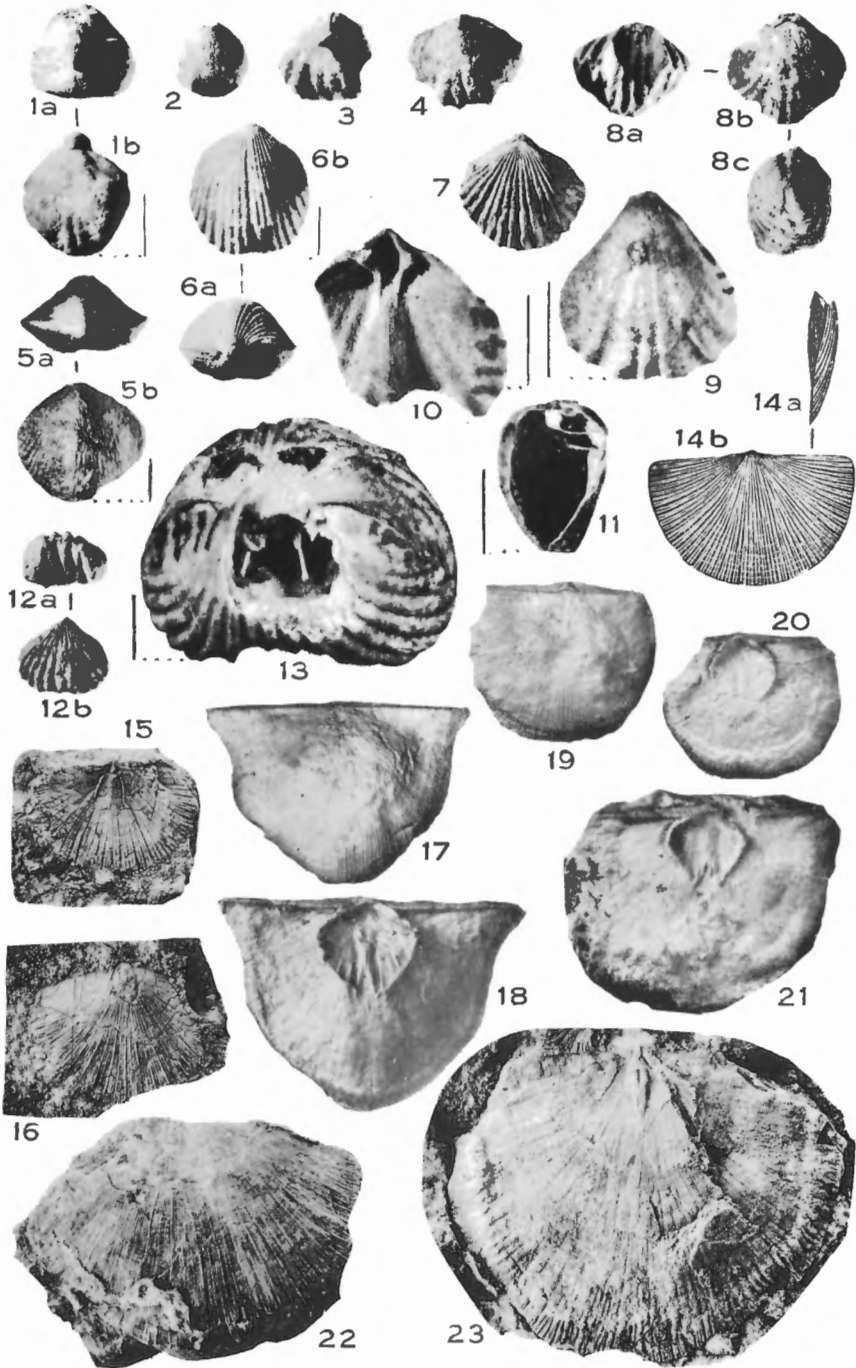
- Figure 1. *Trigrammaria pulchra* Wilson. Brachial valve. Holotype, G.S.C. No. 7652. (Page 108.)
- Figure 2. *Trigrammaria pulchra* Wilson. Pedicle valve. Paratype, G.S.C. No. 7653.
- Figure 3. *Trigrammaria trigonalis parva* Wilson. Pedicle valve. Holotype, G.S.C. No. 7656. (Page 110.)
- Figure 4. *Trigrammaria trigonalis parva* Wilson. Brachial valve. The illustration resembles Figure 1, but the convexity is greater and the sides are more abrupt. Paratype, G.S.C. No. 7657.
- Figure 5. *Microtrypa ? plana* Wilson. Interior of pedicle valve. Holotype, G.S.C. No. 7646. (Page 113.)
- Figure 6. *Microtrypa ? plana* Wilson. Exterior of brachial valve. Paratype, G.S.C. No. 7646a.
- Figure 7. *Trigrammaria trigonalis* Wilson. Brachial exterior. Holotype, G.S.C. No. 7614. (Page 109.)
- Figure 8. *Trigrammaria trigonalis* Wilson. Brachial valve exfoliated. Paratype, G.S.C. No. 7614a.
- Figure 9. *Trigrammaria trigonalis* Wilson. Interior of pedicle valve. The muscle scar on the left is more correct. The right side is slightly thickened by extraneous matter. Paratype, G.S.C. No. 7637.
- Figure 10. *Microtrypa altilis* Wilson. Interior of brachial valve. Holotype, G.S.C. No. 7649. (Page 111.)
- Figure 11. *Microtrypa altilis* Wilson. Exterior of brachial valve exfoliated. Paratype, G.S.C. No. 7649a.
- Figure 12. *Microtrypa altilis* Wilson. Worn exterior of a pedicle valve. Paratype, G.S.C. No. 7650.
- Figure 13. *Microtrypa ? nasuta* Wilson. Brachial valve, showing the typical striation. Paratype, G.S.C. No. 7641a.
- Figure 14. *Microtrypa ? nasuta* Wilson. Brachial valve, partly exfoliated. The illustration seems similar to *T. pulchra*, Figure 1, and to *T. trigonalis parva*, Figure 4, but the striation is different and the convexity is even and not so pronounced. Holotype, G.S.C. No. 7641. (Page 112.)
- Figure 15. *Trigrammaria trigonalis tumida* Wilson. Brachial valve. Holotype, G.S.C. No. 7659. (Page 111.)
- Figure 16. *Microtrypa ? modesta* Wilson. 16a, cardinal view; 16b, exterior of exfoliated pedicle valve. Paratype, G. W. Sinclair collection.
- Figure 17. *Microtrypa ? modesta* Wilson. Brachial valve. Holotype, G.S.C. No. 7643. (Page 112.)
- Figure 18. *Microtrypa ? tersa* Wilson. Interior of a pedicle valve. Holotype, G.S.C. No. 7647. (Page 114.)
- Figure 19. *Microtrypa ? tersa* Wilson. Exterior of a pedicle valve. Paratype, G.S.C. No. 7648.
- Figure 20. *Trigrammaria trigonalis prima* Wilson. Brachial valve. Holotype, G.S.C. No. 2658. (Page 110.)
- Figure 21. *Microtrypa ? nitida* Wilson. Pedicle interior, showing the striæ from the inner side. Holotype, G.S.C. No. 7644. (Page 113.)
- Figure 22. *Microtrypa ? nitida* Wilson. Partly exfoliated brachial valve, from which the finer striæ are obliterated. Paratype, G.S.C. No. 7645.

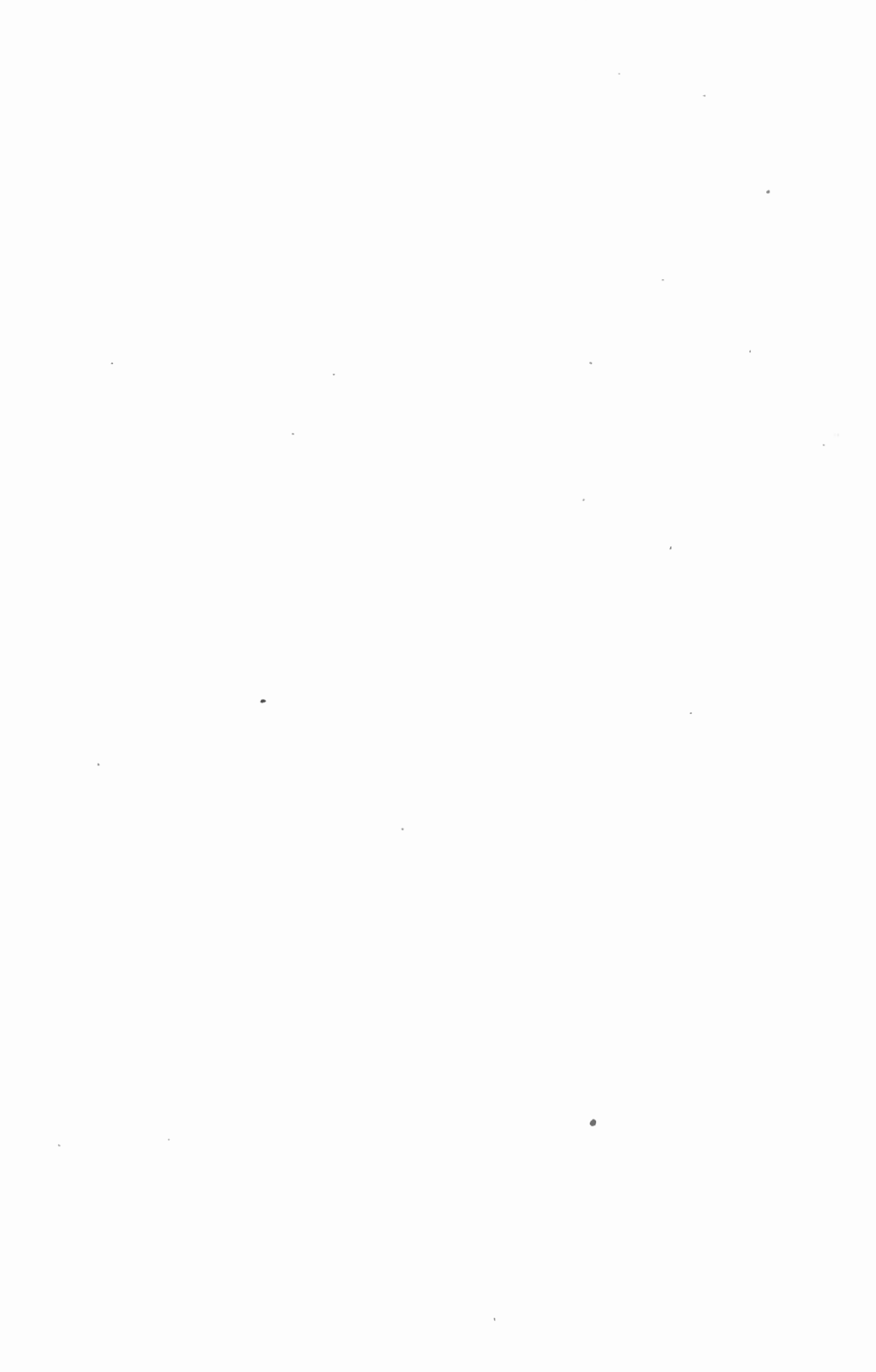




## PLATE XI

- Figure 1. *Cyclospira bisulcata* (Emmons). 1a, posterior view, showing the gibbosity; 1b, brachial valve. Plesiotype, G.S.C. No. 6422, x 2. (Page 123.)
- Figure 2. *Camerella panderi* Billings. Pedicle valve, showing the faint sinus. Plesiotype, G. W. Sinclair collection. (Page 118.)
- Figure 3. *Camerella volborthi* Billings. Pedicle valve, partly exfoliated showing part of a septum and the shallow sinus. Plesiotype, G.S.C. No. 6417. (Page 119.)
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