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CANADA

DEPARTMENT OF MINES AND RESOURCES

MINES AND GEOLOGY BRANCH

GEOLOGICAL SURVEY BULLETIN

No. 9

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

BY

Alice E. Wilson



OTTAWA
EDMOND CLOUTIER, C.M.G., B.A., L.Ph.,
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PREFACE

This report is the third of a series of planned reference texts on the palæontology of the Palæozoic strata of the Ottawa-St. Lawrence Lowland. The series commenced with studies of the fauna of the Ottawa formation, a thick, highly fossiliferous limestone formation of Middle Ordovician age that occupies a prominent place in the Palæozoic section. The initial contribution, Geological Survey Bulletin No. 4, dealt with the Echinodermata of that formation, and was followed by Geological Survey Bulletin No. 8, in which an exhaustive study was made of the Brachiopoda, the most important group of fossils, both in respect to numbers of genera and species and numbers of specimens, in the Ottawa formation. The present contribution deals with the Trilobita, the second most important group, and it is intended that succeeding bulletins will deal with still other significant faunal classes of this formation.

Information on the geology and economic resources of the region is contained in Memoir 241, recently published by the Geological Survey, on the "Geology of the Ottawa-St. Lawrence Lowland". That report, by the same author, includes a full bibliography on the geology and palæontology of this early Palæozoic basin.

GEORGE HANSON,

Chief Geologist, Geological Survey

OTTAWA, October 17, 1946

TRILOBITA 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 west 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 because fossils found in the lower beds show that they, too, are of Black River age. The 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 previously into seven divisions, variously termed "members" or "formations". These several divisions are here considered to be beds of faunal associations. There is no sharp dividing line between them 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 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 the 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' are retained in conjunction with the more elastic term 'beds' to designate the general level at which each 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 AND RANGE OF TRILOBITA

The Trilobita constitute the second most important group of fossils found in the Ottawa formation. They are not as prolific in genera, in species, nor in number of specimens, as the Brachiopoda; nevertheless they are outstanding. The study of the Trilobita, like the previous studies of the Echinodermata and Brachiopoda, show many long ranging forms, and corroborates the conclusion that in this area the divisions of the limestone of Black River-Trenton age should be considered as faunal associations rather than as 'formations' or 'members'. Later discoveries may add to the species or even to the number of genera, probably extending the range of some forms and thereby serving to strengthen the evidence for this conclusion.

The following tables analyse three main features of the occurrence and range of the Trilobita. As in previous studies by the author the widths of the separate columns of the tables are drawn to scale, to indicate the relative thicknesses of the original 'members' or 'formations' as they have been variously described.

Table I is arranged biologically, bringing together all the species of the several genera and showing that most genera range throughout the formation, but that, in a few instances, one species of a genus occurs at a low horizon and is replaced at a higher horizon by another species of the same genus.

Table II is arranged according to the first occurrence of the species and genera. It shows very clearly the long range of many forms that first appear early in Black River-Trenton time. As previously noted, subsequent discoveries may add to the range of some species or even of some genera.

Table III is a synopsis of the information in Tables I and II, showing the number of species first appearing in each group of faunal beds, the number confined to those beds, as far as known now (the figures in brackets), and the number and range of those that continue beyond the beds in which they first occur. Of the 55 species found, 35 appear in the lowermost 135 feet or approximately in what is usually assigned to the Black River 'members' or 'formations', and 20 in the succeeding 555 feet, or 50 first appear in the lower half of the formation as compared to 5 in the upper half.

TABLE I
Range of *Tribolita* in Biological Order

SPECIES	OTTAWA FORMATION FAUNAL BEDS						
	Pamella	Lowville	Leroy	Rockland	Hull	Sherman Fall	Cobourg
<i>Eoharpes dentoni</i> (Billings)					X	X	X
<i>E. ottawaensis</i> (Billings)						X	X
<i>Cryptolithus bellulus</i> (Ulrich)						X	X
<i>C. tessellatus</i> Green						X	
<i>Bathyurus acutus</i> Raymond	X	X	X				
<i>B. bandifer</i> Sinclair			X				
<i>B. extans</i> (Hall)	X	X					
<i>B. ingalli</i> Raymond	X	X					
<i>B. johnstoni</i> Raymond		X					
<i>B. magnus</i> n.sp.		X					
<i>B. springer</i> (Hall)		X	X				
<i>B. superbus</i> Raymond	X						
<i>B. trispinosus</i> n.sp.			X				
<i>Homotelus</i> ? <i>elongatus</i> Raymond				X			X
<i>Basitacus barrandi</i> (Hall)			X				
<i>Isotelus gigas</i> DeKay		X	X	X	X	X	X
<i>I. towensti</i> (Owen)		X	X	X	X	X	X
<i>I. latus</i> Raymond		X	X	X	X	X	X
<i>I. maximus</i> Locke			X				X
<i>I. ottawaensis</i> n.sp.							X
<i>Isotolitoides homalonotoides</i> (Walcott)			X				
<i>Vagdesia stueclairi</i> n.sp.			X				
<i>Illaenus americanus</i> Billings			X			X	X
<i>I. angusticollis</i> Billings			X				
<i>I. conradi</i> Billings		X	X				
<i>I. latrariatus</i> Raymond			X				X
<i>Bumastus bilingei</i> Raymond and Narraway				X		X	X
<i>B. indeterminatus</i> (Walcott)		X	X	X			
<i>B. milleri</i> (Billings)	X						

TABLE I—*Contc.*
 Range of *Trilobita* in Biological Order—*Contc.*

SPECIES	OTTAWA FORMATION FAUNAL BEDS						
	Pamella	Lowville	Leroy	Rookland	Hull	Sherman Fall	Cobourg
<i>B. porrectus</i> Raymond.....					X		X
<i>Thalopsis ovata</i> Conrad.....		X		X	X		
<i>Eobronteus lamatus</i> (Billings).....						X	X
<i>Otarion wilsonae</i> Sinclair.....					X	X	X
<i>Acroichas cucullus ottawaensis</i> Foerste.....					X		
<i>Acroichas narrawayi</i> Foerste.....							
<i>Hemimarges paulianus</i> (Clarke).....				X		X	X
<i>Odomtopleura parvula</i> (Walcott).....					X	X	X
<i>Encrinurus cybeleformis</i> Raymond.....				X			X
<i>E. tremionensis</i> Walcott.....				X			X
<i>Cybeloides ella</i> Narraway and Raymond.....							
<i>C. plana</i> Sinclair.....						X	
<i>Flecticalymene senaria</i> (Conrad).....				X	X	X	X
<i>Cerurus bispinosus</i> Raymond and Barton.....				X	X		X
<i>C. dentatus</i> Raymond and Barton.....				X	X		X
<i>C. pleurozanthemus</i> Green.....				X	X		X
<i>Sphaerocorphe robusta</i> Walcott.....						X	X
<i>Ceraurinus marginatus</i> Barton.....						X	
<i>Pterygomelopus billingsi</i> (Sinclair).....						X	
<i>Calliopterus alatus</i> Okulitch.....					X		
<i>C. callicephalus</i> (Hall).....				X	X		X
<i>C. narrawayi</i> Okulitch.....				X	X		X
<i>Calyptaulax calderi</i> n.sp.....				X	X		X
<i>C. ollawanus</i> Okulitch.....				X	X		X
<i>Achalta achates</i> (Billings).....				X	X		X
<i>Chasmodon ? bebryc</i> (Billings).....				X	X		X

TABLE II

Range of *Trilobites* in Order of Their First Appearance

Species	OTTAWA FORMATION FAUNAL BEDS						
	Pamella	Lowville	Leray	Rockland	Hull	Sherman Fall	Cobourg
<i>Bathyurus acutus</i> Raymond.....							
<i>B. extans</i>							
<i>B. johnstoni</i> Raymond.....							
<i>B. superbus</i> Raymond.....							
<i>Bumastus malleri</i> (Billings).....							
<i>Illaenus conradi</i> Billings.....							
<i>Bathyurus magnus</i> n.sp.....							
<i>B. spiniger</i> (Hall).....							
<i>Isotelus gigas</i> DeKay.....							
<i>I. townensis</i> (Owen).....							
<i>Cerurus pleurocanthemus</i> Green.....							
<i>Bathyurus bandifer</i> Sinclair.....							
<i>Basileus barrandi</i> (Hall).....							
<i>Isotelus latus</i> Raymond.....							
<i>Isoteloides homalonotoides</i> (Walcott).....							
<i>Vogdesia sinclairi</i> n.sp.....							
<i>Illaenus americanus</i> Billings.....							
<i>I. angusticollis</i> Billings.....							
<i>I. lakaratus</i> Raymond.....							
<i>Bumastus indeterminatus</i> (Walcott).....							
<i>Thaloeops ovata</i> Conrad.....							
<i>Hemitargetes paulkanus</i> (Clarke).....							
<i>Encrinurus cybeleformis</i> Raymond.....							
<i>Cybeleoides ella</i> Raymond and Narraway.....							
<i>Flecticalymene senaria</i> (Conrad).....							
<i>Cerurus bispinosus</i> Raymond and Barton.....							
<i>C. deniatus</i> Raymond.....							
<i>Calliope callicephalus</i> (Hall).....							

TABLE II.—*Conc.*

Range of *Tribolites* in Order of Their First Appearance—*Conc.*

Species	OTTAWA FORMATION FAUNAL BEDS						
	Pamella	Lowville	Leroy	Rockland	Hull	Sherman Fall	Cobourg
<i>Bathyrus ingalli</i> Raymond.....							
<i>B. trispinosus</i> n.sp.....							
<i>Isotelus maximus</i> Locke.....							
<i>Encrinurus trentonensis</i> Walcott.....							
<i>Calliops narrawayi</i> Okulitch.....							
<i>Calyptraux calderi</i> n.sp.....							
<i>Achatella achates</i> (Billings).....							
<i>Bumastus porrectus</i> Raymond.....							
<i>Eoharpes dentoni</i> (Billings).....							
<i>Homotelus ? elongatus</i> Raymond.....							
<i>Bumastus billingsi</i> Raymond and Narraway.....							
<i>Acrolichas cucullus ottawaensis</i> Foerste.....							
<i>A. narrawayi</i> Foerste.....							
<i>Calliops alatus</i> Okulitch.....							
<i>Calyptraux ottawanus</i> Okulitch.....							
<i>Cryptolichas bellulus</i> (Ulrich).....							
<i>C. tessellatus</i> Green.....							
<i>Otarion wilsonae</i> Sinclair.....							
<i>Odontopleura parvula</i> (Walcott).....							
<i>Cybeloides plana</i> Sinclair.....							
<i>Sphaerocorphe robusta</i> Walcott.....							
<i>Pterygomotopus billingsi</i> (Sinclair).....							
<i>Eoharpes ottawaensis</i> Billings.....							
<i>Isotelus ottawaensis</i> n.sp.....							
<i>Eobronteus lunatus</i> (Billings).....							
<i>Ceraurinus marginatus</i> Barton.....							
<i>Chasmops ? bebrya</i> (Billings).....							

TABLE III

Numerical Synopsis of the Range of Trilobite Species

Pamelia or Pamelia-Lowville	Lowville or Lowville-Leray	Leray or Leray-Rockland	Rockland	Hull	Sherman Fall	Cobourg
6 (2)	2 5 (1)	1 1 24 (8)	1 — 1 1(0)	1 2 — 7 (3)	— — — 7 (5)	2 13 1 4 2 5 (5)

FOSSIL LOCALITIES

1. Eganville, Ontario
2. Southeast of Eganville, Ontario
3. Fourth Chûte of Bonnechère River, Ontario
4. Cobden road, 1½ miles northwest of Douglas, Ontario
5. Edge of hill above Sand Point, Ontario
6. Top of area west of MacLaren Landing, Ontario
7. MacLaren Landing, Ontario
8. Quarry east of Pakenham, Ontario
9. Lot 6, con. X, Pakenham, Ontario
10. First corner east of Panmure, Ontario
11. Lot 18, con. XI, Goulburn tp., Ontario
12. North of Aylmer, second block west of Klock road, Quebec
13. Lot 20, con. V, Hull tp., Quebec
14. Two miles north of Aylmer, Quebec
15. Small quarry near the top of the hill, Aylmer, Quebec
16. Val Tetreau, Quebec
17. La petite Chaudière, Quebec
18. East side of Fairy Lake, Quebec
19. Cement quarry, Hull, Quebec
20. Brewery Creek, Hull, Quebec
21. Behind axe factory, Hull, Quebec
22. Brigham Lake (Leamy Lake), Hull, Quebec
23. Brigham quarry, Hull, Quebec
24. Wright's dam, Hull, Quebec
25. Opposite the packing factory, Hull, Quebec
26. Cliff behind the match factory, Hull, Quebec
27. The 'Heap', Hull, Quebec
28. Between the C.P.R. tracks and the Armouries, Hull, Quebec
29. C.P.R. cutting south of Aylmer road crossing, Hull, Quebec
30. Philemon Island, Hull, Quebec
31. East end of Philemon Island, Hull, Quebec
32. Island below Hull slide, Quebec
33. Chaudière Falls, Hull, Quebec
34. Booth Mills, Hull, Quebec
35. Unspecified locality, Hull, Quebec
36. Loc. ?, con. A, Nepean tp., Ontario
37. La petite Chaudière, Ontario side, west of Mechanicsville, Ottawa, Ontario

38. Road at Duntile quarry, Carling avenue, Ottawa, Ontario
39. Foster's quarry, Merivale road, Ottawa, Ontario
40. Merivale road, just south of Carlington, southwest of Ottawa, Ontario
41. Merivale road, about 2 miles south of Carlington, southwest of Ottawa, Ontario
42. City View, southwest of Ottawa, Ontario
43. Westboro, west of Ottawa, Ontario
44. Mechanicsville, Ottawa, Ontario
45. Lemieux Island, Ottawa, Ontario
46. Lemieux Island bridge, Ottawa, Ontario
47. Victoria Island, Ottawa, Ontario
48. Ottawa River, unspecified, Ontario
49. Clarendon avenue, at the Sanatorium, Ottawa, Ontario
50. Ruskin avenue, west of Holland avenue, Ottawa, Ontario
51. West side of Parkdale avenue, north of the C.P.R. tracks, Ottawa, Ontario
52. C.P.R. tracks east of Parkdale avenue, Ottawa, Ontario
53. Rochesterville, Ottawa, Ontario
54. Hogsback, southwest of Ottawa, Ontario
55. South of road crossing Hogsback bridge, southwest of Ottawa, Ontario
56. DeLury farm, near Ottawa, Ontario
57. Booth street, Ottawa, Ontario
58. Lakeside Park avenue, Ottawa, Ontario
59. West end of Fifth avenue, Ottawa, Ontario
60. Corner Fifth avenue and Percy street, Ottawa, Ontario
61. Old limekiln, Rochester street, Ottawa, Ontario
62. Corner Rochester and Lydia streets, Ottawa, Ontario
63. Corner Booth and Elm streets, Ottawa, Ontario
64. Mount Sherwood, Ottawa, Ontario
65. Parliament Hill, Ottawa, Ontario
66. Nepean Point, Ottawa, Ontario
67. Between Nepean Point and Queens wharf, Ottawa, Ontario
68. Steamboat landing, foot of Sussex street, Ottawa, Ontario
69. Laurier avenue, Ottawa, Ontario
70. LaSalle Academy, Ottawa, Ontario
71. Cliff back of the Research Laboratories, Ottawa, Ontario
72. Ottawa River, below Earnscliffe, Ottawa, Ontario
73. Governor Bay, Rockcliffe, Ontario
74. East side of Governor Bay, Rockcliffe, Ontario
75. From an unspecified locality, Ottawa, Ontario
76. Eastview cemetery, Ontario
77. Road east of Eastview cemetery, Ontario
78. Road to Rockcliffe Aerodrome, Ontario
79. Powder House magazine quarry, east of Ottawa, Ontario
80. East of Robillard quarry, Montreal road, east of Ottawa, Ontario
81. Skead road, north of Montreal road, east of Ottawa, Ontario
82. Quarry at cottage gate, Skead road, east of Ottawa, Ontario
83. Montreal road not specified, east of Ottawa, Ontario
84. Outcrop west of Green Creek on Montreal road, east of Ottawa, Ontario
85. One-half mile southeast of Green Creek bridge, east of Ottawa, Ontario
86. Tank testing field, southeast of Green Creek bridge, east of Ottawa, Ontario
87. Lot 35, R.F., Gloucester tp., Ontario
88. Lot 2, con. III, R.F., Gloucester tp., Ontario
89. Lots 3 and 4, con. III, Gloucester tp., Ontario
90. Daniston gully, Ontario
91. Near junction of Montreal and Navan roads, Ontario
92. Squiggley Hill, west of Cumberland, Ontario

93. Old falls west of Cumberland, Ontario
94. Cumberland, Ontario
95. Southeast of Cumberland, Ontario
96. Lot 14, con. II, Cumberland tp., Ontario
97. Stewart quarry, south of Rockland, Ontario
98. Below massive bed of the Lowville, Stewart quarry, Rockland, Ontario
99. Near turn in the old highway southeast of East Rockland, banks of Clarence Creek, Ontario
100. Lot 21, con. F, Clarence tp., Ontario
101. Quarry northeast of Orient, Ontario
102. Southeast of Wendover, Ontario
103. Con. II, N. Plantagenet tp., south of Wendover, Ontario
104. Jessop Rapids, Nation River, Ontario
105. Lot 14, con. III, N. Plantagenet tp., Ontario
106. Lot 10, con. IV, N. Plantagenet tp., Ontario
107. North of Plantagenet village, Ontario
108. Below bridge, Plantagenet village, Ontario
109. Above bridge, Plantagenet village, Ontario
110. Lot 10, con. VI, N. Plantagenet village, Ontario
111. Sarsfield road, con. X, Clarence tp., Ontario
112. South and west of Embrun, Ontario
113. Small quarry south of main quarry, south of Embrun, Ontario
114. Castor River cut below Embrun, Ontario
115. Lemieux road, $\frac{3}{4}$ mile north of Castor River, Ontario
116. Quarry west of Lemieux road, north of Castor River, Ontario
117. Casselman, Ontario
118. Lot 19, con. XVI, S. Plantagenet tp., Ontario
119. East of St. Albert, Ontario
120. Between Morewood and North Winchester, Ontario
121. Winchester tp. (loose?), Ontario
122. Payne River, 900 feet east of Berwick road and south of bridge on road between cons. IV and V, Finch tp., Ontario
123. Lot 13, con. VII, Finch tp., Ontario
124. East of Goldfield, Ontario
125. One mile west of Finch, Ontario
126. Payne River in Finch, Ontario
127. Lot 22, con. V, Finch tp., Ontario
128. Lalonde quarry, south of highway, 3 miles west of Alfred, Ontario
129. Alfred Industrial School, Ontario
130. North of cheese factory, Ange gardien, west of L'Orignal, Ontario
131. Quarry south of Ange gardien road, west of L'Orignal, Ontario
132. Roadside, Ange gardien road, west of L'Orignal, Ontario
133. Near L'Orignal, unspecified, Ontario
134. North of Vankleek Hill, Ontario
135. Southeast of Skye, con. IX, Kenyon tp., on old right of way, Ontario
136. Lot 33, con. III, Kenyon tp., Ontario
137. Dam west of Alexandria, Ontario
138. Lot 23, con. VII, Roxborough tp., Ontario
139. Lots 24 and 25, con. V, Roxborough tp., Ontario
140. Lot 22, con. III, Roxborough tp., Ontario
141. Lots 11-14, con. III, Roxborough tp., Ontario
142. Lot 3, con. IV, Roxborough tp., Ontario
143. Back of cheese factory, Strathmore, Ontario
144. Con. I, Roxborough tp., where stream crosses road east of Strathmore, Ontario
145. Cut in creek just east of road between Lunenburg and North Lunenburg, Ontario

146. Lots 25 and 26, con. V, Osnabruck tp., Ontario
147. Lot 21, con. VIII, Cornwall tp., Ontario
148. Lots 1-3, con. VIII, Cornwall tp., Ontario
149. Near Bonville, Ontario
150. Mille Roches, Ontario
151. First crossing south of St. Andrews, Ontario
152. Con. V, Cornwall tp., southeast of St. Andrews, Ontario
153. Loose in field near Eamer Corners, Ontario
154. Con. IV, Cornwall, north of Grant Corners, Ontario
155. Cons. VIII and IX, Indian Lands, Charlottenburg tp., Ontario
156. Lots 34 and 35, con. IX, Charlottenburg tp., southeast of Apple Hill, Ontario
157. Con. IX, Charlottenburg tp., the second north-south road east of Sandfield Mills, Ontario
158. East of McGillivray bridge, Ontario
159. Black River Station, Ontario
160. East of Dunvegan, Ontario
161. Lot 22, con. IV, Kenyon tp., southeast of Greenfield, Ontario
162. Grenville, Quebec
163. An unspecified locality in the region, Ontario
164. Paquette Rapids, Ottawa River, Ontario
165. Near Meath, 7 miles northwest of Cobden, Ontario
166. Rideau Hall grounds, Ottawa, Ontario
167. Murray's quarry, near L'Original, Ontario
168. Lot 24, con. XII, Fitzroy tp., Ontario
169. Intersection Lisgar road and Dufferin terrace, Rockcliffe, Ontario
170. Corner Booth and Norman streets, Ottawa, Ontario
171. Major Hill Park, Ottawa, Ontario
172. Lots 27, and B, con. I, Torbolton tp., Ontario
173. Lot 16, con. VI, Bromley tp., Ontario
174. Lot 18, con. VIII, Wilberforce tp., Ontario
175. Allumette Island near Pembroke, Ontario
176. Mines Branch, corner Booth street, Ottawa, Ontario
177. C.N.R. tracks, west of Bronson avenue, Ottawa, Ontario
178. Quarry west of Lake Flora, Hull, Quebec
179. Queen street pump-house, Ottawa, Ontario
180. Lady Grey drive, Ottawa, Ontario

DESCRIPTION OF SPECIES

Genus, *Eoharpes* Raymond

Genotype, *Harpes primus* Barrande

Broadly horseshoe-shaped, oval in front, narrowing posteriorly; flat or concave border, produced into long spines; hypostoma oval.

Cephalon semicircular, convex; dorsal furrows curving around in front of the glabella; neck furrow shallow and broad; glabella narrowing anteriorly, three pairs of glabellar furrows, the anterior pair faint or obsolete, the middle pair faint, curving obliquely backward, the third pair deep, sloping backward almost to the neck furrow, forming a triangular convex posterior pair of lobes; eyes far forward, eye line present; on each side of the base of the glabella an oval section of the cheek, with axis about perpendicular to the glabella axis, limited posteriorly by the neck furrow, on the inner edge by the dorsal furrows, and with the outer edge curving inward anteriorly to reach the dorsal furrow at about the beginning of the anterior lobe; the convexity of the cheeks on either side of the glabella and perpendicular to it giving the cranium a trilobed appearance; genal angles produced into long spines curving towards the body posteriorly; sutures marginal; surface generally pitted.

Thorax with 14 to 18 ? segments; axial lobe narrow, convex; pleural lobes wide, flat on top, segments grooved, outer edges free, blunt, turned backward.

Pygidium short and wide.

Eoharpes is distinguished from other genera by its horseshoe outline and the trilobed effect of the combination of glabella and inner part of the cheek. It differs from *Harpes*, the most closely related genus, in having an oval hypostoma. A true *Harpes*, however, has not yet been described from the Ordovician of North America.

Eoharpes dentoni (Billings)

Plate I, figures 7, 8

Harpes dentoni Billings, Can. Nat. Geol., 8, 1863, p. 36, fig.; Geol. Surv., Canada, Pal. Foss., I, 1865, p. 183, fig. 166.

Eoharpes dentoni (Billings), Raymond, Geol. Surv., Canada, Victoria Mem. Mus., Bull. 1, 1913, p. 33, Pl. 3, fig. 5.

Border narrow and concave ending in narrow spines which extend almost to the tip of the pygidium.

Cephalon very convex; dorsal furrow rather shallow; neck furrow shallow; glabella extending four-fifths of distance to the margin of the abrupt edge of the convexity. Only the posterior pair of glabellar furrows is clearly preserved, curving backward, the end of the middle pair faintly visible, the crushing of the glabella completely obliterating the third pair; eyes placed at the edge of the convex part, eye line indistinct; cheek in two sections, the inner and smoother part adjacent to the base of the glabella less convex than the outer part; genal angles grooved, the outer part almost flat, the inner part almost erect having the same tilt as the outer edge of the thorax, continuing beyond and almost surrounding the pygidium; surface pitted, even the eye line; surface of glabella and inner part of the cheek obliterated.

Thorax with 16 to 18 ? segments; axial lobe small, tapering; pleural lobes flat for three-quarters of their width, turning down on their outer quarter, ends of pleura not visible.

Pygidium broad and flat, posterior margin broadly rounded; axial lobe indistinct, tapering rapidly, continuing almost to the extremity, defined on either side by a narrow groove; axial segments numerous, the exact number cannot be ascertained, somewhat constricted at the ends; pleural lobes numerous, exact number doubtful.

E. dentoni differs from the following *E. ottawaensis* in being smaller, in having a concave border, eyes farther apart and proportionately longer, and grooved spines.

Occurrence. Hull beds, locality 23 ? 33; Sherman Fall beds, localities 32, 48; Cobourg beds, localities 75, 170.

Type. Unfortunately Billings type is missing. The best preserved specimen, G.S.C. No. 1767, is here chosen as the neotype. Its locality is marked "Ottawa river" and it probably came from the same place as the holotype, the island below the Hull side.

Eoharpes ottawaensis (Billings)

Plate I, figure 9

Harpes ottawaensis Billings Geol. Surv., Canada, Pal. Foss. I, 1865, p. 182, fig. 165.

Harpina ottawaensis (Billings), Raymond, Ann. Carnegie Mus., 3, 1905, p. 331, Pl. 10, fig. 2.

Eoharpes ottawaensis (Billings), Geol. Surv., Canada, Victoria Mem. Mus., Bull. 1, 1913, Pl. 3, fig. 6.

Cephalon having a very broad, flat border; anterior pair of glabellar furrows almost obsolete, or visible as shallow depressions, second pair curving backward, posterior pair deep and extending backward almost to the neck furrow; eye line marked, continuing beyond the eye curving backward and fading out at the flat border; inner part of the cheek convex, standing above the outer part; border and outer part of the cheek heavily pitted; surface of the glabella and inner part of the cheek minutely punctuate; eye line smooth.

Thorax of the type specimen having 11 segments preserved (there may be 2 or 3 more), grooved, flat on top, outer quarter of each pleuron ending in a free blunt spine.

Pygidium not known.

For differences from *E. dentoni* see under that species.

Occurrence. Cobourg beds, localities 30, 35, 75.

Type. Holotype, G.S.C.¹ No. 329; paratype No. 329c; Cobourg beds ?, from an unspecified locality at Ottawa, Ontario.

Genus, *Cryptolithus* GreenGenotype, *C. tessellatus* Green

Small, with cephalon forming nearly half the specimen.

Cephalon divided into three prominent sections by the dorsal furrows; the middle section, the glabella, being the more prominent; the two outer lobes formed by the side cheeks, being triangular or subquadrate; the whole is surrounded by a broad, flat, pitted brim, ending in a pair of spines at the genal angles.

Thorax, short, broad, and flat; axial lobe narrow, outer part of the pleura grooved.

Pygidium short, very wide, flat, sub-triangular; axial lobe comparatively broad in front, tapering, and extending almost to the margin.

The broad flat pitted brim of the cephalon distinguishes this genus from any other.

The history of the introduction of the generic synonyms *Cryptolithus*, *Trinucleus*, and *Nuttainia*, and the reason for adopting *Cryptolithus* are given by Foerste in Denison University, Sci. Lab., Bull. 16, 1910, p. 78.

Cryptolithus bellulus (Ulrich)

Plate I, figure 4

Trinucleus bellulus Ulrich, Jour. Cincinnati Soc. Nat. Hist., 1, 1878, p. 99, Pl. 4, fig. 15.

Cryptolithus bellulus (Ulrich), Bassler, Geol. Surv., Maryland, Cambrian and Ordovician, 1919, p. 333, Pl. 56, figs. 5 and 6; Foerste, Geol. Surv., Canada, Mem. 138, 1924, p. 237, Pl. 43, figs. 19 and 20, Pl. 45, fig. 17.

Small, nearly flat.

Cephalon three or four times as wide as long; subquadrate, rather low and flat; anterior and posterior margins almost parallel, the anterior margin curving almost at right angles to meet the lateral margins; dorsal furrows deep,

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

subparallel; neck furrow narrow, with a posteriorly directed curve behind the glabella; neck ring narrow, bearing a long stout spine; glabella pyriform, prominent, most convex in front; cheeks triangular, not as convex as the glabella, finely punctate; genal angles acute, ending in a short fine spine; brim flat, wide, with three rows of pits directly in front of the glabella, four rows in front of the cheeks, the pits of the two outer rows being larger and somewhat elliptical, in many cases concurrent, the two inner rows smaller, circular, alternating with one another, number of rows increasing to six or seven in the inner part of the posterior lateral margins.

Thorax with 6 segments; axial lobe narrow, depressed, with two rows of minute punctæ between the segments; pleural lobes flat, three times as wide as the axial lobe; segments straight, furrowed on the outer half.

Pygidium short, small, four times as wide as long, broadly rounded, or subtriangular, thickened margin; axial lobe very small, with a blunt posterior end, having some faintly defined annulations; pleural lobes each with three segments.

The usual Trenton species is *C. tessellatus* Green from which *C. bellulus* is distinguished by the almost straight anterior and posterior margins of the cephalon as compared with the curved margins of *C. tessellatus*, by its flatter, broader brim, and by its proportionately broader cephalon and pygidium. *C. bellulus* has not heretofore been cited from beds as low as this, but it has frequently been noticed that certain Upper Ordovician forms have their origin in the upper beds of Trenton age.

Occurrence. Sherman Fall beds, locality 20; Cobourg beds, locality 119.

Cryptolithus tessellatus Green

Plate I, figure 3

Cryptolithus tessellatus Green, Mon. Tril. North Amer., 1832.

Trinucleus concentricus Hall, Pal. New York, I, p. 249, Pl. 65, figs. 4a, c; p. 255, Pl. 67, figs. 1a-h.

Cryptolithus tessellatus Green, Foerste, Denison Univ. Sci. Lab., Bull. 17, 1914, p. 317; Geol. Surv., Canada, Mem. 138, 1924, p. 235, Pl. 45, figs. 16 a,b.

Small, broadly oval.

Cephalon, a little more than twice as wide as long; semicircular in outline, both anterior and posterior margins curved; the whole rather strongly arched; dorsal furrows shallower than those of *C. bellulus*; neck furrow and neck ring narrow, the latter prolonged into a short sharp spine; glabella pyriform, very convex; cheeks about as broad as long, less convex than glabella; brim curved downward, most steeply anteriorly, extending backward and prolonged into genal spines; two continuous rows of concentrically arranged pits, a ridge between the two outer rows, additional rows added as the brim widens laterally.

Thorax, 6 segments as in *C. bellulus*; axial lobe narrow, depressed; pleural lobes bent down at the extremities.

Pygidium subtriangular, more than twice as wide as long.

For differences between this species and *C. bellulus* see description of that species.

C. tessellatus has not been seen by the writer from this area, but elsewhere it is more common in rocks of Trenton age than is *C. bellulus*, and it has been cited by others from the Ottawa-St. Lawrence Lowland.

Occurrence. Sherman Fall beds, localities 99, 125, 152.

Genus, *Bathyurus* BillingsGenotype, *Asaphus extans* Hall

Outline elongate, oval; having a concave border; surface smooth, pustulose or wrinkled; hypostoma broadly oval, with two short, narrow wings, and a flat narrow border extending from within the wings around the posterior; two transverse indentations within the border, opposite the wings.

Cephalon longer than pygidium; rounded anteriorly; dorsal furrows subparallel; glabella subconical, expanding anteriorly, and extending almost to front margin; glabellar furrows nearly or quite obsolete; eyes very large, set close to glabella and to neck furrow; free cheek rather long; genal spine present, generally flat on top; facial sutures beginning on posterior margin back of outer rim of eye, directed inward, thence encircling the palpebral lobe, returning close to the glabella and thence forward at a little distance from the glabella, cutting the anterior margin in front of the dorsal furrows.

Thorax, having 9 segments; axial lobe prominent; pleura grooved, bevelled beyond the geniculation and blunt ended.

Pygidium convex; axial lobe prominent, from 1 to 3 annulations on the anterior end, elevated at posterior end; 3 or 4 pairs of ribs on the pleural lobes usually extending across the border.

The genus differs from *Asaphus* in having a depressed border, annulations on the pleural lobes of the pygidium, and a hypostoma which is rounded posteriorly, not forked as in *Asaphus*.

Recently Sinclair¹ defined as a subgenus, *Raymondites*, including those species of *Bathyurus* having a pustulose cephalon and prominent spines, characteristics of a decaying group. The writer would agree with this form except for the inclusion in *Raymondites* of all tuberculate forms. *Bathyurus johnstoni* Raymond has coarse tubercles on the posterior half of the cranidium, but no spine at its base and no spine on the axial lobe of the pygidium. *Bathyurus acutus* Raymond presents another variation. The cranidium is smooth, but there is a short, sharp spine at the posterior extremity of the pygidium. Until more species are available *Bathyurus* is retained in this study, although it is recognized that the genus has a tendency to develop along two or perhaps more lines.

The grouping shown in the following table seems more definite, so far as present knowledge goes; first, those forms having a smooth or tubercled cranidium, with no spine at its base and no spine on the axial lobe of the pygidium; second, those forms having a pustulose cranidium, a very shallow neck furrow, and a spine or spines on the neck ring in conjunction with a spine on the axial lobe of the pygidium. The first group occurs in the Pamela and Lowville beds only, and is abruptly succeeded by the second group, which is represented in the beds from the Leray to the Hull inclusive, above which the genus has not been found.

¹ Sinclair, G. W., Roy. Can. Inst., Trans. 25, 1944, pt. 1, No. 53, p. 15.

Bathyrurus species

Species	OTTAWA FORMATION FAUNAL BEDS						
	Pamella	Lowville	Leray	Rockland	Hull	Sherman Fall	Cobourg
Smooth or tuberculate cranium:							
<i>Bathyrurus acutus</i> Raymond.....	X	X					
<i>B. extans</i> Hall.....	X	X					
<i>B. johnstoni</i> Raymond.....	X						
<i>B. magnus</i> n.sp.....		X					
<i>B. superbus</i> Raymond.....	X						
Cranidium and pygidium spines:							
<i>Bathyrurus bandájer</i> Sinclair.....			X				
<i>B. ingallsi</i> Raymond.....			X	X			
<i>B. spiniger</i> (Hall).....			X	X	X		
<i>B. trispinosus</i> n.sp.....			X				

A. *Bathyurid* species with smooth or tuberculate cranidium and no spine on cranidium or on axis of pygidium

Bathyurus acutus Raymond

Plate II, figures 1a, 1b, 2

B. acutus Raymond, Geol. Surv., Canada, Victoria Mem. Mus., Bull. 1, 1913, p. 56, Pl. 7, fig. 4.

Concave border, narrowed and abruptly turned up in front; hypostoma strongly convex posteriorly, two comparatively deep anterior slits; surface wrinkled.

Cephalon with a narrow and rather deep neck furrow; convexity of the glabella extending to the rounded front, 2 pairs of faint glabellar furrows hardly visible; eyes large, close to the posterior margin; free cheeks narrow; short genal spines; surface of well-preserved specimens covered with fine wrinkles not unlike finger-print markings.

Thorax unknown.

Pygidium triangular, posterior ending in a short acute spine; axial lobe narrow, convex, with two clear annulations, a third and a fourth barely visible; pleural lobes with four pairs of simple ribs extending to and partly over the concave border; surface finely granulated on the axial lobe becoming wrinkled over the pleural lobes.

The species differs from others in having an acute caudal spine, in its small size, and in its peculiar surface markings.

Occurrence. Pamelia beds, localities 43, 44, 54, 86, 162; Lowville beds, locality 89.

Type. Holotype, G.S.C. No. 7821; paratype, Nos. 7821a-d; Pamelia beds, from Westboro, west of Ottawa, Ontario.

Bathyurus extans (Hall)

Plate II, figures 5, 6

Asaphus extans Hall, Pal. New York, 1, 1847, p. 228, Pl. 60, fig. 2a-c.

Bathyurus extans (Hall), Billings, Can. Nat. Geol., 4, 1859, p. 364.

Outline oval; a concave border, usually wider on the pygidium than on the cephalon; hypostoma simple, rounded, convex, typical.

Cephalon with a narrow concave anterior border; deep dorsal furrows; neck furrow complete; a convex glabella with 2 pairs of faintly marked furrows; eyes large, posteriorly situated; free cheeks with concave border; genal spines long; a few fine pustules on the surface and a low median tubercle on the neck ring.

Thorax strongly convex; 9 segments; axial lobe narrow; pleura flat on top.

Pygidium very convex, subtriangular, length three-quarters of width; axial lobe with two rings anteriorly and a faint third, smooth posteriorly, and terminating very abruptly above the concave border; pleura sloping abruptly to the border, having 3 broad segments, first two of which have an impressed line on each, a faint fourth pair visible.

The cranidium of *B. extans* is very similar to that of *B. acutus* but is much larger, and *B. extans* lacks the acute spine on the extremity of the pygidium. The species differs from *B. johnstoni* in having a smooth glabella and a more convex, more subtriangular pygidium. It is smaller than *B. magnus* and has a more sharply subtriangular pygidium. It is more convex than *B. superbus* and has a narrow concave border on the pygidium.

Occurrence. Pamelia beds, localities 14, 49, 50, 52, 82, 86, 101, 133, 162; Lowville beds, localities 36, 40-42, 44, 83, 85, 88, 97, 98, 133, 153.

Type. Plesiotypes, G.S.C. Nos. 7938, 7938a, Pamelia beds, from near L'Orignal, Ontario.

Bathyurus johnstoni Raymond

Plate II, figures 12, 13

B. johnstoni Raymond, Geol. Surv., Canada, Victoria Mem. Mus., Bull. 1, 1913, p. 53, Pl. 7, figs. 2, 3.

Known from a cranium, and from a pygidium with part of an attached thorax supposed to belong to this species.

Cephalon blunt; length 18.5 mm. lacking the outer edge of the concave border; neck furrow deep; neck ring elevated on its posterior edge; glabella very convex, with its greatest convexity about one-third distant from the anterior margin thence sloping steeply to its anterior and more gradually to the posterior edge; one pair of glabellar furrows faintly visible, beginning at the side a little less than mid-length of the glabella and curving back to the neck furrow, ending 1.5 mm. on either side of the median line; sutures typical of the genus; fixed cheeks convex; free cheeks not known; eyes far back; surface of the median part of the posterior of the glabella and the central region of the neck ring covered with coarse tubercles.

Thorax typical of the genus as far as can be seen.

Pygidium short and wide, length 11 mm., width 18 mm.; axial lobe with three rings and the faint indication of a fourth; pleural lobes bearing four pairs of ribs extending faintly over the concave border; surface wrinkled.

B. johnstoni differs from *B. extans* as indicated in description of that species, and from other non-spinose Bathyurids in that it has tubercles on the posterior part of the cranium and the pygidium is less convex and more rounded.

Occurrence. Pamelia beds, localities 85, 163.

Type. Cotypes, G.S.C. Nos. 7830, 7831. The types do not come from this region but from Lowville beds in Cardin tp., Victoria co., Ontario.

Bathyurus magnus n.sp.

Plate II, figure 14

Known from thorax and pygidium only.

Oval outline; large for the genus, thorax and pygidium together measuring 45 mm. in length, and 35 mm. in width at the greatest diameter; convex; concave border, moderately wide; surface wrinkled.

Cephalon unknown.

Thorax typical of the genus, the pleural lobes bearing very wide, shallow grooves.

Pygidium roughly subtriangular; large for the genus, 20 mm. in length and 37 mm. in width; axial lobe prominent, long, extending over a part of the concave border to within 2 mm. of the posterior edge; the top worn but 6 rings showing faintly on the side, the last two of which are very faint; 4 broad, flat, faintly grooved rings on the pleural lobes.

B. magnus in outline is very similar to *B. extans* Hall, but differs in being larger, in having more rings on the axial lobe of the pygidium, and four faintly grooved ribs on the pleural lobes, and in having a proportionately longer axial lobe and a proportionately narrower concave border. The greater number of

rings on the axial lobe and ribs on the pleural lobes might be due to the stage of the moult were it not for the other differences, and if this large form were the adult of the prolific *B. extans* it would not be so rare.

Raymond's¹ specimen from the Lowville beds at Black River, New York, probably belongs to this species.

B. magnus and *B. superbus*, which follow, differ from other described forms of the non-spinose Bathyurids in their larger size. *B. magnus* differs from *B. superbus* in its greater convexity, its more acutely rounded pygidium, and much narrower concave border.

Occurrence. Pamela-Lowville beds, locality 54; Lowville beds, locality 42.

Type. Holotype, G.S.C. No. 7744, from Lowville beds, at City View, southwest of Ottawa.

Bathyurus superbus Raymond

Plate II, figures 10, 11

B. superbus Raymond, Ottawa Nat., 24, No. 8, 1910, p. 129, Pl. 2, figs. 1-3.

Broadly oval in outline, not very convex for the genus; hypostoma as broad as long, almost straight anteriorly, semicircular posteriorly, side wings narrow, muscle attachments anterior to the middle.

Cephalon short and wide; narrow concave border; anterior and posterior margins broadly rounded; dorsal and neck furrows shallow; neck ring narrow; glabella expanding slightly in front of the eyes; two very faint pairs of glabellar furrows; free cheeks wide, drawn out into genal spines that extend back to the fifth or sixth thoracic segment; surface bearing a few wrinkles.

Thorax having deep dorsal furrows; axial lobe convex, tapering rather sharply at the posterior; pleural lobes with deep depressions.

Pygidium nearly semicircular; broad concave border; axial lobe low, having one clearly marked ring followed by two faint ones; pleural lobes bearing broad, faintly furrowed ribs, curving slightly backward at the outer edge and ending abruptly at the concave border, giving the impression of a shallow pit, but having the dividing furrows faintly visible across the border; surface at both thorax and pygidium with transverse wrinkles on the axial lobe and lengthwise ones on the pleural lobes.

B. superbus differs from *B. extans* (Hall) in being considerably larger, specimen measuring 74 mm. in length; in being wider in proportion to its length, which makes the outline of cephalon and pygidium more semicircular; in being considerably less convex; in having a wider concave border, and in having a smooth, non-tuberculate glabella. For comparison with *B. magnus* see description of that species.

Occurrence. Pamela beds, localities 15, 44, 86.

Type. Cotypes, G.S.C. Nos. 7422, 7422A. These beds were originally considered of Chazy age, but they are now thought to be of earliest Black River age. From Mechanicsville, Ottawa, Ontario.

B. Bathyurid species with spine or spines on cranidium and pygidium

The spinose Bathyurids have a peculiar neck ring which it has not been possible to interpret completely with the material at hand. All specimens intact show a very shallow neck furrow. The holotype of *B. trispinosus* is cracked and somewhat depressed along the neck furrow, but the paratype shows a shallow furrow with the tripartite spine upon the neck ring, not upon the posterior of the glabella. In cleaning the holotype of *B. trispinosus* the outer

¹ Raymond, P. É., Ann. Carnegie Mus. 7, 1910, Pl. 15, fig. 7.

spine-bearing shell of the neck ring was accidentally broken away revealing beneath it a smooth almost flat neck ring. After cleaning the holotype of *B. ingalli* as much as is feasible the angular posterior of the fixed cheek can be seen protruding from beneath the base of the heavy spine, as though attached laterally to a neck ring beneath the spine.

This heavily tuberculate, spine-bearing neck ring of the spinose Bathyrurids seems to be an outer shell superimposed upon the true neck ring. More specimens are needed to obtain a complete interpretation, but attention is here called to this unusual feature.

Bathyrurus (Raymondites) bandifer Sinclair

Plate II, figure 7

B. (Raymondites) bandifer Sinclair, Roy. Can. Instit., Trans. 25, pt. 1, No. 53, 1944, p. 17, Pl. 1, figs. 12, 13.

Cephalon known only from the interior; concave border narrow; dorsal furrows deep; neck furrow very shallow; neck ring flat, bearing a spine which divides into two short, diverging spines; glabella moderately convex, two faint pairs of glabellar furrows indicated on the underside; free cheek not seen; attached cheek small and convex; surface of whole cranidium covered with tubercles.

Thorax unknown.

Pygidium associated with the cranidium small and depressed; axis prominent, with two definite rings, the third and fourth indefinite rings bearing a blunt spine; pleural lobes poorly defined; margin wide and flat; surface showing a few faint pustules on the axis, smooth elsewhere.

The species differs from *B. spiniger* and *B. ingalli* in the bifurcation of the spine.

Occurrence. Leray beds, locality 165.

Type. Holotype from Leray beds, 7 miles west of Cobden, Ontario, in the private collection of G. W. Sinclair.

Bathyrurus ingalli Raymond

Plate II, figures 15a-15b, 16-18

B. ingalli Raymond, Victoria Mem. Mus., Bull. 1, 1913, p. 57, Pl. 7, fig. 7; Geol. Surv., Canada, Mus. Bull. 31, 1921, p. 31, Pl. 9, figs. 3-5.

Known only from a somewhat crushed cranidium and an associated pygidium.

Cranidium subquadrate in outline, sides almost parallel, slightly expanding anteriorly; anterior margin almost straight; anterior border broad and concave; anterior of glabella rounded; glabellar furrows, if any, have been lost in the cracks due to the flattening of the glabella; eyes large, prominent, posteriorly placed, grooved on top, though some of the breadth and depth of the grooving may be due to the state of preservation; neck ring covered by a long stout spine, as wide as the neck ring at the point of attachment, tapering regularly, apparently circular in section except at the base; suture lines beginning posterior to the outer half of the eye, almost at right angles to the neck, making the base of the attached cheek rectangular, and at the other extremity cutting the anterior margin so directly as to produce two rounded corners at the anterior of the cranidium; surface of the glabella and base of the spine strongly pustulose. The cephalon of the species differs from others in the length and stoutness of its spine.

Thorax unknown.

Pygidium detached but found at the type locality and supposed to belong to this species. The posterior of the plesiotype is somewhat crushed but the extent to which the concave border is preserved shows that not much is lacking. Small, short, very convex; axial lobe distinct, posterior crushed but with two clearly defined uninterrupted anterior rings; third and fourth rings partly coalesced from which arises a long, delicately tapering spine, laterally compressed in section, erect at its base but curving downward posteriorly; four pleural ribs fading out across the border, each having a faintly discernible longitudinal groove along the posterior edge; surface smooth as far as preserved.

Another pygidium from Paquette Rapids, Ottawa River, has been identified and figured by Sinclair¹ as this species. The specimen is considerably larger than Raymond's plesiotype and shows some differences: caudal spine arising about mid-length of the axial lobe from the fourth, fifth, and sixth axial ring; a row of tubercles on each axial ring and numerous irregularly placed tubercles on the rest of the axial lobe; five pleural lobes, of which the faint groove is more centrally placed than on the plesiotype. The presence of one more ring on the axial lobe anterior to the spine and an additional pleural lobe may be due to the stage of the moult. If the other differences, the presence of tubercles on the axial lobe and the position of the groove on the pleural lobes, are constant, the two pygidia do not both belong to this species, unless one is a variety of the other. If the differences are variable then both may belong to the species. More material and some complete specimens are required to establish the authentic pygidium of the species.

Occurrence. Leray Rockland beds, locality 164; Hull beds, locality 77.

Type. The holotype, G.S.C. No. 4318, is from Kirkfield, Ontario, but the species has been found at Ottawa.

Bathyurus spiniger (Hall)

Plate II, figures 3-4

Acidaspis spiniger Hall, Pal. New York, 1, 1847, p. 241, Pl. 64, fig. 5.

Bathyurus spiniger (Hall), Clarke, Geol. Minnesota, 3, pt. 2, 1884, p. 723, figs. 38-40.

Raymond, Ann. Carnegie Mus. 7, 1910, p. 48, Pl. 15, figs. 4-6.

Cephalon having a very convex glabella with two pairs of faint glabellar furrows not always visible on the adult; eye large; free cheek rather small; genal spine, long, flat, and smooth; tubercles over the whole cephalon except the neck furrow, border, and genal spines; neck ring bearing a short, stout spine.

Pygidium short, very convex; on the pleural lobes, 4 pairs of distinct ribs, the last pair not showing the groove; on the axial lobe, the first two rings distinct, bearing a median and lateral tubercles, then several additional indistinct ribs present, from the third and fourth arises a large spine tapering rapidly and curving backward, a few tubercles posterior to the spine.

Bathyurus spiniger (Hall) differs from *Bathyurus ingalli* Raymond in having a smaller spine at the base of the cranidium and in having a blunter spine on the axial lobe of the pygidium.

Occurrence. Lowville beds, localities 54, 97; Leray beds, localities 5, 16; Leray-Rockland beds, locality 8; Rockland beds, locality 81; Hull beds, locality 19.

Type. Plesiotype, G.S.C. No. 7747, from Leray beds, edge of hill above Sand Point, on Ottawa River.

¹Sinclair, G. W., Roy. Can. Instit. 25, pt. 1, No. 53, 1944, p. 16, Pl. 1, figs. 9-11.

Bathyurus trispinosus n.sp.

Plate II, figures 8-9

Known from cephalon and associated pygidium.

Cephalon very convex, broad and rather short; anterior and posterior broadly rounded; concave margin narrow; dorsal furrows deep; neck furrow broken; neck ring bearing a broad spine, which divides into three small spines, the median one being the longest; glabella very convex, overhanging the anterior border, two pairs of indistinct glabellar furrows present, the posterior pair curving back to meet the neck furrow very close to the median line; fixed cheeks small and convex; free cheeks small, convex, and terminating posteriorly in a short genal spine; eyes long, prominent, and close to the neck ring; surface of glabella, fixed cheek, and posterior of the free cheek coarsely pustulose.

Thorax unknown.

Pygidium, associated with several cranidia, small; concave border comparatively narrow; axial lobe prominent, having three complete, pustulose rings followed by three indistinct ones, pustulose on the sides; axis terminating in a blunt elevated knob; a delicate spine arising from the three indistinct posterior axial rings and curving backward to project a short distance beyond the posterior of the pygidium; five pleural ribs, the second and third faintly grooved, the furrows between the ribs faintly crossing the concave border; surface wrinkled.

Occurrence. Leray-Rockland beds, locality 8.

Types. Holotype and paratype from Leray-Rockland beds, east of Pakenham, in the private collection of J. A. Calder.

Genus, *Homotelus* RaymondGenotype, *H. ulrichi* Raymond

Broadly oval outline; without concave border; hypostoma forked.

Cephalon short, wide and comparatively flat, more or less rounded anteriorly; dorsal furrows indistinct; neck furrows absent or faint; an indistinct smooth glabella merging with the cheeks; eyes moderately prominent, set widely apart; genal angles without spines; facial sutures beginning at the posterior margin considerably outside the line of the eye, crossing obliquely inward to the inner posterior part of the eye which it circles, approaching the glabella, thence with a sigmoid curve inward, then outward to the margin which it cuts almost in front of the eye.

Thorax with a comparatively wide axial lobe and segments flat on top.

Pygidium wider than long, short; axial lobe poorly defined; no annulations.

The genus differs from *Asaphus* in its wider, less prominent axial lobe, in being less convex, and in that the axial lobe of the pygidium lacks annulations.

Homotelus differs from *Isotelus* in having more rounded extremities, in lacking a concave border, and in having a narrower axial lobe in the thorax.

Homotelus was substituted by Raymond¹ for a group of trilobites formerly classed under the European genus *Onchometopus* because it was found that the North American species did not have the peculiar hooked doublure of the European *Onchometopus*.

In Raymond's description of the first described species originally called *Onchometopus* and then transferred to *Homotelus* he states² "*Onchometopus* may be readily distinguished from *Isotelus* by the presence of a median tubercle

¹ Raymond, P. E., Mus. Comp. Zool. Bull. 64, 1920-21, p. 285.

² Raymond, P. E., Ann. Carnegie Mus. 7, 1910, p. 64.

on the glabella, the absence of a concave border on both cephalon and pygidium, and by the somewhat narrower axial lobe in the thorax", and yet the median tubercle is not mentioned in the twice repeated description of *Homotelus*, and of the described cephalons of eight species the tubercle is mentioned and illustrated in two; in one species it is shown in some illustrations but not in others; and in the cephalons of five species it is neither mentioned nor illustrated.

There are present in the Ottawa-St. Lawrence collections parts of cephalons that agree with *Homotelus* except that they lack the tubercle on the posterior of the glabella. It may be there are two types. For the present they are designated by a query.

Homotelus ? elongatus Raymond

Plate I, figure 5

H. elongatus Raymond, Mus. Comp. Zool., Bull. 64, 1920-21, p. 288. Ibid., Bull. 67, 1925, p. 88, Pl. 4, figs. 1-3.

Species large, and convex; surface smooth except for a few wrinkles.

Cephalon subtriangular, width to length approximately 3:2; anterior margin subtriangular, posterior broadly curved; neck furrow and neck ring obsolete; glabella smooth, not outlined; sutures beginning behind the centre of the eye, and at the anterior cutting the margin in line with the outer edge of the eye, meeting one another anteriorly in a broad angle; fixed cheek small; free cheek large, convex, terminating in a bluntly rounded, short, genal angle; eyes large, far apart, their own length from the posterior margin.

Thorax depressed on top, abruptly deflected on the sides; axial lobe broad, segments flat on top; pleural segments grooved on top, flat on the deflected sides and rounded at the extremities.

Pygidium subtriangular, strongly and evenly convex; axial lobe barely perceptible, wide at the anterior, narrowing posteriorly; no rings visible; faint traces of pleural ribs and a shallow indistinct concave border on exfoliated specimens, but not visible on well preserved specimens.

The species differs from *H. simplex* in its more convex form and its triangular cephalon. The Canadian specimen is a little smaller, otherwise it corresponds exactly to the type.

Occurrence. Hull beds, locality 33; Cobourg beds, localities 138, 139.

Type. Plesiotype, G.S.C. No. 7748, from Hull beds at Chaudière Falls Hull, Quebec.

Genus, *Basilicus* Salter

Genotype, *Asaphus tyrannus* Murchison

Oval in outline, moderately convex; having a concave border; forked hypostoma.

Cephalon semicircular; dorsal furrows shallow; neck furrow present; glabella expanding in front; faint glabellar furrows; eyes moderately large; genal angles produced into short spines; sutures marginal along the front, beginning outside of the posterior of the eye, crossing inward, and thence circling the inner part of the eye, coming very close to the glabella, thence turning outward cutting off a very wide frontal section; surface smooth.

Thorax with axial lobe one-third or less the total width; pleura grooved.

Pygidium semicircular, broader than long; anterior almost straight, posterior very broadly rounded; regularly convex; concave border broader than in cephalon; axial lobe strongly annulated right to the abrupt tip; pleural lobes ribbed, ending abruptly at the concave border.

This genus and *Ogygites* differ from other Asaphidae in having strongly ribbed pygidia. *Basilicus* differs from *Ogygites* in having a wider concave border; in having fewer and coarser ribs, both on the axial and pleural lobes; and in the ribs being less definite posteriorly.

Raymond¹ considers *Basilicus* to be one stage beyond *Ogygites* in the general simplification of the ribs of the Asaphidae.

Basilicus barrandi (Hall)

Plate I, figures 1, 2

Asaphus barrandi Hall, Geol. Lake Superior Land Dist., Foster and Whitneys Rept., 1851, p. 210, Pl. 27, figs. 1a-d, Pl. 28.

Basilicus romingeri (Walcott), Raymond, Ann. Carnegie Mus. 7, 1910, p. 49, Pl. 15, figs. 9, 10, Pl. 16, figs. 1-4.

Basilicus barrandi (Hall), Raymond, Geol. Surv., Canada, Victoria Mem. Mus., Bull. 1, 1913, p. 42.

Cephalon having definite dorsal furrows; neck furrow shallow; neck ring narrow; glabella prominent, constricted between the eyes; a pair of oblique glabellar furrows forming obscure basal lobes; a low ridge from the anterior of the glabella across the concave border, ending abruptly; eye having large palpebral lobes; short broad genal spines; a prominent median tubercle in front of the neck furrow; surface wrinkled.

Pygidium nearly semicircular; wide concave border; axial lobe prominent with 7 to 11 rings; pleural lobes with 5 or 6 pairs of prominent ribs ending abruptly at the border.

B. barrandi differs from *B. ? vetustus* in having a few segments on both axial and pleural lobes of the pygidium. *B. marginalis* of the Chazy has a granular surface.

Occurrence. Leray beds, localities 16, 40, 89, 96.

Type. Plesiotype, G.S.C. No. 7749, Leray beds, from lot 4, con. III, Gloucester tp., Ontario.

Genus, *Isotelus* DeKay

Genotype, *I. gigas* DeKay

Oval outline interrupted by more or less angular extremities; cephalon and pygidium subequal, both subtriangular; concave border; forked hypostoma.

Cephalon with indistinct dorsal furrows; neck furrow absent; glabella not distinct, expanding anteriorly, no glabellar furrows; eyes large and prominent; free cheek comparatively large; genal angles acute or prolonged in a spine; facial sutures very similar to those of *Homotelus* but beginning and continuing closer to the glabella and meeting in a sharp curve in the front.

Thorax with 8 segments, and a wide axial lobe; pleura obliquely grooved on the inner flatter part and bevelled on the outer part, apparently in order to slip over one another when the specimen is rolled.

Pygidium with axial lobe distinct but not prominent; annulations faint.

Isotelus is closely related to *Homotelus* but differs primarily in having a concave border, more angular extremities, and a narrower axial lobe.

Raymond² has summarized the criteria for distinguishing three somewhat similar and rather common species of *Isotelus*: the genotype *I. gigas* DeKay, *I. iowensis* Owen, and *I. maximus* Locke. "If the pygidium has straight sides it

¹ Raymond, P. E., Roy. Soc. Canada, Trans., 3rd ser. 5, sec. 4, 1912, p. 115.

² Raymond, P. E., Mus. Comp. Zool., Bull. 58, 1913-14, p. 259.

can be quickly placed as *I. gigas*. If the posterior end is rounded, it might be taken for either *I. iowensis* or *I. maximus*, but if the ratio of length to breadth is above .65 it is probably *I. iowensis*, and if below *I. maximus*."

Isotelus gigas DeKay

Plate III, figures 2a-2c, 3

I. gigas DeKay, Ann. Lyceum Nat. Hist. New York 1, 1824, p. 176, Pl. 12, fig. 1, Pl. 13, figs. 1, 2; Raymond, Ann. Carnegie Mus. 7, 1910, p. 53, Pl. 15, figs. 1, 2; Roy. Soc., Canada, Trans. and Proc., 3 ser., 5, sec. 4, 1912, p. 119, Pl. 2, figs. 7, 9; p. 120, Pl. 3, fig. 6; Mus. Comp. Zool., Bull. 58, 1914, p. 248, Pl. 1, figs. 1 and 2; Pl. 2, figs. 2-5, Pl. 3, fig. 3.

Outline oval but with subangular extremities; concave border; surface smooth.

Cephalon typical of the genus, but without a genal spine in the adult.

Thorax of 8 segments; axial lobe less than half and more than one-third the whole width; geniculation of pleural lobes only a short distance from the axial lobe.

Pygidium having a comparatively long axial lobe.

I. gigas differs from *I. iowensis* in its more angular extremities, in having lost its genal spines, in the longer axial lobe of the pygidium, and in that the geniculation of the pleural lobes is nearer to the dorsal furrows.

I. gigas differs from *I. maximus* in its subtriangular shields, in having cephalon and pygidium longer in proportion to the width, and in having lost the genal spine in the adult.

For quick identification see the generic description.

Occurrence. Lowville beds, localities 42, 97, 112, 172; Leray beds, localities 5, 16, 44, 81, 85, 89, 101; Leray-Rockland beds, localities 8, 97, 133, 164, 174, 175; Rockland beds, localities 7, 97, 107; Hull beds, localities 19, 21, 23, 28, 35, 108, 131; Sherman Fall beds, localities 16, 20, 21, 56, 73, 99, 111, 114; Cobourg beds, localities 30, 66, 68, 69, 73, 75, 76, 129, 136, 140, 144, 156, 176, 177.

Type. Plesiotypes, G.S.C. Nos. 5591, from Hull beds, at Hull, Quebec, and 7750, from Hull beds, below the bridge at Plantagenet, Ontario.

Isotelus iowensis (Owen)

Plate III, figure 4; Plate IV

Asaphus iowensis Owen, Rept. Geol. Surv., Wisconsin, Iowa and Minnesota, 1852, p. 557, Pl. 2a, figs. 107.

Isotelus iowensis (Owen), Clarke, Geol. Minnesota, 3, pt. 2, 1894, p. 704.

Isotelus sp. Raymond and Narraway, Ann. Carnegie Mus. 7, No. 1, 1910, p. 56, Pl. 15, fig. 3; Raymond, Mus. Comp. Zool., Bull. 58, 1914, p. 255, Pl. 2, fig. 6, Pl. 3, figs. 1, 2.

Cephalon rounded anteriorly, leaving the front of the glabella well defined for the genus; facial sutures reaching the margin in front of the eyes, coinciding with the margin anteriorly; free cheeks, therefore, ending in front of the eyes; long genal spines present extending to the 5th, 6th, or 7th segment; eyes far apart.

Thorax having an axial lobe a little less than half and more than one-third the entire width; geniculation of the pleural lobes at about the mid-length of the pleura.

Pygidium long, but posterior end rounded and raised a little so that it almost has a truncated appearance; a fairly convex axial lobe, and traces of ribs on the pleural lobes.

For differences between *I. iowensis*, *I. gigas*, and *I. maximus* see description of *I. gigas*.

Occurrence. Lowville beds, localities 7, 97; Leray beds, localities 17, 44, 154; Leray-Rockland beds, localities 2, 4.

Type. Plesiotype, from Leray beds at Mechanicsville, in the private collection of G. W. Sinclair.

Isotelus latus Raymond

Plate VI

Asaphus platycephalus Stokes, Billings, Geol. Surv., Canada, Geol. Canada, 1863, p. 184, fig. 183.

I. latus Raymond, Victoria Mem. Mus., Bull. 1, 1913, p. 45, fig. 5.

Holotype very large, greatest length 190 mm., of which the anterior border is 15 mm. and the posterior 10 mm.; greatest width 120 mm.; roughly oval in outline; extremities broadly rounded; surface finely pustulose on the exterior, particularly on the cephalon, but revealing punctæ on the inner layer when exfoliated.

Cephalon a little more than half as long as wide, measuring 64 mm. in length including the 15 mm. of the concave border, and 120 mm. in width (in Raymond's description 94 mm. length in place of 64 mm. is a typographical error); depressed convex; concave border widest at the anterior, narrowing laterally to less than half the anterior width; anterior margin broadly rounded, posterior margin almost straight; dorsal furrows obsolete, and glabella undefined; free cheeks large, convex; eyes prominent, situated 25 mm. from neck to centre of eye, and far apart, 56 mm. from eye centre to eye centre; no genal spine, and genal angles rounded.

Thorax very flat on top; segments broad and flat; dorsal furrows shallow, wide, and rather indefinite; axial lobe almost half of the entire width; pleural lobes geniculate at about two-fifths of their length from their outer ends, flat, and with broad grooves on the upper three-fifths, with a broadly bevelled outer area having thickened extremities which curve slightly forward.

Pygidium very short and broad, 68 mm. in length, including the 10 mm. border, and 114 mm. in width; border very broad and flat and 10 mm. to 14 mm. wider laterally at the posterior; dorsal furrows indistinct; axis and pleural lobes undefined.

In his species Raymond included the specimens typified by the well known and well illustrated specimen showing appendages. The specimen is later¹ re-illustrated and again referred to *I. latus*. The writer thinks that there is a greater difference between *I. latus* and the specimen with appendages than between *Isotelus gigas* and *Isotelus maximus*, and the latter form is described below under the name *Isotelus ottawaensis* n.sp.

I. latus differs from *I. gigas* and *I. maximus* in its broader outline, less convex profile, its very broad and comparatively short cephalon and pygidium, its wider concave border, and its widely spaced eyes.

The differences from *I. ottawaensis* are cited in describing that species.

Occurrence. Leray beds, localities 40, 150; Hull beds, locality 19; Cobourg beds, localities 30, 75, 140, 148, 149.

Type. Holotype, G.S.C. No. 1788, Cobourg beds ? , from an unspecified locality at Ottawa, Ontario.

¹ Raymond, P. E., Connecticut Acad. Arts Sci., Mem. 7, 1920, p. 34, Pl. 10, fig. 1.

Isotelus maximus Locke

Plate III, figure 1

I. maximus Locke, 2nd Ann. Rept. Geol. Surv., Ohio, 1838, p. 246, figs. 8, 9; Clarke, Geol. Minnesota, 3, pt. 2, 1894, p. 701, figs. 5-7; Raymond and Narraway, Ann. Carnegie Mus. 7, 1910, p. 55, fig. 3; Mus. Comp. Zool., Bull. 58, 1914, p. 257.

Isotelus maximus has been frequently confused with *I. gigas* and *I. iowensis*. When the anterior of the cephalon is preserved the suture lines are seen to parallel the anterior margin, with the free cheeks projecting in front of the cephalon, not ending in front of the eye as in *I. iowensis*. *Isotelus maximus* is more rounded at the extremities than either of the other two; both cephalon and pygidium are shorter and broader, the axial lobe is narrower in proportion, the pleural lobes of the thorax are proportionately wider, and the species has long genal spines. A quick method of distinguishing the pygidia of the three species is outlined in the description of the genus.

Occurrence. Leray Rockland beds, locality 173; Hull beds, locality 19; Sherman Fall beds, localities 20, 21, 25, 73, 99, 111, 125, 145; Cobourg beds, localities 75, 106, 141, 147.

Type. Plesiotype, G.S.C. No. 332, from Cobourg beds ?, from an unspecified locality at Ottawa, Ontario.

Isotelus ottawaensis n.sp.

Plate III, figure 5; Plate V, figures 1a, 1b

Asaphus platycephalus Stokes, Billings, London, Quart. Jour. Geol. Soc., 26, 1870, Pl. 31, figs. 1-3, Pl. 32, figs. 1, 2; Woodward, Geol. Mag., 8, 1871, Pl. 8, fig. 1, 1a.

Isotelus latus Raymond, Victoria Mem. Mus., Bull. 1, p. 45, Connecticut Acad. Arts Sci., Mem. 7, 1920, p. 34, Pl. 10, fig. 1.

The holotype of this species is not new, but has been described and figured under both of the above names. It is especially noteworthy, because of its comparatively well preserved appendages. The species, also, has an exceptionally wide concave border, the axis of the pygidium is very broad in front tapering rapidly, and the ribs of the pleural lobes are indistinctly visible.

Raymond included the holotype and other specimens of the species with his *Isotelus latus*, but the differences are evident in a comparison of the proportions of the two forms.

	<i>Isotelus latus</i> Raymond millimetres	<i>Isotelus ottawaensis</i> n.sp. millimetres
Length	190	120
Width	120	62
Width of axial lobe of thorax	50	28
¹ Length of cephalon	64	40
Width of cephalon	120	62
Eye length	12	7
Eye distance from posterior margin	17	10
Distance between eyes	50	29
Length of pygidium	70	45
Width of pygidium	115	60
Convexity	11.5	15

A comparison of these measurements of the type specimens shows that *I. ottawaensis* n.sp. is smaller, longer in proportion to its width, proportionately more convex, and not so broadly rounded at either extremity as *I. latus*; furthermore the cephalon is longer in proportion to its width, the eyes are closer together, and the axial lobe of the pygidium is very wide anteriorly.

¹ A typographical error gives this as 94 mm. in the original description

A large, imperfect pygidium that appears to belong to this species has been found among a Lowville-Leray fauna. It has the outline and the broad concave border of the species. More complete specimens are needed to establish its occurrence so low in the beds, but it has frequently been noticed that forms of the Leray fauna appear among the Cobourg fauna.

Occurrence. Cobourg beds, localities 75, 144.

Type. Holotype, G.S.C. No. 1789; paratype No. 1789b; Cobourg ? , from an unspecified locality at Ottawa, Ontario.

Key to the species of *Isotelus*

- A. Extremities angular or subangular; concave border moderately wide on the cephalon, narrowing somewhat laterally.
 - (a) Cephalon length more than three-quarters width; concave border narrow on pygidium.
 - (i) Pygidium with straight sides, no genal spine—*I. gigas*.
 - (ii) Pygidium with gently rounded sides, genal spine on adult—*I. iowensis*.
 - (b) Cephalon length less than three-quarters width, concave border wide on pygidium and sides considerably rounded—*I. ottawaensis*.
- B. Extremities rounded, length of cephalon less than three-quarters width.
 - (a) Concave border narrow on pygidium, genal spines present—*I. maximus*.
 - (b) Concave border very wide on cephalon, narrowing considerably, wide on pygidium, no genal spine—*I. latus*.

Occurrence of *Isotelus*

Species	* OTTAWA FORMATION FAUNAL ASSOCIATIONS						
	Pamella	Lowville	Leray	Rockland	Hull	Sherman Fall	Cobourg
<i>Isotelus iowensis</i> (Owen).....		X	X				?
<i>I. gigas</i> DeKay.....		X	C	X	X	C	cc
<i>I. maximus</i> Locke.....			r	r	r	cc	cc
<i>I. latus</i> Reymond.....			r				c
<i>I. ottawaensis</i> n.sp.....					r		c

*c—common; cc—very common; r—rare; X—present.

Omitting *Isotelus gigas*, which has a long range, it will be seen that the presence of *I. iowensis* is usually indicative of the lower beds of the Ottawa formation and that the forms with the more rounded pygidium are more common in the higher beds.

Genus, *Isoteloides* Raymond

Genotype, *I. whitfieldi* Raymond

Long narrow outline; forked, convex hypostoma with wings separated from the body by deep furrows; flattened border on both cephalon and pygidium.

Cephalon with dorsal furrows faintly impressed for about half the length of the cephalon; neck furrows nearly obsolete, more evident just behind the glabella; faintly outlined glabella not expanding anteriorly and not reaching the front of the cephalon; glabellar furrows faint or absent; short broad genal spines; facial sutures very similar to those of *Isotelus* being pointed in front; small prominent tubercle on posterior of glabella.

Thorax of 8 segments, narrow axis, pleural segments grooved.

Pygidium with narrow, defined axis, traces of segmentation faint or absent.

Raymond states that *Isoteloides* differs from *Asaphus* in its longer and narrower form, in the presence of a depressed border on cephalon and pygidium, in the fading of the glabella anteriorly, and in the presence of the genal spines.

It is more closely related to *Isotelus* in the faint or obsolete dorsal and neck furrows, and in having a depressed border on cephalon and pygidium. It differs from *Isotelus*, however, in the convexity and general form of the hypostoma, in having a partly defined glabella, in the presence of a median tubercle on the posterior of the glabella, and in the narrow axial lobe.

Isoteloides homalonotoides (Walcott)

Plate I, figure 6

Asaphus homalonotoides (Walcott), 31st Rept., New York State Nat. Hist., 1879, 1880, p. 71.

Isoteloides homalonotoides (Walcott), Raymond, Ann. Carnegie Mus. 7, No. 1, 1910, p. 52, Pl. 14, figs. 9-11.

The Ottawa specimen cited by Raymond in the above reference has not been seen by the writer, but one young specimen from Pakenham appears to belong to this species, and also a plesiotype from Kirkfield, Ontario, in the collections of the Geological Survey.

Cephalon having the dorsal furrows marked for a short distance, the neck furrow with the dorsal furrows resulting in a subquadrate outline of the posterior part of the glabella, which is elongate, the convexity of the subquadrate posterior part fading into the barely defined convexity of the anterior; one pair of oblique glabellar furrows showing between the eyes, three pairs of faintly indicated furrows visible on casts of the anterior; median tubercle present.

Thorax with the axial lobe narrower than in *Isotelus*.

Pygidium triangular in outline and straight-sided, having a rather acute posterior angle with a tendency to turn up, anterior showing a distinct pleural groove; a prominent, narrow, strongly convex axis extending to the depressed border, and having faintly marked or obsolete annulations.

Only two other species of this genus have been cited, one from the Chazy, and one from the Beekmantown. *I. homalonotoides* differs from the Chazy form, *I. angusticaudatus* in its wider pygidium, and from *I. whitfieldi*, the Beekmantown form, in its more elongate outline, in the lack of annulations, and in the more acute posterior angle of the pygidium.

Occurrence. Leray beds, localities 8, 75.

Type. The plesiotype figured, G.S.C. No. 7934, is not from this locality but from Kirkfield, Ontario.

Genus, *Vogdesia* Raymond

Genotype, *Isotelus bearsi* Raymond

Usually comparatively small and enrolled, hypostoma forked.

Cephalon broad, convex, lacking a border; broadly rounded in front; dorsal furrow and neck furrows obsolete; glabella not differentiated; eyes far apart, comparatively prominent; free cheek produced across the front; genal angle rounded; facial sutures of the *Isotelus* type, short and broadly rounded in front.

Thorax having 8 flat segments; axial lobe broad, not clearly defined.

Pygidium without segmentation or dorsal furrows, broadly rounded posteriorly. As Troedsson¹ pointed out, Raymond has included in his genus of *Vogdesia* species with and without concave border on the pygidium, which seems to suggest that the border is a variable feature.

Vogdesia is most closely related to *Brachyaspis* from which it differs in the prominence of the eyes, and to *Homotelus* from which it differs in being proportionately broader and shorter.

Vogdesia sinclairi n.sp.

Plate VII, figures 2a, 2b

Cephalon small, broadly rounded in front; convexity greater anterior to the eyes; width 19 mm., length 9 mm.; eyes prominent, far apart, 12 mm. between the edge of the palpebral lobes; genal angle broken but apparently rounded; free cheeks produced in front; sutures outlining a broad, short frontal area; surface very finely punctate.

Thorax poorly preserved, only a few segments present exhibiting the flat surface and the broad, poorly defined axial lobe.

Pygidium poorly preserved but showing a trace of a depressed border.

This species is smaller than *V. minnesotensis* and has the free cheek produced in front. It is more like the Richmond form *V. vigilans*, though it is smaller and proportionately more broadly rounded anteriorly.

Occurrence. Leray beds, locality 94.

Type. Holotype, Leray beds, west of Cumberland, Ontario, in the private collection of G. W. Sinclair, after whom it has been named.

Genus, *Illaeus* Dalman

Genotype, *Entomostracites crassicauda* Wahlenburg

Oval outline, convex, without border; surface smooth or punctate; hypostoma convex and ovoid.

Cephalon larger than pygidium, transverse; front broadly rounded; dorsal furrows extending only a short distance on the cephalon, then disappearing; glabella not defined; no glabellar furrows; eyes small, far apart, and posteriorly set; neck furrow not deep or absent; genal angles blunt; sutures beginning back

¹Troedsson, G. T., Medd. om Grönland, B 72, Nr. 1, 1929, p. 33.

of the eye, curving inward, circling the eye, then, with a broad curve obliquely to the anterior margin, enclosing about one-third of the entire margin of the cephalon.

Thorax with 8 to 10 segments; axial lobe about one-third or less the total width, defined by two depressions which converge slightly; pleural ribs turning backward; ribs not grooved.

Pygidium transverse; anterior almost straight; axial lobe short, defined by a shallow depression, annulations faint or absent; no annulations on the sides.

Illaeus is distinguished from *Bumastus* by the presence of the axial lobe for a short distance on the cephalon and pygidium.

Illaeus americanus Billings

Plate VII, figures 3, 4

I. americanus Billings, Can. Nat. Geol., 4, 1859, p. 371; Geol. Surv., Canada, Pal. Foss., 1, 1865, p. 329, figs. 316a-d, 318; Raymond and Narraway, Ann. Carnegie Mus. 4, Nos. 3, 4, 1908, Pl. 60, figs. 1-3.

Oblong; 2 to 3 inches in length, surface wrinkled.

Cephalon rounded, very convex, in some specimens slightly flattened in front of the glabella; dorsal furrows short, comparatively deep posteriorly but becoming shallow and disappearing before one-quarter to one-third the length of the head, not quite half cephalon width distant from one another, directed outward at the neck, then converging, then turning slightly outward again before disappearing, the whole course making a sigmoid curve; no neck furrow; glabella not defined anteriorly, no glabellar furrows; eye subconical, moderately large, half the width of the glabella from the dorsal furrows; free cheek small, subtriangular; genal angles rounded; surface wrinkled, especially noticeable on the cephalon.

Thorax with 10 segments; axial lobe from one-third to nearly one-half the whole width, a little narrower posteriorly; geniculation of the pleural lobes at about half their own width.

Pygidium a little shorter than the thorax, moderately to strongly convex; posterior margin broadly rounded; anterior angle truncated, forming an angle of 40 to 60 degrees with the longitudinal axis; axial lobe well defined by side furrows, converging and forming apex of lobe which is about half the total length of the pygidium.

Illaeus americanus is larger than *I. conradi* and has a more rounded and proportionately longer cephalon; the eyes are proportionately closer to the dorsal furrows; the axial lobe of the pygidium is more rounded at the posterior end.

An unattached pygidium is very similar to that of *Thaleops ovata* from which, however, it can be distinguished by its more rounded posterior margin, and the less perpendicular truncation of the lateral margins.

Some especially large forms are found in the upper beds.

Occurrence. Leray beds, localities 16, 17, 40, 44, 89, 91, 93, 97, 104; Sherman Fall beds, localities 21, 73, 109; Cobourg beds, localities 30, 34, 46, 57, 59, 65, 72, 75, 76, 105, 117, 127, 129, 133, 136, 138-141, 146, 147, 171, 176, 177.

Type. Unfortunately the type of *Illaeus americanus* is missing, and there is no complete specimen in the collection; plesiotypes, Cobourg beds, G.S.C. No. 7757, from lots 10-12, con. III, Roxborough tp., and No. 7758, from lots 1-3, con. VIII, Cornwall tp., Ontario.

Illæenus angusticollis Billings

Plate VII, figures 10, 11

Illæenus angusticollis Billings, Can. Nat. Geol., 4, 1859, p. 376, fig. 10; Geol. Surv., Canada, Geol. Canada, 1863, p. 151, figs. 113a-d; Raymond and Narraway, Ann. Carnegie Mus. 4, 1908, p. 245, Pl. 61, figs. 1-5.

Specimens nearly always enrolled; small, short and proportionately wide; dorsal furrows on cephalon and pygidium.

Cephalon convex, very wide, anterior gently rounded, lateral margins slightly contracted in front of the eye; dorsal furrows very deep, converging at the neck for a short distance then turning and diverging, becoming more shallow and almost reaching the margin; neck furrow very shallow, only on the posterior of the glabella; glabella tumid and narrow posteriorly, but broadening anteriorly and becoming less and less convex until lost in the general convexity; no glabellar furrows; eyes far apart and far back, at the end of wide, tumid palpebral lobes; free cheek tumid; genal angles acute almost a spine; facial sutures just back of the eye directed inward for a very short distance, skirting the contracted end of the palpebral lobe, thence curving over the broad convex part to the anterior margin; surface punctate.

Thorax with 8 or 9 segments, short, broad, almost straight, flat, without grooves, bent slightly downward and backward posteriorly; axis moderately convex, converging posteriorly, the first four rings thickly set with lines of punctæ, few on the others.

Pygidium short and wide, sides truncated, much smaller than the cephalon; axial lobe extending about half the length of the pygidium, sides deeply differentiated, converging slightly posteriorly, and becoming more shallow; three or four faint rings on exfoliated specimens, which also show a shallow groove from the posterior of the axis extending nearly to the margin; posterior broadly rounded; no pleural lobes; minutely punctate.

I. angusticollis is most closely allied to *I. conradi*, from which it is distinguished by the narrowness and tumidity of the posterior part of the glabella, the depth of the dorsal furrows on the cephalon, and the more acute genal angles.

Occurrence. Leray beds, localities 16, 38, 44.

Type. Holotype, G.S.C. No. 1314b, and paratype, No. 1314d. Neither is from this area, both being from St. Joseph Island, Lake Huron.

Illæenus conradi Billings

Plate VII, figures 14, 15

I. conradi Billings, Can. Nat. Geol., 4, 1859, p. 372, figs. 7-9; Geol. Surv., Canada, Geol. Canada, 1863, p. 151, figs. 110a-c; Raymond and Narraway, Ann. Carnegie Mus. 4, 1908, p. 245, Pl. 60, figs. 9, 10.

Oval, convex, small, length averaging approximately 30 mm., greatest width 21 mm., at the genal angles, surface punctate.

Cephalon very transverse; front very broadly rounded; convex; length about one-half of width; dorsal furrows 8 mm. apart extending less than one-half distance to front; glabella not distinguishable beyond the dorsal furrows; no glabellar furrows; eyes 2 mm. from posterior margin and 17 mm. apart; level with the surface on inner side but elevated abruptly above free cheek; free cheeks small; no neck furrow; surface coarsely punctate in the median region, more finely punctate towards the eyes and on the free cheeks.

Thorax with 8 segments; axial lobe convex anteriorly, less so posteriorly; pleura divided into two parts, the inner half next the axial lobe flat, the outer half curving down to the margin, and ribs turning backward; punctæ in rows, 2-5 rows of punctæ on anterior four segments, one row on posterior four.

Pygidium quadrate, flanked by backward curved posterior ribs of thorax; smaller than cephalon, width 15 mm., length 8 mm., axial lobe separated by shallow depression and extending half the length of the pygidium from the anterior; posterior end blunt; no ribs on axial lobe or sides.

The differences between *I. conradi* and *I. americanus* and *I. angusticollis* have been given in the description of the two latter species.

Occurrence. Pamela or Lowville beds, locality 54; Leray beds, localities 16, 17, 40.

Type. Holotype, G.S.C. No. 1320a; paratype No. 1320; from Leray beds, La petite Chaudière, Ottawa River, above Hull, Quebec.

Illænus latiaxiatus Raymond

Plate VII, figures 5, 6

I. latiaxiatus Raymond, Ann. Carnegie Mus. 4, 1908, p. 243, Pl. 60, figs. 4-8.

Raymond describes this species as differing from *I. americanus* in having a cephalon wider in proportion to its length with shorter, straighter, and shallower dorsal furrows, and in having the pygidium more strongly truncated at the sides, less arcuate posteriorly, and with a more convex and prominent axial lobe.

Occurrence. Leray beds, localities 16, 17, 44; Cobourg beds, localities 50, 72, 128, 139.

Subgenus, *Bumastus* Murchison

Genotype, *B. barriensis* Murchison

Oval; cephalon and pygidium subequal; convex; without border; surface smooth or punctate; hypostoma convex and ovoid.

Cephalon semicircular; dorsal furrows absent or poorly defined, in some cases represented by two small curved pits, far apart; glabella not defined; no glabellar furrows; eyes small, set far apart, posteriorly placed; neck furrow poorly defined or absent; free cheeks very small; genal angles bluntly rounded; sutures beginning directly back of the eyes, around which they curve then turn anteriorly cutting the margin almost directly in front of the eyes, enclosing most of the broadly rounded front of the cephalon.

Thorax with 8 to 10 segments; axial lobe very broad; rings smooth.

Pygidium semicircular; front almost straight; no axial lobe; no annulation; surface smooth.

The subgenus is nearest to *Illænus*, from which it is distinguished by the very broad and poorly defined axial lobe on the cephalon and complete absence of it on the pygidium.

Bumastus billingsi Raymond and Narraway

Plate VII, figure 13

B. billingsi Raymond and Narraway, Ann. Carnegie Mus. 4, 1908, p. 250, Pl. 62, figs. 1 and 2; Raymond, Geol. Surv., Canada, Victoria Mem. Mus., Bull. 1, 1913, p. 34, Pl. 3, fig. 12.

Oval outline, very large; surface smooth.

Cephalon regularly rounded in front, slight constriction anterior to eye; very convex; dorsal furrows far apart, faint, directed obliquely inward, then straight to two lunar depressions; no glabella; neck furrow invisible on exterior, faint on cast; eyes far apart, half their own length from the posterior margin; free cheeks small.

Thorax with 10 segments, smooth, wide, nearly flat; dorsal furrows very far apart, almost obsolete; pleura bent down. Raymond in his later reference stated that the first five segments were truncated, making them shorter. This appears to be due to preservation, because the opposite side of the same specimen shows the pleura to be almost equal in size except that the two posterior ones are slightly longer. The specimen from which his description is taken is bent backward, which foreshortens the pleura. The type specimen in the Royal Ontario Museum, Toronto, also has normal pleura slightly broken.

Pygidium large, very convex, a little wider than long.

The species is readily distinguished from others of the genus by its large size and its convexity, also by the great width of the axial lobe of the thorax.

Occurrence. Hull beds, localities 22, 23, 35, 178; Sherman Fall beds, locality 32; Cobourg beds, localities 66, 71, 75.

Type. Plesiotype, G.S.C. No. 331, Cobourg beds ?, from an unspecified locality at Ottawa, Ontario.

Bumastus indeterminatus (Walcott)

Plate VII, figure 12

Illaeus indeterminatus Walcott, 31st Ann. Rept. New York State Mus. Nat. Hist., 1879, p. 70.

Bumastus indeterminatus (Walcott), Raymond, Ann. Carnegie Mus. 4, p. 253, Pl. 62, figs. 8, 9.

Cephalon large, moderately convex, more than twice as wide as long; anterior very broadly rounded; dorsal furrows forming almost a semicircle, beginning back of the eye, turning inward, then curving back outward; eyes large, depressed, set far apart; free cheek extended into broad genal spines; surface finely punctate and in addition four or five concentric wrinkles around the outer edge.

Thorax with 9 or 10 segments; axial lobe not distinct.

Pygidium very convex, anterior lateral margins depressed.

Only the cephalon has been found in the area. It differs from *B. milleri* and *B. porrectus* in its large size, proportionately greater breadth, more defined, curved dorsal furrows, and its wrinkled margin.

Occurrence. Leray beds, localities 16, 17, 44; Rockland beds, localities 51, 97.

Type. Plesiotype from Rockland beds on the west side of Parkdale Ave., Ottawa, Ontario, in the private collection of G. W. Sinclair.

Bumastus milleri (Billings)

Plate VII, figures 1a, 1b

Iliaenus milleri Billings, Can. Nat. Geol. 4, 1859, p. 375, fig. 10; Geol. Surv., Canada, Geol. Canada, 1863, p. 151, fig. 112.

Bumastus milleri (Billings), Raymond and Narraway, Ann. Carnegie Mus. 4, 1908, p. 249, Pl. 61, figs. 9, 10, Pl. 62, figs. 3-5.

Small; oval and convex; surface smooth.

Cephalon abruptly convex in front becoming less so posteriorly; dorsal furrows represented by two, faint, slightly curved indentations between the eyes, about one-quarter length of cephalon from the posterior and one-third width of the cephalon apart, best visible in exfoliated specimens; eyes lunate, less than their own length from the posterior border, and at least three-quarters the total width of the cephalon apart; free cheeks very small; no neck furrow; outer surface smooth, but an exfoliated specimen shows punctæ.

Thorax with 9 segments; axial lobe outlined by two faint depressions, which converge a little posteriorly; pleura curved backward slightly; surface smooth.

Pygidium a little longer than the thorax, abruptly convex posteriorly; front margin nearly straight; no axial lobe; surface smooth.

This species has often been confused with *B. trentonensis* Emmons. Because of the confusion connected with the name *B. trentonensis* Raymond¹ has abandoned the latter name entirely and introduced the new term *B. porrectus*. *B. milleri* differs from *B. porrectus* in being a little wider in proportion to its length, though it is difficult to distinguish the separate cephalia and pygidia, but the thorax of *B. milleri* has 9 segments as compared with 10 segments of *B. porrectus*.

Occurrence. Pamela beds, localities 50, 52; Pamela-Lowville beds, localities 12, 85; Leray beds, localities 2, 3, 11, 16, 17, 40-42, 44, 81, 84, 85, 89-91, 93, 150, 158; Leray-Rockland beds, localities 8, 39, 44, 133, 134; Rockland beds, localities 95, 97.

Type. Holotype, G.S.C. No. 1319b, Leray-Rockland beds, near L'Original, Ontario.

Bumastus porrectus Raymond

Plate VII, figures 7-9

Bumastus trentonensis Clarke (non Emmons), Geol. Minnesota, 3, pt. 2, 1897, p. 720, fig. 32 (non figs. 30, 31, 33).

B. porrectus Raymond, Mus. Comp. Zool., Bull. 67, No. 1, 1925, p. 114, Pl. 8, figs. 7, 8.

The cephalon is more than one-quarter of a sphere, the dorsal furrows are marked externally by lunettes, but show a little more distinctly on exfoliated specimens; eyes small, far back and far apart.

Thorax with 10 segments and wide axial lobe with broad shallow dorsal furrows.

Pygidium short, no trace of axial lobe.

Surface smooth except for anterior wrinkles on cephalon and pygidium.

For discussion of differences between this species and *B. milleri* and the reasons for erecting the species to include *B. trentonensis* see under *B. milleri*.

Occurrence. Rockland, locality 97; Hull beds, locality 18; Sherman Fall beds, localities 124, 125; Cobourg beds, localities 30, 57-60, 63, 66, 71, 72, 76.

¹ Raymond, P. E., Mus. Comp. Zool., Bull. 67, No. 1, 1925, p. 144.

Types. Plesiotypes, G.S.C. Nos. 7759 and 7760, Cobourg beds, from corner of Percy Street and Fifth Avenue and from corner Booth and Elm Streets, Ottawa, and from Hull beds on east side of Fairy Lake, Quebec, in the private collection of G. W. Sinclair.

Genus, *Thaleops* Conrad

Genotype, *T. ovata* Conrad

Ovoid outline, broader anteriorly.

Cephalon with deep dorsal furrows disappearing anteriorly; glabella poorly defined anteriorly; eyes stalked, on prominent diverging palpebral lobes; free cheeks small, extended into stout diverging spines; facial sutures beginning back of the eye, thence inward, turning to encircle the eye, from there diverging rapidly, then curving inward again, and finally cutting the margin in front of the dorsal furrows; surface punctate.

Thorax with flat-topped segments, abrupt geniculation, smooth surface.

Pygidium, transversely subquadrate; steep margins; axial lobe surrounded by dorsal furrow, tapering, then ending abruptly at the top of the steep margin; surface punctate.

Thaleops is nearest to *Illaenus* from which it differs in the attenuated divergent palpebral lobes, divergent stalked eyes, and genal spines.

Thaleops ovata Conrad

Plate VII, figures 16a, 16b

Thaleops ovata Conrad, Acad. Nat. Sci., Philadelphia, Proc. 1, 1843, p. 332; Clarke, Geol. Minnesota, 3, pt. 2, 1897, p. 716, figs. 25-28; Raymond and Narraway, Ann. Carnegie Mus. 4, 1908, p. 247, Pl. 60, figs. 11-13; Pl. 61, figs. 6, 7.

Ovoid, broadest anteriorly; length and width equal; very convex.

Cephalon broadly semicircular, very convex; dorsal furrows diverging, deep posteriorly, disappearing in the region of the greatest convexity, about one-third width of cephalon apart at the posterior; neck furrow shallow; glabella well defined posteriorly, faint but expanding in the anterior, anterior slope almost vertical, a single pair of lateral indentations slightly constricting the posterior part; eye peduncular, on the upper surface of the convexity; fixed cheeks less convex than glabella, attenuated; free cheeks small, abruptly constricted beneath the eye; genal angle prolonged into two strong, divergent, keeled spines; surface punctate.

Thorax transversely subquadrate; 10 segments; axial lobe convex, comparatively narrow; geniculation about one-third breadth of pleural lobes; segments flat, broad, not furrowed on pleura, curved backwards; surface smooth.

Pygidium short, transversely subquadrate, sides and posterior almost perpendicular; posterior margin very broadly rounded; width twice the length; axial lobe prominent, entirely surrounded by the dorsal furrows, showing 5 faint annulations, terminating abruptly at the top of the convexity where it is faintly bilobed; punctæ deep and coarse, in transverse rows on the anterior of the axis.

T. ovata differs from *T. arcuata* in its less attenuated palpebral lobes and cheeks, in having less prominent eyes, and in having a keel on the genal spine.

It is difficult to distinguish loose pygidia of *Thaleops ovata* and *Illaenus angusticollis*. The pygidium of *T. ovata* is generally larger, and the five faint rings on its axial lobe are generally discernible and serve as a means of identification.

Occurrence. Leray beds, localities 16, 17, 40, 44, 55, 85, 87, 88, 91, 93; Leray-Rockland beds, locality 133; Rockland beds, locality 81; Hull beds, locality 19.

Type. Plesiotype, G.S.C. No. 1321, Leray beds, Mechanicsville, Ottawa, Ontario.

Subgenus, *Eobronteus* Reed

Genotype, *Entomostracites laticauda* Wahlenberg

Cephalon having breadth more than twice its length; dorsal furrows shallow; neck furrow shallow; glabella very much expanded in front; glabellar furrows, indistinct grooves or represented by three pairs of shallow pits; eyes near the posterior margin; genal spine broad and flat; sutures beginning at the posterior margin outside the eye, directed inward almost parallel with the margin, turning sharply to surround the palpebral lobe thence sharply outward, diverging rapidly and reaching the margin anterior to the outer edge of the eyes.

Thorax with 10 segments; axial lobe prominent; pleural lobes rather flat; ends of pleura pointed and free.

Pygidium flattened or strongly convex; straight in front, broadly rounded posteriorly; axial lobe short, generally simple, in some cases, with one or two faint rings on the anterior end, losing itself in a median post-axial rib which is usually faintly furrowed longitudinally; six pairs of pleural ribs.

The subgenus *Eobronteus* was established by F. R. Cowper Reed¹ and is distinguished from *Bronteus* by having six pairs of lateral ribs in the pygidium as compared with seven or more in *Bronteus*, restricted; in having a single, undivided or faintly furrowed median axial rib as compared with the simple, grooved or terminally bifurcated median post-axial rib of *Bronteus s. s.*; and in having simple flattened thoracic rings of uniform width in contact except at the tips, as compared with the thoracic pleura of *Bronteus s. s.* in which the thoracic rings have marginal bands for part of their length and a slight constriction beyond which they are free.

There is some difference of opinion in the use of the generic name from which *Eobronteus* is derived.

In 1833 Pusch² described a fossil as a gastropod giving it the name *Scutellum*. He evidently thought it one of the Patellacea. Later, in 1836, he recognized it as a trilobite pygidium, and assigned it to *Asaphus* ? with a query. Both references are published in volumes not now readily obtainable.

In 1839 Goldfuss, recognizing the form as a trilobite, gave it the name *Brontes*. In 1843 he revised it to *Bronteus* because *Brontes* was pre-occupied. Meanwhile, in 1841, de Koninck had introduced for the same form the name *Goldius*, which by the strict rules of priority should have had precedence, but *Bronteus* has continued in use, and is still used in Europe. In the 1913 translation of Zittel, Raymond re-introduced *Goldius*, which usage has been followed by American authors since that time. Richter³ maintains that *Scutellum* has priority and in this is followed by Shimer and Shrock⁴. Reed⁵, however, points out the danger of confusion with the echinoid *Scutella*. Actually the name *Scutellum* has never been in use whereas the literature of Europe and North America has contained references to *Bronteus* and *Goldius* for more than 100

¹Reed, F. R. Cowper, Ann. Mag. Nat. Hist. 10, ser. 1, 1928, pp. 49-78.

²Pusch, G. G., geogn. Beschreib von Polen, I, 1833, p. 119, and Polens Pal. oder Abbildung and Beschreibung, etc., 1836, p. 166, Pl. 14, fig. 5.

³Richter, R., and E. Senckenbergiana, Bd. 7, H. 6, 1925, pp. 239-243.

⁴Shimer, H. W., and Shrock, R. R., Index Foss. of North America (Revised), 1944, p. 653.

⁵Reed, F. R. Cowper, Ann. Mag. Nat. Hist., 10 ser., 1, 1928, p. 49.

years. The present author thinks it makes for clearness to continue the use of *Goldius* for the genus or even *Bronteus* rather than revive the stillborn and confusing *Scutellum*.

The basis of the establishment of *Eobronteus* is given above. The following species is the only one yet found in the Ordovician in North America.

Eobronteus lunatus (Billings)

Plate VIII, figures 10, 11

Bronteus lunatus Billings, Geol. Surv., Canada, Rept. Prog. for 1853-1856, 1857, p. 338; Geol. Canada, 1863, p. 188, fig. 187.

Goldius lunatus (Billings) Raymond, Geol. Surv., Canada, Mus. Bull. 31, 1921, p. 32, Pl. 9, fig. 8.

Eobronteus lunatus (Billings), Reed. Ann. Mag. Nat. Hist., 1928, 10 ser. 1, pp. 50, 58, 66.
Scutellum lunatum (Billings), Shimer and Shrock, Index Fossils of North America, 1944, p. 653, Pl. 269, fig. 15.

Broadly oval; length of the holotype 40 mm., greatest width 30 mm., about opposite the mid-length of the form; surface finely wrinkled, and having fine, scattered tubercles.

Cephalon crescent-shaped; narrow, concave border in front merging with a pair of broad, flat, genal spines; dorsal furrows rather shallow, converging from the neck, curving outward from opposite the back of the eye; neck furrow shallow; glabella broadly expanding in front so that the lateral edge of the frontal lobe is in line with the outer extremity of the eye; glabellar furrows very shallow, the anterior pair almost perpendicular to the axis of the glabella, the other two directed forward on their inner end; posterior part of the glabella swollen just anterior to the neck furrow returning to normal convexity anterior to the median glabellar furrow; eyes large, lunate, close to the neck furrow, about their own length from the glabellar furrow; free cheek rather large because of the very broad, flat, genal spine, which extends back to the pygidium; surface markings very fine, wrinkles centring around the swollen part of the posterior of the glabella and the convex part of the palpebral lobes, and fanning out towards the margin to join the wrinkles on the broad flat spines, occasionally a few fine tubercles on the anterior of the glabella.

Thorax short, less than the cephalon in length, having 10 very short, but broad segments; axial lobe distinctly marked by dorsal furrows, less than one-quarter the greatest width of the shell; pleura very flat, pleura termini, free points obliquely truncated anteriorly; surface covered with fine wrinkles, convex forward on the axial lobe, and obliquely upward and outward on the pleural lobes; very fine tubercles, not always visible.

Pygidium straight in front, rounded off at the anterior corners, rather narrowly rounded posteriorly; axial lobe short, unsegmented but slightly constricted anteriorly, convex, the swelling in the middle lessening, drawn out and narrowing posteriorly, blending with the posterior rib; median posterior rib longitudinally grooved at its posterior end; 6 pairs of broad, flat, pleural ribs radiating from the short axis; surface with fine wrinkles pronouncedly convex forward on the swelling of the axis, and convex to a less degree on each rib pointing towards the axis, forming a sharp V in the base of the trough between each rib.

This is the only form yet found in the Ordovician of North America. The genus is usually represented by pygidia with their characteristic ribs.

A small specimen of one of the paratypes is illustrated here because, though incomplete, it shows the dorsal furrows, the wrinkled ornamentation, and the grooving of the median rib of the pygidium more clearly than does the holotype.

The species differs from the genotype *Eobronteus laticauda* (Walh.) in the lateral glabellar furrows which in one of the cotypes show broad, shallow grooves rather than pits; the posterior part of the glabella is shorter, extending only to the second pair of glabellar furrows instead of to the third pair as in the genotype; the free cheeks are less divergent; the pygidium of *E. lunatus* has a somewhat longer axis and no trace of a ring, and unlike *E. laticauda* (Wahl.) the pygidia of the cotypes of *E. lunatus* do not show two distinct types of pleural ribs. All but the anterior pair of ribs reach the margin.

Occurrence. Cobourg beds, localities 53, 65, 75.

Type. Holotype, G.S.C. No. 1781; paratype Nos. 1781 a-c; Cobourg beds ?, from an unspecified locality at Ottawa, Ontario.

Genus, *Otarion* Zenker (= *Cyphaspis* Burmeister)

Genotype, *O. diffractum* Zenker (= *C. burmeisteri* Barr)

Small, oval; axial lobe markedly distinct throughout; hypostoma subquadrate, centre evenly convex, lateral margins widening toward the base; whole surface smooth, granulose to tuberculate, or even spinose.

Cephalon about one-third the whole length, semi-elliptical, surrounded by a border which is convex near the glabella, curving downward and then slightly thickened near the margin, of varying width in the several species, ending in genal spines; dorsal furrows deep; glabella subpyriform, convex, first and second glabellar lobes faint or obsolete, the third pair lying conspicuously at the base of the main part of the glabella and separated from it by furrows curving in from the dorsal furrows to a furrow anterior to the distinctly defined neck ring; eyes conspicuous, crescent-shaped, usually more or less elevated; fixed cheeks and palpebral lobes very convex; free cheeks triangular, curving steeply to the border; facial sutures beginning just within the genal angle, converging towards the palpebral lobes, surrounding the eye, and again diverging somewhat and reaching the border in front of the eye.

Thorax with an axis occupying about one-third the total width; pleura grooved for a short distance near the axis, abruptly deflected at about one-third their length from the axis, ends bevelled.

Pygidium convex, nearly semicircular; axis strongly convex, having 3 distinct annulations and 1 indistinct and ending just within the posterior margin.

The genus differs from *Proetus* in its greater convexity, in the lack of the defined border of the pygidium, in its tendency to be more coarsely granulate or tuberculate, and in the length and acuteness of the genal spines.

The genus *Otarion* and *Cyphaspis* are exact synonyms. *Otarion* has been revived by a ruling of the International Commission on Zoological Nomenclature although *Cyphaspis* has been in use for three-quarters of a century and cannot be eradicated from the literature.

Otarion wilsonae Sinclair

Plate VIII, figures 4a, 4b

O. wilsonae Sinclair, Roy Can. Inst., Trans. 25, pt. 1, No. 53, 1944. p. 18, Pl. 1, figs. 3, 4.

Holotype very small, surface finely pustulose.

Cephalon crescent-shaped, slightly protruding in front between the suture lines; border narrow and flat; dorsal furrows deep, gently sigmoid; neck furrow deep; neck ring broad and flat; glabella convex, a little narrowed anteriorly;

three pairs of glabellar furrows, the anterior pair almost obsolete, making a very faint narrow anterior lobe, the second pair deeper, beginning at the level of the anterior of the eye, cutting at right angles to the dorsal furrow, extending less than a third across the width of the glabella, the third pair deep beginning about one-third from the anterior of the eye, a first almost paralleling the second pair then curving back, becoming deepest about mid-way, then shallow and finally obsolete before reaching the neck ring; third pair of lobes thus prominent, with their axis almost parallel with that of the main glabella; sutures typical of the genus; free cheek convex triangular; fixed cheek small, convex; eyes close together and prominent; genal spines flat, broken on the holotype.

Thorax with 9 segments; axial lobe prominent, about one-third the total width, segments grooved; pleural lobes having segments grooved for three-quarters their length, extremities pointed.

Pygidium not known.

Other described species of *Otarion* found in North America approximately of the same age are: *O. globosus* Bradley, *O. trentonensis* (Weller), and *O. matutinum* (Ruedemann). *O. wilsonae* can be readily distinguished from the two former by the presence of the anterior pairs of glabellar furrows. *O. matutinum* (Ruedemann) shows glabellar furrows, the two anterior pairs of which are directed backward from the dorsal furrows instead of at right angles to them, and the third pair is more oblique than that of *O. wilsonae* producing a less conspicuous pair of basal glabellar lobes lying at an angle to the central axis of the glabella rather than almost parallel to it. Other species in Upper Ordovician beds differ in yet other characteristics.

Occurrence. Sherman Fall beds, locality 1.

Type. Holotype from Sherman Fall beds, Eganville, Ontario, in the private collections of G. W. Sinclair.

Genus, *Acrolichas* Foerste

Genotype, *Lichas cucullus* Meek and Worthen

Cephalon with a narrow, concave border; a strongly convex middle lobe of which the anterior margin is nearly three times the width of the posterior margin, and of which the posterior half of the profile is straight or slightly concave, the anterior half convex, steeply rounded at the front; middle lobe marked off by two well defined furrows, slightly divergent from the neck ring to the region of greatest convexity where they turn more rapidly outward; second pair of furrows widely separated, divergent for a short distance then turning towards the anterior, ending at the narrow concave border; side lobes neither as long nor as wide as the central lobe; palpebral lobes much smaller; neck furrow distinct; neck ring convex but on a lower plane than the glabella; surface with numerous unequal pustules.

Thorax not known.

Pygidium having three pairs of ribs all with free tips, the first two pairs having short median grooves at the inner end; axial lobe with two segments of very different size, anterior one very short, the posterior one having at its anterior end a shallow crescent-shaped groove not complete to the rachis edge, the convexity of the segment ending abruptly about mid-length of the posterior half, continuing on the plane of the pleural lobes and narrowing to a point which reaches the notch between the free tips of the posterior pair of ribs.

Acrolichas differs from *Amphilichas* in that the two large central furrows of the cephalon continue to the neck furrow, whereas in *Amphilichas* they extend only part way.

F. B. Phleger Jr. suggests¹ that the genus be confined to the type species and makes a new genus in which the only difference stated is the less flat profile of the posterior part of the central lobe of the glabella. Phleger has drawn the pygidium of Conrad's species *Asaphus ? trentonensis* as Conrad and Emmons illustrated it. It is very evident that the original was broken. The axial lobe and the side lobes as far as they are preserved are so exactly like the type of *A. cucullus ottawaensis* that Foerste's interpretation may be correct and this may be an additional species of the genus.

Acrolichas cucullus ottawaensis Foerste

Plate VIII, figures 1, 2

A. cucullus ottawaensis Foerste, Denison Univ. Sci. Lab., Bull. 19, 1919, Pl. 17, figs. 4A, 4B.

A. cucullus (Meek and Worthen), Foerste, Amer. Jour. Sci., 49, 1920, p. 43, Pl. 1, figs. 1A, B, E.

Cephalon typical of the genus in general form but having a very gibbous middle glabellar lobe which bears a large, blunt, rounded protuberance about mid-length; surface, particularly the posterior half, covered with coarse tubercles. Thorax not known.

Pygidium large; axial lobe having one clearly defined, narrow segment, a second also narrow, partly differentiated, and a third very large one, bulbous for half its length, becoming flat and tapering to a point at the junction of the posterior pair of pleural lobes; three pairs of broad, rather flat, pleural lobes, the first pair bearing a distinct median groove, the second pair a faint one; termini of all lobes bluntly angular, from one-third to one-quarter their total length, the right anterior lobe of the holotype bearing a narrow concave flange which widens towards the tip and extends beyond it; surface covered with coarse tubercles.

Foerste made *Lichas cucullus* Meek and Worthen the genotype of his genus *Acrolichas*. In the same paper he figured *A. cucullus ottawaensis*, but did not describe it except to state that it differed from the species in having the free tips of the pleura of the pygidium more rounded. In his second reference to the genus he refigured the same species of *A. cucullus ottawaensis* but omitted the variety name. It is not possible to say now whether this was a typographical error or whether he decided there was no variety, but as he mentioned no change in his conception probably it was an error.

The variety would seem to be valid for other reasons.

In the cephalon there is a greater differentiation in the size of the lobes in the variety than in the species, particularly evident in the very small palpebral lobe; the pygidium is wider in proportion to its length, the free tips are blunter, and the right rib of the type shows a concave flange on the outer side.

Occurrence. Hull beds, localities 19, 24, 33, 79, 133, 167; Sherman Fall beds, locality 21, 73; Cobourg beds, locality 30.

Type. Royal Ontario Mus., cotypes Nos. 18791A, 18791B.

Acrolichas narrawayi Foerste

Plate VIII, figure 3

A. narrawayi Foerste, Amer. Jour. Sci., 49, 1920, p. 31, Pl. 1, fig. 2.

Foerste described briefly and figured a small pygidium which is characterized by a narrow notch between the free tips of the posterior ribs, and the furrow

¹Phleger, F. B. Jr., Jour. Pal., 10, 1936, p. 606, fig. 47.

at the anterior end of the posterior segment of the axis is not well defined. All the free tips are more rounded than those of the typical species or of the variety name. It is not possible to say now whether this was a typographical variety *A. cucullus ottawaensis*.

The species may be a young form of *A. cucullus ottawaensis*.

Occurrence. Hull beds, locality 24.

Genus, *Hemiarges* Gürich

Genotype, *Lichas (Arges) wesenbergensis* Schmidt

The genus has been rather loosely defined, mainly hinging on the description of the genoholotype. Schmidt¹ described the species, placing it in the subgenus *Arges* of Goldfuss and stated that the species differs from the other species of *Arges* in having a flatter glabella, and in the weakness of the development of the middle lateral furrow.

Gürich², in a general summary of Lichadidae, states "If the converging lines are followed backward then the Argetinae must be derived from intermediate forms between the oldest *Hoplolichas*, the oldest *Platylichas* and *Platopolichas* species. The existence of such intermediate forms must be looked for in the Ordovician. The Argetinae also fall into groups of which the first is already recognizable in the Upper Ordovician. Passing by the long problematical *Trochurus nodulosus* Salter (McCoy), from the Upper Bala then *Lichas wesenbergensis* Schmidt is the oldest species.

The incomplete cutting and differentiation of the three side lobes leads me to consider this form as representing a subgenus *Hemiarges* which persists into the Silurian". (Translation is the author's.)

Hemiarges paulianus (Clarke)

Plate VIII, figures 7, 8

Lichas (Arges) wesenbergensis paulianus Clarke, Geol. Minnesota, 3, pt. 2, 1894, p. 744, figs. 62-64.

Hemiarges paulianus (Clarke), Raymond, Geol. Surv., Canada, Mus. Bull. 31, 1921, p. 32, Pl. 9, fig. 2.

Form small; hypostoma broader than long, anteriorly convex, posterior margin broadened out.

Cephalon having a narrow concave border in front; broader than long; five glabellar lobes, central one somewhat expanded and most convex anteriorly, a pair of large elongated, convex, anterior, side lobes formed by the coalescing of the first and second lobes; anterior furrow deep, posterior side lobes small, elongated nodes, forming an obscure annulation at the base of the median lobe; dorsal furrow shallow between the posterior lateral lobes and the palpebral lobes; neck furrow deep; neck ring narrow, elevated; free cheeks convex below the eye; genal angle acute; surface covered with tubercles, coarser over the glabella and towards the posterior region of the sides.

Thorax known only from fragments.

Pygidium short, broader than long; axial lobe about one-third width of shell, broadly rounded anteriorly, extending half the length of the pygidium, terminating in a ridge which unites posteriorly with the thickened margin; three annulations; pleural lobes depressed having two distinct pairs of ribs, another pair deeply sulcate, both pairs ending in spines, the second smaller rib having the

¹ Schmidt, Fr., Ostbalt. Sil. Trilobiten, L'Acad. Imp. Sci. de St. Petersburg, 7 ser., 33, No. 1, p. 44, Pl. 6, figs 1-4, 1885.

² Gürich, G., Neues Jahrb. Min. Geol. Pal. Beil., Bd. 14, 1901, pp. 526 and 534.

larger spine; posterior part of the pygidium flat; posterior margin bearing two other pairs of small spines, one pair terminal on either side of the posterior end of the axial ridge, the second pair one on either side of the terminal pair and between them and the long spines of the second ribs; tubercles on the depressed space between the second pair of ribs and the posterior axial ridge.

H. paulianus differs from *H. wesenbergensis* in having more isolated anterior side lobes and larger marginal spines on the pygidium.

Occurrence. Leray beds, locality 40; Sherman Fall beds, localities 20, 21; Cobourg beds, locality 30.

Type. Plesiotypes, Sherman Fall beds, from Brewery Creek, Hull, Quebec, in the private collection of J. A. Calder, and Cobourg beds from Philemon Island, Hull, Quebec, in the private collection of G. W. Sinclair.

Genus, *Odontopleura* Emmrich

Genotype, *Odontopleura ovata* Emmrich

Broad, flat, usually small; margins spinose.

Cephalon semicircular, glabella oblong, two pairs of glabellar furrows, and two pairs of glabellar lobes; neck ring smooth or with one tubercle; eyes small, smooth, prominent, far apart; genal angle extended into a spine; surface tuberculate.

Thorax with 8 broad, flat segments; axial lobe narrow; each pleuron of the pleural lobes ending in a spine; tubercles on both axial and pleural lobes.

Pygidium small, much broader than long; axial lobe prominent, stopping short of the margin, the anterior segment ending in a pair of spines.

The characteristics of the genus are its width in proportion to its length, the numerous tubercles, the neck ring with one tubercle, and the marginal spines on the cephalon and pygidium.

Odontopleura parvula (Walcott)

Plate X, figure 8

Acidaspis parvula Walcott, 31st Rept. New York State Mus. Nat. Hist., 1880, p. 69; Geol. Minnesota, 3, pt. 2, 1894, p. 744, fig. 61.

Cephalon semicircular; dorsal furrows shallow; glabella oblong; two pairs of shallow glabellar furrows making two pairs of glabellar lobes; eyes small, prominent, far apart, smooth; fixed cheek long and swollen; free cheek comparatively large; genal angle produced into a spine; margin spinose.

Thorax with 8 ? segments; axial lobe one-quarter width; each segment of axial lobe having four tubercles; pleura ending in spines; each pleuron having four tubercles and two on each spine; posterior part of each pleuron convex, the anterior depressed.

Pygidium having a circumfurrowed axial lobe, central segments bearing tubercles, a continuation of those on the axial lobe, the first segment of the pleural lobes prolonged into a pair of spines, second segment visible; margin spinose.

The species differs from *O. trentonensis* in the great number of tubercles and in the marginal spines.

Occurrence. Sherman Fall beds, locality 21; Cobourg beds, locality 30.

Genus, *Encrinurus* EmmrichGenotype, *Trilobus punctatus* Brunn

Rounded in front, acute posteriorly; hypostoma convex, broadly elliptical.

Cephalon having a convex border; distinct dorsal furrows; shallow neck furrow; glabella spindle-shaped, very much expanded in front, and very convex; three pairs of shallow glabellar furrows; eye small, elevated; free cheeks narrow, separated anterior to the glabella by a small plate; genal angles rather acute; facial sutures rising anterior to the genal angle, crossing inward and forward to the palpebral lobes, obliquely forward across the dorsal furrow, bending abruptly forward to meet the plate between the free cheeks, thence crossing the anterior margin; surface covered with tubercles and pits.

Thorax with 11 segments; axial lobe narrow and convex.

Pygidium long, triangular, axial lobe with numerous annulations, complete or interrupted by a solid axis; pleural segments curved backwards; the posterior pair curving in to meet the prolonged rib-like tip of the axis, all more or less pustulose.

Encrinurus cybeleformis Raymond

Plate VIII, figure 6

E. cybeleformis Raymond, Geol. Surv., Canada, Mus. Bull. 31, p. 33, Pl. 11, fig. 2.

"Known from pygidia only. Pygidium narrowly triangular in outline, strongly convex, with long, narrow axial lobe which is very low at the posterior end but is distinctly outlined. Pleural lobes curved sharply downward, and marked by nine pairs of rounded ribs, not ornamented with tubercles. Anterior end of axial lobe crossed by three sharp rings, and back of the third ring is a wide smooth area along the median portion. At the sides of this area about fifteen or sixteen pairs of incomplete rings are interrupted by the smooth band, and extend to within about 2 mm. of the posterior end, where the whole lobe becomes smooth. There is a median tubercle on the third ring, another where the sixth would have crossed, and faint traces of tubercles where the ninth and thirteenth should cross. Length of holotype, 8.5 mm., width at front 7.5 mm."

To this original description it may be added that the solid part of the axial lobe of the pygidium has fine scattered tubercles, that the 9 pairs of ribs of the pleural lobes are almost rectangular in section, as is also the trough between them. The first, second, and third posterior pleural ribs coalesce forming a solid posterior border, each of the other ribs expand on their outer edges touching one another.

The outstanding characteristic of the species is the solid central rod of the pygidium axis, which interrupts the annulations.

Occurrence. Leray beds, localities 13, 80; Rockland beds, localities 6, 97; Sherman Fall beds, locality 20; Cobourg beds, localities 57, 66, 72.

Type. Holotype, G.S.C. No. 3385. The holotype comes from outside this area, from the Rockland beds at Kirkfield, Ontario.

Encrinurus trentonensis Walcott

Plate VIII, figure 5

E. trentonensis Walcott, 31st Rept. New York State Mus. Nat. Hist., 1880, p. 68; Weller, Geol. Surv., New Jersey, Pal. 3, 1903, p. 202, Pl. 15, figs. 26, 27.

This species also has been described from pygidia only.

Pygidium triangular, convex, length and breadth about equal; axial lobe marked by twenty-three rings, with several indistinct additional ones, tubercles on first, third, sixth, tenth, fourteenth, eighteenth, and twenty-second rings; nine or ten pleural ribs.

The species differs from *E. cybeleformis* in being more nearly an equilateral triangle in outline, and the annulations of the axial lobe of the pygidium are complete, not interrupted by a solid central axis within the axis as in the latter species.

In the collections are several pygidial fragments too incomplete to show their outline but exhibiting the complete axial annulations. These are provisionally classed as *E. trentonensis*.

Walcott's original description of *E. trentonensis* cites nine pleural ribs. Weller gives nine or ten for this species. The descriptions also contain some difference in the position of the median tubercles on the axial lobe. Hall's *E. vigilans* is described as having nine pleural ribs, and a median tubercle on every third or fourth axial ring. The specimens of the Ottawa-St. Lawrence Lowland are referred to *E. trentonensis* rather than to *E. vigilans* because those that can be counted have ten pleural ribs.

F. R. Cowper Reed¹ has pointed out that within one species there is no constancy in the ratio of axial rings and pleural ribs, and that the pleural ribs rather than the axial rings may represent the segments. The present writer would suggest that both the ratio of axial rings to the pleural ribs, and the number of pleural ribs might vary within a species according to the stage of the moult. A series would have to be studied from this angle before it is certain that *E. trentonensis* Walcott differs specifically from *E. vigilans* Hall.

Occurrence. Leray-Rockland beds, localities 112, 113; Cobourg beds, localities 30, 70, 169.

Type. Plesiotype from Rockland beds, south of Embrun, Ontario, in the private collection of G. W. Sinclair.

Genus, *Cybeloides* SlocumGenotype, *C. iowensis* Slocum

Cephalon sub-lunate; dorsal furrows distinct; glabellar furrows represented by three pits, two or three of which are confluent making two longitudinal furrows, which divide the glabella into a median and two lateral lobes; eyes small, pedunculate; genal angles produced into spines; facial sutures arising somewhat in front of the genal angles; surface tuberculate.

Thorax having 12 segments, the 5 anterior ones faceted at the outer end; the sixth and in some cases the posterior ones bent backward and produced into spines.

Pygidium small; axis conical with many annulations; pleural lobes with few annulations all of which are practically parallel with the main axis of the carapace.

The genus is distinguished from *Encrinurus* in the glabella by the presence of the longitudinal glabellar furrows, and in the pygidium by the longitudinal

¹ Reed, F. R. Cowper, Geol. Mag., 65, 1928, p. 59.

axis of the segments of the pleural lobes. It differs from *Cybele*, to which many of its species have been referred, in the presence of the longitudinal glabellar furrows and in having genal spines.

Cybeloides ella (Raymond and Narraway)

Plate VIII, figure 9

Cybele ella Raymond and Narraway, Ann. Carnegie Mus. 3, 1906, p. 598, fig. 1.

A single specimen is known measuring 14 mm. in length and 12 mm. in width at the genal angles; hypostoma not known.

Cephalon short and wide; front rounded; dorsal furrows subparallel; neck furrow curving forward on the glabella with a pit at each end just inside the dorsal furrow; glabella expanding; glabella furrows represented by three pits, the second and the third being confluent, forming a longitudinal furrow cutting off a longitudinal lobe, partly separated from the glabella; eye not seen; free cheek broken; fixed cheek depressed, having a transverse ridge crossing the dorsal furrow opposite the first glabellar pit; large diverging genal spines; facial sutures cutting the border in front of the spine, obliterated for some distance, but again discernible opposite the first pair of glabellar pits passing around the glabella; surface having large round pustules on the glabella, the four on top being paired and each pair connected by two ridges; in front of the first pair in the median line is a pit, also there are two deep pits on the fixed cheeks opposite the widest part of the frontal lobe; free cheeks coarsely reticulate; fixed cheeks smooth.

Thorax having 12 segments, the sixth from the front most prominent; axial lobe prominent, convex, bearing three pustules on the outer edge of each segment, the inner pustule being the largest; pleural lobes grooved, the posterior portion the larger with a narrow flange to receive the segment posterior to it; surface bearing several pustules on the outer part.

Pygidium small, about equal in length and width; axial lobe wide, not extending to posterior border, 15 or 16 segments, interrupted by a solid central axis which bears five pairs of small tubercles at the end of the incomplete annulations; pleural lobes narrow and depressed, four pairs of double ribs, the first pair being the larger, bordering the whole pygidium.

C. ella differs from *C. iowensis* Slocum in having fewer pustules on the cephalon, the longitudinal furrows are straight not curved, and are interrupted, the first pair of pits being separate, the second and third confluent as compared with those of *C. iowensis* in which the furrow is formed by the confluence of the three pairs of pits.

Occurrence. Leray beds, locality 37.

Type. Royal Ontario Museum, Toronto.

Cybeloides plana Sinclair

Plate X, figure 3

C. plana Sinclair, Roy. Can. Instit., Trans. 25, pt. 1, No. 53, 1944, p. 19, Pl. 1, fig. 8.

Known only from a part of a cephalon and thorax.

Cephalon small, short and broad, length 5 mm. width 18 mm., convexity low; anterior and posterior margins subparallel; border narrow and flat, ending in a genal spine broken at the end; dorsal furrows deep; neck furrow broad and shallow; neck ring moderately narrow, tapering at the ends, apparently smooth; glabella T-shaped with narrow, rectangular base, the narrow shaft

continuing to beyond the eye, where the upper section widens becoming twice the basal width; shaft of the T-shaped glabella bearing three transverse rows of large regularly placed pustules, four pustules in each row; the expanded anterior of the glabella also bears three less regularly arranged transverse rows of pustules, two pustules on the first row placed farther apart than the median pustules of the preceding row, the second row consisting of five or six at the outer edges, forming a slight curve corresponding to the curve of the anterior of the glabella, the third and outer row, at the anterior of the glabella somewhat worn but apparently consisting of seven pustules more closely spaced; only one pair of glabellar furrows visible, broad and deep, beginning about one-quarter distant from the anterior, curving slightly inward, thence almost parallel with the glabella axis to the neck furrow, cutting off two posterior long, narrow basal lobes, parallel to the glabella axis, and bearing a few small pustules; sutures beginning anterior to the genal spine but posterior to the eye, curving gently forward to it, thence with a broad long curve along the inner edge of the eye, then gently inward and outward describing half a circle, the outer part broken but apparently cutting the border in line with the eye; free cheeks large, broad, gently convex, and bearing a few indistinct pustules; fixed cheeks small and narrow; eye not present in the holotype but apparently long, as defined by the suture line; genal spine broken.

Thorax broad and low, broken so that parts of only nine long and narrow segments are visible; axial lobe a little less than one-third the total width; segments sharp on top, the first two or three bearing three pustules in line with the outer ones of the shaft of the T-shaped glabella, the two outer pustules only continue on the succeeding segments diminishing in prominence as they approach the posterior; pleural lobes grooved on both inner and outer portions; no pustules preserved.

The number of pustules in the several rows of the species may not be specific, but their arrangement probably is.

C. plana Sinclair differs from *C. ella* (Narraway and Raymond) in having the longitudinal grooves of the glabella continuous, not interrupted as in *C. ella*, in the regularity of its pustule arrangement, and in being slightly larger, although until more specimens are found it is not certain that the latter difference is constant.

Occurrence. Sherman Fall beds, locality 125.

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

Genus, *Flexicalymene* Shirley

Genotype, *Calymene caractaci* Salter

Body suboval, possessing power of enrolment; hypostoma subquadrate and notched.

Cephalon semicircular, with projecting or recurving central anterior margin without distinct ridge between the outer convex and inner concave parts; dorsal furrows distinct, not contracted; neck furrow complete; glabella convex, narrowed in front, three pairs of glabellar furrows decreasing in size and depth anteriorly, widening inwardly giving the consequent lobes a circular or subquadrate outline; eye small; free cheek narrow, elongate; genal angles usually rounded; facial sutures just in front of the genal angle, curving in towards and then encircling the eye, thence obliquely forward to the margins.

Thorax with 13 segments; axial lobe strongly differentiated, convex rings bevelled to allow movement; pleural lobes curving downward.

Pygidium very convex, short; axis prominent, tapering quickly, rings complete; pleural lobes loping abruptly backward, pleura few, fading out posteriorly.

Flexicalymene has been separated from *Calymene* mainly on the basis of the lack of contraction of the outer edge of the dorsal furrows of the cephalon. In *Calymene* the furrow is contracted opposite the second lateral glabellar lobe. The glabella of *Flexicalymene* in general is proportionately longer and narrower than that of *Calymene*.

Flexicalymene senaria (Conrad)

Plate X, figures 11a, 11b, 12

Calymene senaria Conrad, 5th Ann. Rept., Geol. Surv., New York, 1841, pp. 38, 49; Emmons, Nat. Hist. New York, Geol. 2, 1842, p. 390, fig. 2; Billings, Can. Nat. Geol. 1, 1856, p. 46, fig. 10.

Flexicalymene senaria (Conrad) Shimer and Shrock, Index Foss. of North America, 1944, p. 645, Pl. 272, figs. 3-5.

Cephalon having the central anterior margin produced; glabella long, with narrow, rounded anterior lobe; dorsal furrow not constricted; surface granulose.

Thorax having grooved pleura; granulose surface.

Pygidium short; axial lobe with 6 or 7 coarse rings, gradually disappearing posteriorly, apex abrupt; 5 coarse pleura on the pleural lobes, the anterior ones simple, the posterior ones having a shallow groove more evident on the outer half; surface granulose.

Only two other Calymenidae are cited from beds of Black River-Trenton age in North America: *Calymene abbreviate* Foerste and *Calymene platycephala* Foerste. From the names and descriptions it is possible that the latter belongs to Shirley's genus *Platycalymene*, and that the former has a straight anterior border.

Occurrence. Leray beds, localities 3, 9, 150; Leray-Rockland beds, locality 95, 113; Rockland beds, localities 10, 35, 97, 130; Hull beds, localities 19, 23, 28, 33; Hull or Sherman Fall beds, locality 26; Sherman Fall beds, localities 16, 20, 21, 25, 29, 31, 56, 73, 74, 99, 109, 114, 120, 124, 125, 145, 146, 152; Cobourg beds, localities 30, 57, 61-63, 66-68, 72, 75, 76, 103, 110, 116, 119, 122, 129, 140, 143, 144, 147-149, 155-157, 166, 176.

Type. Plesiotypes, G.S.C. No. 7761, Rockland beds, 4 miles west of L'Original, No. 7762, Sherman Fall beds, Governor Bay, Ottawa, Ontario.

Genus, *Ceraurus* Green

Genotype, *C. pleurexanthemus* Green

Broadly ovoid, omitting spines; convex; no concave border; pustulose and spinose; hypostoma ovoid, pustulose, surrounded by a deep, narrow, concave border which slightly widens anteriorly, ending short of the attachment at the doublure.

Cephalon very broad in front, surrounded by a smooth, narrow, convex rim prolonged into a pair of spines; dorsal furrows deep; neck furrow distinct, the ring continued across the back of the cephalon to meet the outer convex rim; glabella moderately expanding in front, four short glabellar furrows, sloping gently backward, the basal furrow not reaching the neck furrow but connected on the inner end by a shallow longitudinal constriction, lobes less than one-third the width of the glabella, and basal lobe quadrangular, whole glabella strongly pustulose; eyes prominent, far apart; free cheeks subtriangular.

pustulose, not bearing the spine, surrounded on the outer side by the convex rim; genal angles prolonged into two, long, smooth spines which are part of the cranium not of the free cheeks: sutures beginning anterior to the spines, curving forward across the smooth border, turning backward to the lower inner part of the eye, encircling the palpebral lobe, thence forward after a second sharp turn, and curving inward to cut the anterior border opposite the dorsal furrows; surface spinose.

Thorax with 11 segments; convex; axial lobe very distinct, often with nodes, traversed by a groove; pleura slightly convex then curving downward abruptly, having an oblique groove on the upper part; pustulose.

Pygidium very small; usually 4 segments, the first being prolonged into a pair of long spines, the remainder having short spines or none at all.

Ceraurus differs from *Cheirurus* in that the posterior lobe of the glabella is quadrangular not triangular, its furrow does not open into the neck furrow; the pleural spines are unequal in length.

Ceraurus differs from *Ceraurinus* in not having the basal glabellar furrow connected with the neck furrow by a constriction, the glabellar lobes are less than a third instead of greater than a third the width of the glabella; the glabella is spinose, not smooth as in *Ceraurinus*; cheeks are pustulose not pitted; the pygidium has one long pair of spines instead of 3 shorter pairs.

Ceraurus bispinosus Raymond and Barton

Plate IX, figure 1

C. bispinosus Raymond and Barton, Mus. Comp. Zool., Bull. 54, 1913, p. 536, Pl. 1, figs. 3, 4; Föerste, Denison Univ. Sci. Lab., 19, 1920, Pl. 22, fig. 23.

Known only from parts of cephalo.

Cephalon roughly semicircular, a little wider than long, surrounded by a convex border wider at the cheeks, narrower in front, separated from rest by a deep groove; dorsal furrows, deep; neck furrow narrow and moderately deep; glabella very convex, the frontal lobe and first pair of glabellar lobes much more convex than the posterior ones; 3 pairs of glabellar furrows, only the posterior pair deep, each curved backward slightly at its inner end; eyes set forward, nearer the glabella than the posterior margin; eye line faint; free cheeks small; fixed cheeks very convex; genal angles not preserved; 3 pairs of pustules strongly developed and numerous small ones on the glabella, the middle pair the most prominent, pits on the free cheeks and granules on the border.

C. bispinosus differs from *C. pleurexanthemus* and *C. dentatus* in its pairs of strong spines on the glabella, in the more rapid expansion of the glabella, in having the eyes more forward, and in the slightness of the eye line.

Occurrence. Leray beds, localities 16 and 44.

Type. Royal Ontario Museum, Toronto.

Ceraurus dentatus Raymond and Barton

Plate IX, figures 2a, 2b

Ceraurus pleurexanthemus Hall (partim), Pal. New York, 1, 1847, Pl. 56, figs. 1d, 1h, 1i, 1m, Pl. 66, fig. 1a-1g; Billings, Geol. Canada, 1863, p. 188, fig. 188.

Ceraurus dentatus Raymond and Barton, Mus. Comp. Zool., Bull. 54, 1913, p. 534, Pl. 1, fig. 2, Pl. 2, figs. 4, 5.

Often large, the holotype measuring 83 mm. in length and 60 mm. in width; hypostoma ovoid, very convex, surrounded on posterior end and sides by a

smooth, concave border which widens about mid-length and ends abruptly at about three-quarters length from the posterior end, convex portion tuberculate.

Cephalon having width more than twice the length; front broadly rounded, surrounded by a smooth convex border separated from the rest of the cephalon by a shallow concave groove, the evenness of its course interrupted at the dorsal furrow; dorsal furrows deep; neck furrow complete, deepening on the fixed cheeks and continued to the genal angles; glabella expanding in front where it is very broadly rounded, almost straight, 3 deep glabellar furrows, the two anterior ones perpendicular to the axis of the glabella and producing quadrate nodes a little less than one-third the width of the glabella, the posterior furrow slightly oblique towards the neck furrow with which its inner end is connected by a shallow groove resulting in a pair of smaller more globose nodes; eye large, placed far back; free cheek subtriangular; genal angles produced into long spines; facial sutures typical of the genus; surface of glabella, free cheeks, and fixed cheeks tuberculate; border, spines, and neck ring and furrow smooth.

Thorax very convex; axial lobe tapering near the posterior end; each segment grooved transversely and constricted just short of the outer end making a row of nodes adjacent to the dorsal furrows; pleural lobes geniculate about mid-width, each pleuron grooved along the posterior edge, bevelled on the outer downward-turning portion; surface smooth.

Pygidium small in proportion to the complete form, bounded by two large divergent spines; the two annulations which make up the axial and pleural lobes ending in two pairs of minute spines within the large pair; surface smooth.

The species differs from *C. pleurexanthemus* in lacking the eye line, in having the eye set farther back, and in the presence of the two small spines between the pair of great spines on the pygidium.

Occurrence. Leray beds, locality 121; Leray-Rockland beds, localities 6, 97, 133, 134, 168; Hull beds, localities 19, 131; Cobourg beds, localities 30, 33, 134 (loose).

Type. Holotype, G.S.C. No. 1775, Leray-Rockland beds, north of Vankleek Hill, Ontario.

Ceraurus pleurexanthemus Green

Plate IX, figures 3-5

C. pleurexanthemus Green, Monthly Amer. Jour. Geol., 1, 1832, p. 560, Pl. 4, fig. 10; Hall (partim), Pal. New York, 1, 1847, p. 242, Pl. 65, figs. 1a-1c, 1e-1g; Raymond and Barton, Mus. Comp. Zool., Bull. 54, 1913, p. 528, Pl. 1, fig. 1, Pl. 2, figs. 1, 2, 7.

Generally smaller than *C. dentatus*.

Cephalon obovate, front broadly curved, almost straight, surrounded by a convex border, broad at the cheeks, narrow in front; dorsal furrows deep; neck furrows deep and continued across the fixed cheeks; glabella convex; glabellar furrows short, cutting off small, convex, more or less rounded nodes, the posterior pair of glabellar furrows oblique, becoming faint as they reach the neck furrow, and making a small, convex, subtriangular posterior pair of nodes; eyes small, high, minutely faceted; a ridge crossing from opposite the first pair of glabellar furrows to the palpebral lobes; genal angles ending in two short diverging spines; surface of glabella, fixed and free cheeks covered with pits and tubercles, genal spines granulose, two rows of coarse tubercles on the glabella, roughly in line.

Thorax with 11 segments; axial lobe convex, bordered by two rows of small nodes; pleural lobes geniculate, inner part of each segment crossed by an oblique

groove beginning at the inner anterior end, the outer and perpendicular part free and bevelled; inner portion of pleural lobes nodose, and each pleuron having a prominent tubercle at the area of geniculation.

Pygidium small, short, composed of four anchylosed segments, the first ending in a pair of long, curved, divergent spines; within these spines are two ribs curving around a small convex central part, all terminating in a curved, convex, unbroken, posterior margin.

The differences between *C. pleurexanthemus* and *C. dentatus* are given under the description of *C. dentatus*.

Occurrence. Lowville-Leray beds, localities 40, 85, 91, 102; Leray beds, localities 16, 44, 100, 162; Leray-Rockland beds, localities 4, 8, 54, 55, 89; Rockland beds, locality 97; Hull beds, localities 18, 19; Sherman Fall beds, localities 21, 29, 32, 73, 74, 114, 120, 123, 125, 146, 151, 152, 159; Cobourg beds, localities 30, 46, 57, 65, 68, 70, 71, 75, 76, 105, 115, 119, 129, 141, 149, 160, 180.

Type. Plesiotypes, G.S.C. No. 7763, Leray-Rockland beds, lots 19-24, con. I, Winchester tp., and Cobourg beds, near Alfred, in the private collection of J. A. Calder.

Genus, *Ceraurinus* Barton

Genotype, *C. marginatus* Barton

Cephalon with dorsal furrows subparallel or slightly expanding; neck furrow distinct, arching forward behind the glabella; glabella sub-rectangular or slightly expanding, three pairs of glabellar furrows perpendicular to the central axis or sloping gently backwards, the inner ends of the posterior pair connecting with the neck furrows; eyes large about opposite the mid-length of the glabella; eye line present; short spines on the genal angles; facial sutures beginning near the genal angle sloping inward, thence surrounding the palpebral lobe, then forward making a broad curve around the anterior of the glabella; glabella smooth, cheeks generally punctate.

Thorax 11 segments; axial lobe a little less than one-third of the width of the thorax; pleural lobes having a node-like constriction at the region of geniculation, the inner third with a deep diagonal furrow, the outer two-thirds ending in spines.

Pygidium with three or four segments ending in free spines of about equal length.

The features distinguishing *Ceraurinus* from *Ceraurus* are given under *Ceraurus*.

Ceraurinus marginatus Barton

Plate IX, figures 6, 7

C. marginatus Barton, Mus. Comp. Zool., Bull. 54, 1913, p. 550, Pl. 1, fig. 1.

Species rather large, with a broad marginal border.

Cephalon with clearly defined dorsal furrows; neck furrow parallel to the posterior border, the neck ring becoming broader and arching forward between the dorsal furrows; glabella subquadrangle in outline, rounded in front, gently and evenly convex; three pairs of deep glabellar furrows, about one-third width of glabella, slightly sloping backward, almost perpendicular to the central axis, posterior pair of lobes subquadrangle, separated from the inner glabella by a shallow furrow parallel to the central axis and connecting with the neck furrow; palpebral lobe smaller than the eye, almost opposite the second pair of glabellar furrows, and bearing a depression on the inner edge; eyes fairly large, placed

about the middle of the outer edge of the free cheek; eye line strong, crossing to the first pair of lobes; free cheek large, triangular, slightly convex; facial sutures typical; glabella smooth, free cheeks faintly pitted.

Thorax 10 or 11 segments; axial lobe tapering, about one-quarter the entire width; pleural lobes with a narrow inner portion and a larger outer portion, separated by constrictions of the pleura, the inner part of the segments grooved.

Pygidium not known.

The only specimen found is a cranidium. Though the margin is lacking it is identified as *C. marginatus* because the glabella is less convex than in *C. trentonensis*, the glabella furrows are directed more nearly at right angles to the central axis, the anterior lobe is proportionately shorter and less convex, and the posterior pair of lobes is more subquadrate.

Occurrence. Cobourg beds, locality 30.

Type. Plesiotype, Cobourg beds, Philemon Island, Hull, Quebec, in the private collection of G. W. Sinclair.

Genus *Sphaerocorphe* Angelin

Genotype, *S. dentata* Angelin

Cephalon with characteristic glabella, frontal lobe spheroidal, two pairs of small lateral lobes, glabellar furrows confluent; eyes prominent, set far out from the glabella; free cheek smaller than fixed cheeks; genal angles ending in a spine; facial sutures cutting the lateral and frontal margins.

Thorax with 10 segments, axial lobes less than one-third the whole width; pleura terminating in short spines.

Pygidium having 3 segments the anterior of which is produced in a pair of long spines.

The genus is characterized by the bulbous frontal lobe of the glabella. It differs from *Staurocephalus*, which also has a bulbous frontal lobe, in that it has two instead of three glabellar lobes behind the central glabellar lobe.

Sphaerocorphe robusta Walcott

Plate X, figures 1, 2a, 2b

S. robusta Walcott, Cincinnati, Quart. Jour. Sci., 2, 1875, p. 273, figs. 18a, 18b.

Cephalon subtriangular, strongly convex; dorsal furrows distinct; neck furrow broad, shallow upon the central axis, deeper on the sides; neck ring narrow but elevated; glabella in two parts, anterior central lobe bulbous, constricted at the base, with two confluent glabellar furrows, forming two pairs of small rudimentary lobes, the anterior pair being the larger and more convex; eyes very prominent, subglobose, directed forward and outward; free cheeks triangular and convex; genal spines long, extending more than half the length of the thorax; facial sutures arising near the posterior lateral margin, crossing to the base of the eye, curving around the palpebral lobe thence around the globose anterior glabellar lobe; surface granulated; coarser upon the globose anterior lobe.

Thorax a little longer than cephalon, 10 segments; axial lobe tapering gradually, convex, with segments arching forward; pleural lobes flattened for two-thirds their width then bending downward; pleura straight, terminating in short spines which turn backward slightly.

Pygidium small, posterior margin unbroken; axial lobe having three segments, the anterior of which is produced into a pair of long stout spines, curving backward; surface granulated.

The type specimen came from beds at Trenton Falls, New York, of approximately the same age.

Occurrence. Sherman Fall beds, localities 20, 21.

Type. Plesiotype, Sherman Fall beds, from Brewery Creek, Hull, Quebec, in the private collection of G. W. Sinclair.

Genus, *Pterygometopus* Schmidt

Genotype, *Phacops sclerops* Dalman

In defining his genus *Pterygometopus* Schmidt selected as genotype *Phacops sclerops* Dalman¹. Schmidt's description of *Pterygometopus* is fairly general, the most definite characteristic named is the cutting of the frontal lobe of the glabella by the facial sutures. He, however, re-defines the genotype giving a detailed description that is translated below, because of the comparative inaccessibility of the publication.

The headshield is curved, semi-lunar, breadth less than twice the length; rounded or bluntly angular on the anterior margin; genal angles rounded or bluntly pointed; dorsal furrows beginning at the neck ring at first almost perpendicular to it, appearing almost parallel to one another, then curving slightly outward as far as the first glabellar furrow, where they turn sharply outward almost at an angle crossing at the edge of the eye to the marginal furrow which in turn begins at the juncture of the neck furrow and the genal angle. The front lobe of the glabella extends almost to the margin and is separated from it only by the concave furrow which is cut by this part of the facial suture. The facial suture reaches the dorsal furrow just at the eye, cuts across the glabellar lobes and surrounds the anterior margin of the frontal lobe. That the glabella is not broken but that the facial suture cuts the side lobes can easily be verified by the unbroken junction of the dorsal furrow and the marginal furrow and the angular apex of the margin where the two branches of the facial suture meet. The inner part of the frontal lobe, within the sutures, is transversely oblong, almost straight posteriorly, convex or somewhat produced in front and nearly three-sided. It extends to a position opposite the middle of the eye. Its greatest dimension in the middle is equal to that of the glabellar lobes together. The first and second glabellar lobes are almost similar (the first generally somewhat the larger) slightly convex, round, and four-sided; in some cases the first is three-sided, because of the greater length of the first furrow and the outward curve of the dorsal furrows. The third lobe is flatter, smaller, and button-like at the end. The first glabellar furrow is horizontal with a slight backward bend, the second and third are curved backward somewhat. The space between the right and left furrows is equal to the length of the furrow. The neck ring sometimes has a small tubercle in the middle. The inner side of the cheek is not longer than the posterior side, the outer side is in some cases so strongly convex that it almost results in a four-sided outline (for example T. 11, fig. 1).

The surface of the cephalon is so finely granulose that it appears smooth without a lens. In some cases large tubercles are present. On the flat part of the cheek scattered pits are clearly visible in some species.

The eyes are large and equal in length to the three glabellar lobes, about one-third the length of the cephalon and more than half the length of their own

¹ Schmidt, L'Acad. Imp. des Sci. de St. Petersbourg, Mem. 7, Ser. 30, 1882, No. 1, p. 77, T.1, figs. 3-8, T.11, figs. 1, 2, T.12, figs. 1-4.

bases distant from the posterior edge. The facets are very distinct 23 or 24 vertical rows, the longest row in the middle is 2 mm. long and has 9 or 10 facets. The whole amounts to about 200.

The hypostoma of no specimen is preserved so that the undersurface of the cephalon is studied from several specimens. It consists of a flat band (the doublure) set at an angle of 40 to 60 degrees to the upper surface of the cephalon. On the cheek, at about the level of the upper edge of the eye, the edge makes a sharper angle, expanding to two flat wings which make a fold with the gradually diminishing inner part of the doublure. The corners of the cheeks are sharp-edged leaves, whereas the doublure hardly touches the upper shell.

Of the nature of the thorax not much can be said. The anterior pleura end bluntly, the posterior pointed as in other species.

The pygidium is semicircular produced somewhat in the middle, the axial lobe has 6-8 rings and ends bluntly, and there are 6-8 pleura the upper surfaces of which have a shallow groove. The pleura do not reach the edge and are about 1 mm. wide, with a smooth margin.

Variations. I (Schmidt) believed formerly that I could recognize some variations by definite features and have illustrated such in figures 7 and 8, Plate I. In both, however, the differing characteristics are exaggerated as can be seen from Plate II, fig. 2. At that, the three-cornered shape of the first lobe in figure 8 is not so sharply distinct. I am now of the opinion that the species in the main have variations only within certain limits. Of that type of variation is the anterior margin of the cephalon, which is either quite rounded or more or less bluntly angular. In the same way the form of the front lobe varies from transversely oblong to three-sided and the shape of the whole cephalon from semilunar to three-sided. Further, the course of the dorsal furrows has some variations. They always have an outward bend but the bend is variable in degree, either the furrows are almost vertical from the neck ring to the frontal lobe, so that they appear parallel, in which case the side lobes of the glabella are almost similar, or the outward turning begins closer to the neck furrow, in which case the first glabellar lobe is larger and approaches a triangular form. It has not been possible among so many examples examined to determine fundamental variations.

Also the form of the pygidium seems to vary. The typical form is semilunar, but one of our specimens, Plate 12, fig. 16, shows clearly a projecting tip without being far removed from other characteristics of *Pterygometopus* (translation by the author).

It will be seen from the above translation of the description of *Pterygometopus sclerops* (Dalman) that under the genus *Pterygometopus* Schmidt included several forms that he regarded as variations. Both Dalman's and Schmidt's illustrations of the genotype *P. sclerops*, though not particularly well drawn according to modern ideas, distinctly show the first glabellar furrows directed slightly backward at the inner end, and the other two sub-parallel and almost horizontal, making the three lobes almost similar in their elliptical shape, although decreasing in size.

Pterygometopus restricted, then, may be defined as follows:

Cephalon semicircular, front of the glabella almost overhanging the exceedingly narrow upturned rim, which widens and lies flatter at the sides; dorsal furrows subparallel, with a more pronounced outward curve at the first glabellar furrows, just under the eye; neck furrow well defined; neck ring prominent; glabella with three furrows, the first directed slightly backward, the other two almost horizontal, frontal lobe short and wide, other lobes elliptical or narrowly oblong, progressively decreasing in size backwards, the last pair having a faint constriction at the outer end; eyes prominent; palpebral lobes

swollen; genal angle quite sharp but without a spine; facial sutures cutting the border and crossing back of the eye, turning sharply, crossing the outer ends of the glabellar furrows, outward turn increased at the eye thence crossing the frontal lobe to the margin; surface pustulose.

Thorax with blunt anterior and pointed posterior pleura.

Pygidium semicircular, somewhat acute at the posterior end; axial lobe distinct, with a blunt posterior which does not reach the end of the shield, having 6-8 rings, also 6-8 grooved pleura which do not reach the edge; outer margin smooth.

The main distinctive features of *Pterygometopus* restricted are in the cephalon. It is characterized by the shortness of the frontal lobe, the gradualness of the outer curve of the dorsal furrows, and the subparallel glabellar furrows, both of which result in almost similar elliptical glabellar lobes which decrease slightly backwards.

Pterygometopus billingsi (Sinclair)

Plate X, figures 4a, 4b

Achatella billingsi Sinclair, Roy. Can. Institut., Trans. 25, pt. 1, No. 53, 1944, p. 17, Pl. 1, figs. 1, 2.

Anterior broadly rounded, posterior curving backward, the whole measuring 9 mm. and 16 mm. in length and width respectively; dorsal furrows typical; neck ring 2.5 mm. in width, so worn that the presence or absence of a tubercle is not known; glabella widening greatly anteriorly, glabellar furrows typical, part between each pair of furrows about one-half length of furrow, frontal lobe 10 mm. and 3.5 mm. in width and length respectively, anterior pair of lobes tending to become triangular though not to such a degree as in species of the following genus *Calliops*; other lobes almost oblong; eyes very prominent, cone-shaped, far forward; genal angle curved backward slightly; surface all very finely granular, in addition the glabella has a few coarse tubercles and the free cheek is shallowly pitted.

Pygidium unknown.

The species differs from *P. sclerops* in its smaller size, its more prominent cone-shaped eyes, and in the length of the glabellar furrows, with consequent narrowness of the area between the furrows.

The species is here referred to *Pterygometopus* rather than to *Achatella* because of the more horizontally directed second and third pairs of glabellar furrows, the slightness of constriction in the third pair of glabellar furrows, and the fact that the anterior is rounded rather than slightly angular.

Occurrence. Sherman Fall beds, locality 21.

Type. Holotype, not from this area, and in the private collection of G. W. Sinclair; plesiotype, G.S.C. No. 7764, Sherman Fall beds, axe factory, Hull, Quebec.

Genus, *Calliops* Delo

Genotype, *Phacops callicephalus* Hall

"*Pterygometopinae* with frontal lobe not conspicuously alate, sharply bounded, only slightly wider than large first glabellar lobes, which are distinctly triangular; second glabellar furrows narrower, shallower than the first and third; eyes large, with conspicuously swollen palpebral lobes reaching backward to the posterior marginal furrow; nuchal lobe prominent. Pygidium convex never mucronate, much as in *Pterygometopus* s.s."—original description.

To this it might be added that the dorsal furrows diverge close to the neck giving the whole glabella a somewhat circular outline.

As shown in the previous translation of the description of *Pterygometopus*, Schmidt recognized several variations. *Calliops* is evidently the variation to which he referred in his uneasy remarks about the first glabellar lobes. He described them as triangular, and then partly retracted his statement.

Calliops differs from *Pterygometopus* in the more divergent course of the dorsal furrows, which, in conjunction with the longer frontal lobe of the glabella, results in a more rounded outline of the glabella, and in the shape of the glabellar lobes. In *Calliops* the forward direction of the inner end of the second and third glabellar furrows makes the first pair distinctly triangular and with the divergent dorsal furrows makes a rapid decrease in the length of the posterior glabellar lobes as compared with the more regular elliptical or oblong lobes of *Pterygometopus*.

Calliops alatus Okulitch

Plate X, figure 15

Calliops alatus Okulitch, Roy. Soc., Canada, 3rd ser., 36, 1942, p. 101, Pl. 1, fig. 4.

Known from cranium only.

Complete outline of cephalon not known; dorsal furrows deep, diverging, curved slightly inward towards the rounded anterior of the frontal lobe making the whole glabella almost circular in outline; neck furrow narrow; neck ring moderately high; glabella flatter than that of most species, slightly wider than long, greatest width at the first glabellar lobes; three pairs of glabellar furrows, each deeper than the one anterior to it; the first pair directed slightly backward from the dorsal lobe cutting off a frontal lobe twice as wide as long and approximately half the length of the whole glabella, second and third pair of furrows almost parallel directed gently forward from the dorsal lobe; first of lateral glabellar lobes large, convex, sub-triangular, second pair small, narrow and convex, third pair minute or absent; sutures not seen; palpebral lobes almost triangular and slightly lower than the highest part of the glabella; eye lunate; only partly preserved; fixed cheek and free cheek not preserved, surface of glabella pustulose.

Thorax not known.

Pygidium not known.

C. alatus differs from the genotype *C. callicephalus* (Hall) in the more circular outline of the glabella, in the longer and proportionately narrower frontal lobe, and in the lack of development of the third pair of lateral lobes.

Occurrence. Hull beds ? , locality 35.

Type. Holotype, Royal Ontario Museum No. 25763, Hull beds?, Hull, Quebec.

Calliops callicephalus (Hall)

Plate X, figures 5, 6

Phacops callicephalus Hall, Pal. New York, 1, 1847, p. 247, Pl. 65, figs. 3a-1; Billings, Geol. Surv., Canada, Geol. Canada, 1863, p. 187, fig. 184.

Pterygometopus callicephalus (Hall), Clarke, Geol. Minnesota, 3, pt. 2, 1894, p. 731, figs. 51, 52, p. 732.

Calliops callicephalus (Hall), Delo, Geol. Soc. Amer., Spec. 29, 1943, p. 94, Pl. 11, figs. 1-4.

Cephalon almost twice as wide as long; lateral border wide; anterior rounded or obtusely angular and slightly turned up; posterior margin curved, concave forward; dorsal furrows parallel or even converging as far as opposite

the posterior half of the eye then diverging at about 45 degrees to the axis of the glabella; neck furrow narrow, continuing behind the eye to meet the border; neck ring broad, convex; glabella narrow posteriorly, rapidly expanding, broadly rounded or obtusely angular in front; first pair of glabellar furrows directed gently backward from the dorsal furrows cutting off a frontal lobe nearly twice as wide as long; second and third pair of glabellar furrows roughly paralleling one another, directed gently forward from the dorsal furrows, first pair of lateral lobes subtriangular, blunt at the anterior, second pair oblong, third pair about the same size as the second but constricted at the outer end forming a button-like tubercle; sutures beginning opposite the mid-length of the eye, curving back to its course around the eye thence crossing almost directly to the anterior margin; fixed cheek small, on a level with the base of the eye, ending in lobe-like genal angles; free cheek very small, roughly oblong; palpebral lobes oblique, convex; eye large, lunate, almost half the length of the cephalon, upper edge on a level with the convex glabella; surface of cephalon pustulose.

Thorax with 11 segments; axis of uniform width, a little less than a third the total width; pleura grooved for the greater part of their lengths.

Delo states that the axial lobe of the pygidium has 10 or 11 segments and the pleural lobes 6 to 7. Hall states that the thorax has 11 segments, the pygidium 14 to 15 on the axial lobe and 9 on the lateral lobes. Hall's illustrations show two types of pygidia. It is difficult to reconcile these statements unless Hall was describing separate pygidia.

In the collections of the Ottawa-St. Lawrence region there are three types of loose pygidia, one answering Delo's description, which in one place touches a cephalon of *C. callicephalus*, another very similar, larger and broader, less convex, more in keeping with the cephalon *C. narrawayi*, and a third more pointed and more compact, which is here considered to belong to *Achatella achates*.

For comparison of *C. callicephalus* with *C. alatus* and *C. narrawayi* see under those species.

Occurrence. Leray beds, localities 44, 54; Leray-Rockland beds, localities 8, 17, 27, 44, 107, 133; Rockland beds, localities 74, 75, 78, 92, 97; Hull beds, localities 19, 23, 28, 135; Sherman Fall beds, localities 21, 25-27, 29, 31, 32, 56, 73, 114, 125, 126, 132, 145; Cobourg beds, localities 30, 47, 57, 64, 70, 75, 76, 118, 119, 161, 177, 179.

Type. Plesiotypes, G.S.C. Nos. 7765, 8009, Sherman Fall beds, from C.P.R. cutting, south of Aylmer road, Hull, and from 'The Heap', Hull, Quebec.

Calliops narrawayi Okulitch

Plate X, figure 7

Calliops narrawayi Okulitch, Roy. Soc., Canada, 3rd ser., 1942, sec. 4, p. 100, Pl. 1, figs. 5 and 6.

Cephalon twice as wide as long, very convex, having a very narrow lateral concave border becoming obsolete anteriorly; anterior margin angular and sharply turned up; posterior margin curved forward somewhat; dorsal furrows diverging at a wide angle; neck furrow narrow but distinct; neck ring narrow, convex, extending laterally posterior to the eye; three pairs of glabellar furrows present, the anterior pair directed backward from the dorsal furrow making the frontal lobe rhomboidal in outline, second and third pair directed forward from the dorsal furrow making the anterior lateral lobes sub-triangular; the second pair of lateral lobes narrow and short, the third pair very narrow but longer than the second pair, and with a node-like outer end; sutures beginning

opposite the middle of the eye, arching forward then abruptly backward to curve around the eye, thence gently outward but turning abruptly around the outer edge of the frontal lobe where they become marginal; fixed cheeks gently concave on the outer part, concave next the eye; free cheeks small and irregularly shaped; eye lunate, very prominent; palpebral lobes convex; surface smooth on the cheeks, but scattered tubercles present on the glabella; genal angles rounded, wing-like lobes.

Thorax not known.

Pygidium not known.

Compared with *C. callicephalus* (Hall), *C. narrawayi* Okulitch is considerably larger, has a more rhomboid frontal lobe, and the line of the posterior margin of the cephalon is proportionately not so curved.

Occurrence. Leray-Rockland beds, localities 6, 89; Sherman Fall beds, localities 20, 21; Cobourg beds, localities 30, 64, 75, 129.

Type. Plesiotype, Sherman Fall beds, axe factory, Hull, in the private collection of G. W. Sinclair.

Genus, *Calyptaulax* Cooper

Genotype, *Calyptaulax glabella* Cooper

Cephalon rounded or obtusely pointed; dorsal furrows diverging; neck furrow shallow but distinct; neck ring wider behind the glabella than laterally; glabella greatly expanding, first lateral furrows strong, sloping backward on the inner end, second lateral furrows a short slit, sloping slightly forward, not continuing to the dorsal furrows, third lateral furrows sloping obliquely forward; first and second lateral lobes coalescing on the outer part forming one large lobe the second being enlarged as well as the first, third lateral lobe a short narrow ridge partly constricted distally forming a connected tubercle.

Thorax rarely found, those known showing a great variation in the number of segments; axis a little less than one-third the total width; pleural lobes curving downward and backward, upper surface diagonally grooved.

Pygidium triangular, convex; axis narrow, extending almost to the terminus, extreme tip smooth and inclined to be slightly turned up; division of segments of pleural ribs disappearing towards the border.

Calyptaulax calderi n.sp.

Plate X, figures 9a, 9b, 10a, 10b

Cephalon margin slightly protruding anteriorly; front glabellar lobe being in the proportion of length to width 2:3, bearing three obscure furrows, two long ones radiating from the top of the lobe to the anterior margin ending on either side the apex, and between them one short median furrow which extends from the apex only half way to the top of the lobe; the rest of the glabella, glabellar furrows, and lateral glabellar lobes typical of the genus; eyes long, extending from opposite the front of the first glabellar lobes to the neck furrow; palpebral lobe having a narrow, crescent-shaped furrow on the inner side; free cheek broken, but comparatively broad, four-sided, and produced in a long point around the anterior genal angles; sutures rising at about the level of the base of the eyes, making a sigmoid curve passing inward close to the neck furrow, turning forward to follow the curve of the eyes, thence almost directly forward to within a short distance of the margin where they turn abruptly crossing the front obliquely to the marginal ends of the radial furrows on the frontal lobe, thence curving forward around the projecting median portion of the cephalon; surface pustulose on the glabella, pitted on both fixed and free cheeks.

Thorax with 10 segments visible, possibly one or even two more (one specimen is crushed, another incomplete); dorsal furrows deep; axial lobe about one-third the total width, each segment of the axis consisting of an upper and lower section to permit of enrolling, constricted on its outer edge but not enough to form a node; pleural lobes bending down rather sharply at the outer edge, the inner and upper part diagonally furrowed, the outer part flattened to enrol; surface, not well preserved, appearing to be finely pustulose on top and wrinkled near the sides.

Pygidium sharply triangular, sides turning down abruptly, posterior angle acute with a slight tendency to turn up at the tip; dorsal furrows deep, axial lobe narrow, terminating at the edge of the upper part, having 11 or 12 distinct annulations, further posterior ones obscure, though exfoliated specimens show as many as 17; pleural lobes with 9 or 10 unfurrowed segments dying out at the border.

C. calderi differs from other described species of the genus in the presence of the shallow radial furrows at the anterior of the frontal glabellar lobe, and in having more numerous annulations on the pygidium than all described species except *C. lincolnsis* (Branson).

Occurrence. Leray-Rockland beds, locality 8; Cobourg beds, locality 176.

Type. Holotype and paratype from east of Pakenham, Ontario, in the private collection of J. A. Calder.

Calyptaulax ottawanus Okulitch

Plate X, figure 17

C. ottawanus Okulitch, Roy. Soc., Canada, 3rd ser., 36, 1942, Pl. 1, figs. 2 and 3.

Known from glabella only.

Dorsal furrows diverging, curving anteriorly to meet the round anterior of the frontal lobe of the glabella; neck furrow narrow; neck ring flat, wide, and inclined; anterior glabellar furrows directed backward from the dorsal furrows cutting off a frontal lobe which forms more than half the glabella and is considerably wider than long, second glabellar furrows each a slit only, concave forward and directed obliquely forward, oriented from the dorsal furrow which they do not reach, third pair of glabellar furrows short and deep; first and second pairs of lateral lobes coalesced, convex and bulbous proximally, somewhat acute distally, third pair of lateral lobes small and narrow; sutures, cheeks, palpebral lobes, and eyes not known; surface of glabella pustulose.

Thorax not known.

Pygidium not known.

C. ottawanus Okulitch differs from *C. calderi* n.sp. in the lack of the three radiating furrows, and in the broader, more rounded frontal lobe.

Occurrence. Hull beds?, locality 35.

Type. Holotype, Royal Ontario Museum, No. 25766, from Hull beds?, Hull, Quebec.

Genus, *Achatella* Delo

Genotype, *Dalmanites achates* Billings

Unfortunately it was assumed that the genotype was lost, and the genus *Achatella* was defined from another specimen than Billings' holotype, which is

in the collections of the Canadian Geological Survey. The drawn illustration leaves something to be desired, but there can be no doubt as to the identity of the type because of the broken tip of the pygidium.

Achatella as indicated by the holotype has a very narrow border in front widening at the cheeks.

Cephalon slightly angular at the anterior margin; glabella widening anteriorly, not very convex; dorsal furrows slightly divergent posteriorly, curving outward sharply beyond the eye; frontal lobe very short, twice as wide as long; three glabellar furrows, the anterior pair long almost straight, directed backward from the dorsal furrow, the other two pairs subparallel, the posterior slightly curved, both directed forward; the first pair of lobes triangular, the second elliptical, the third having a small constriction near its outer end giving the 'button like' shape of Schmidt's description of *Pterygomotopus*; space between the pairs of furrows is less than the length of the furrow; eyes very large and prominent; fixed cheek swollen obliquely back of the eye to the junction of the neck furrow and the dorsal furrows; genal spines broad and long; neck ring very prominent, wider in the middle with sloping anterior and steep posterior margins; surface tubercular on the glabella, pitted on the cheek.

Thorax with 11 segments, pleura grooved, some tubercles on the axial lobe.

Pygidium triangular, acute at the apex, axial lobe tapering rapidly, 11-12 segments, pleural lobes with 10-12 segments, grooved, projecting faintly into the otherwise smooth border.

The only difference of note between this description from the holotype and the original description of *Achatella* is the slightly angular anterior margin and the reduction in the size of the glabellar lobes. The ornamentation of the axial lobe of the thorax of the holotype is here taken as a specific characteristic. The dividing line between *Achatella* and *Pterygomotopus* as indicated by *P. sclerops* Dalman is almost a gossamer thread. The genera are similar in the direction of the dorsal furrows, the widening of the border of the cephalon at the cheeks, the button-like ends of the posterior pair of glabellar lobes, and the larger ornamentation of the glabella.

Achatella differs from *Pterygomotopus* in the shorter frontal glabellar lobe, the finer granulose ornamentation, and in having fewer segments in the pygidium, and possibly in the hypostoma which has not been found. The presence of genal spines may or may not constitute a generic difference.

Achatella achates (Billings)

Plate X, figure 16

Dalmanites achates Billings, Can. Nat. Geol., 5, 1860, p. 63, fig. 9; Geol. Surv., Canada, Geol. Canada, 1863, p. 187, fig. 186.

Pterygomotopus achates (Billings), Raymond, Geol. Surv., Canada, Mus. Bull. 31, 1921, p. 38, Pl. 11, fig. 3.

Achatella achates (Billings), Delo, Geol. Soc. Amer., Spec. Pap. 29, 1940, p. 110, Pl. 13, fig. 19.

Billings holotype is here re-described and re-figured. It is in shale and has been slightly crushed.

Cephalon having the outer border narrow in front, apparently turned up a little; anterior margin slightly angular; dorsal furrows, glabella, glabellar furrows, glabellar lobes, eye, cheeks, and genal spines as described under the genus, neck furrow bearing a blunt tubercle at its apex.

The axial lobe of the thorax is broadest at third to fifth segments, contracting somewhat at both ends; the two anterior segments arch backward and are smooth, the succeeding segments each have two blunt tubercles dividing

them into three sections of which the middle is slightly the longer; the grooves of the pleura begin at the axial lobe just posterior to the mid-width of each pleuron, curve out and forward to the centre of the upper flatter part of the pleural lobe and then back.

Pygidium showing an axial lobe with 12 segments and a broken tip which may be solid or have one or two more annulations; tapering rapidly for three-quarters its length then more gradually; pleural lobes showing 10 segments with a broken tip, each pleuron grooved, grooves and divisions becoming faint at the distinctly marked border; the two anterior rings of the axial lobe bearing low blunt spines, a continuation of those on the axial lobe of the thorax, on the next two or three rings a slight swelling only which fades on the posterior rings.

Occurrence. Leray-Rockland beds, localities 85, 97; Hull beds, locality 19; Sherman Fall beds, localities 21, 29, 74; Cobourg beds, localities 30, 64, 75.

Type. Holotype, G.S.C. No. 1784, Cobourg beds?, from an unspecified locality at Ottawa, Ontario.

Genus, *Chasmops* McCoy

Genotype, *Calymene odini* Eichwald

Marginal border narrow, overhung anteriorly by the glabella.

Cephalon semicircular, with obtuse point in front, posterior margin having a concave backward curve; dorsal furrows diverging; neck furrow deep in the central part, dying out laterally; neck ring rounded; glabella moderately convex, greatly expanding in front; front glabellar furrow long, curving backward from the dorsal furrow, posterior pair directed forward; frontal lobe transverse, about twice as wide as long, first pair of side lobes very large and triangular, second pair reduced to minute tubercles or obsolete, third pair small and narrow; eye small, cone-shaped, placed about mid-height of the anterior lobe; free cheek small, triangular; genal spines slightly grooved, extending to eighth or ninth thoracic segment; facial sutures cutting the margin a little posterior to the middle of the first glabellar lobe, crossing to and encircling the back of the eye, thence diverging slightly to accommodate the expanded glabella, meeting in an obtuse point in front; fine granulations on cheeks and glabella.

Thorax having 11 segments; axial furrows deep; axis about one-fifth the total width.

Pygidium triangular, strongly convex; posterior obtusely angular, deflected; axis having about 10 ribs, pleural lobes about 8 grooved ribs; segments flattened, at right angles to the axis on the upper part, thence bent gently backward and downward, ends rounded and flattened; surface granular.

The outstanding characteristic of the genus is the large size of the first pair of glabellar lateral lobes, the suppression of the second pair, and the smallness of the third pair.

Chasmops? bebryx (Billings)

Plate X, figures 13, 14

Dalmanites bebryx Billings, Can. Nat. Geol., 5, 1860, p. 61, fig. 8; Geol. Canada, 1863, p. 187, fig. 185.

Chasmops bebryx (Billings), Delo, Geol., Soc. Amer., Spec. Pap. 29, 1940, p. 132, Pl. 13, fig. 17.

It has been customary recently to consider *Dalmanites bebryx* Billings as a species of the genus *Chasmops*. The writer is exceedingly doubtful. Unfortunately the holotype is missing and it is not possible to re-describe it.

Chasmops is characterized by the minuteness or absence of the second pair of lateral glabellar lobes, the third pair is small, and the furrow between them and the large first pair is clear and continuous to the dorsal furrow. Billings' description of *Dalmanites bebryx* states that the second and third pairs of lateral lobes are united into one large oblique triangular lobe with a small transverse pit between them at the inner edge. The illustration shows two lobes separated by a transverse furrow which does not reach the margin of the lobes. Even allowing some latitude for incorrectness in drawing this is a considerable variation from McCoy's description and illustration of *Chasmops*.

The thorax with 11 segments agrees with *Chasmops*.

The pygidium is described as triangular; axis quite convex, elongate, tapering, with 15 to 20 segments, crowding posteriorly, terminating in a rounded point, a little turned up. The number of segments is greater than in *Chasmops* as given by McCoy.

Among the collections are a number of pygidia corresponding to Billings description which are here designated as *Chasmops?* with a query.

Occurrence. Cobourg beds, localities 30, 75.

Type. Unfortunately the type is missing; plesiotype from Cobourg beds at Philemon Island, Hull, Quebec, in the private collection of G. W. Sinclair.

PLATE I

(Except where otherwise stated all figures are natural size)

- Figure 1. *Basilicus barrandi* (Hall). A cranidium. Reprint from Ann. Carnegie Mus. 7, 1911. Pl. 16, fig. 3.
- Figure 2. *Basilicus barrandi* Hall, showing the wide border and the segments. Plesiotype, G.S.C. No. 7749.
- Figure 3. *Cryptolithus tessellatus*, showing the concavo-convex margins of the cephalon as compared with the outline of *C. bellulus*. Reprint from Geol. Surv., Canada, Mem. 138, 1924, Pl. 45, fig. 16a.
- Figure 4. *Cryptolithus bellulus* Ulrich, showing the subparallel margins of the cephalon. Reprint from Geol. Surv., Canada, Mem. 138, 1924, Pl. 45, fig. 17.
- Figure 5. *Homotclus* ? *elongatus* Raymond, showing its subtriangular cephalon and its convex form. Plesiotype, G.S.C. No. 7748.
- Figure 6. *Isoteloides homalonotoides* (Walcott), showing the acute posterior angle of the pygidium and the prominent narrow axis. Plesiotype, G.S.C. No. 7934 x 1½, not from this area.
- Figure 7. *Eoharpes dentoni* (Billings), showing the ends of the narrow, grooved spines. Plesiotype, G.S.C. No. 7827.
- Figure 8. *Eoharpes dentoni* (Billings), showing the narrow grooved spine and the trilobed effect of the cranidium. Neotype, G.S.C. No. 1767.
- Figure 9. *Eoharpes ottawaensis* (Billings), showing the trilobed effect of the cranidium and the broad border. Holotype, G.S.C. No. 329.

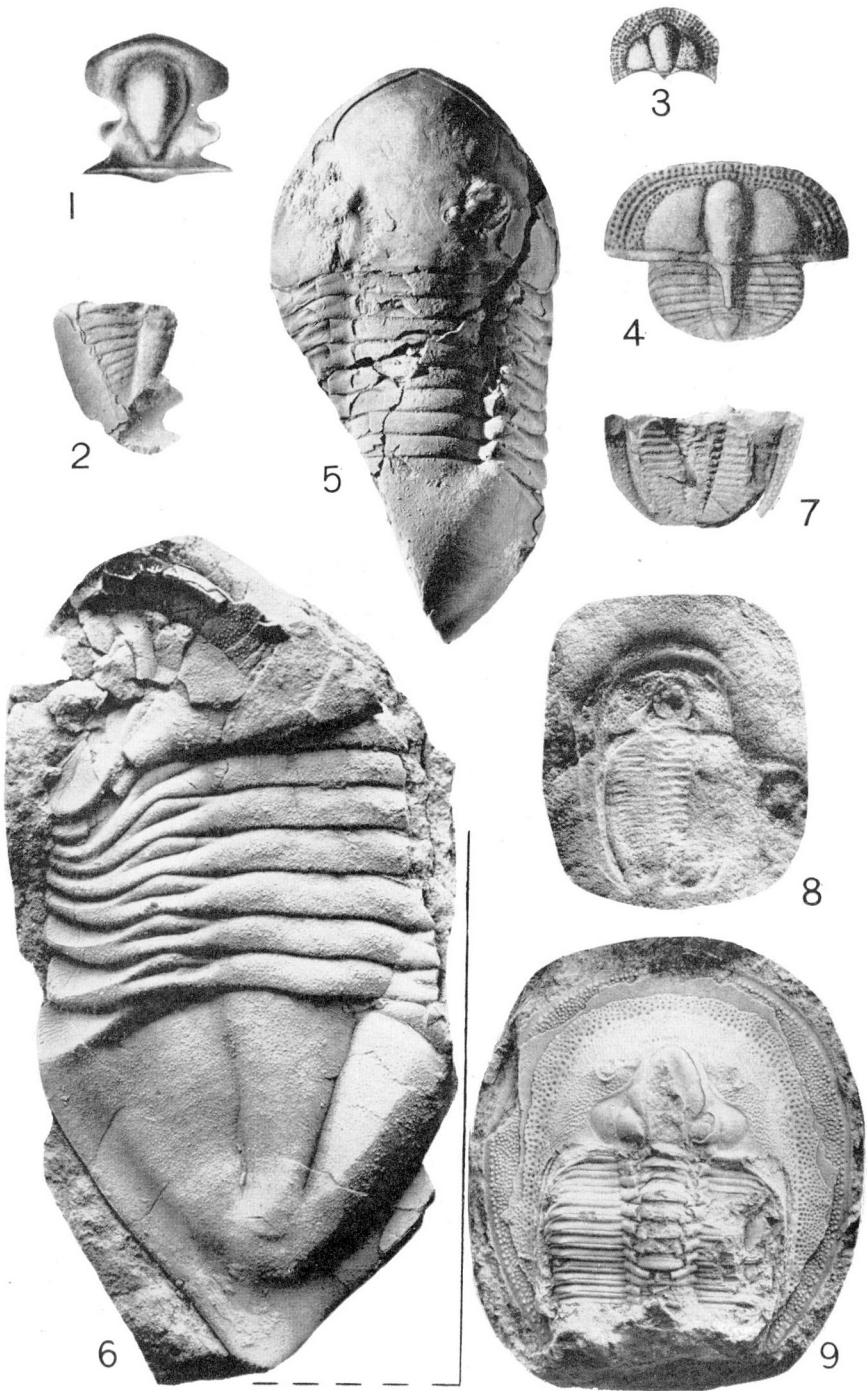


PLATE II

- Figure 1a, 1b. *Bathyrurus acutus* Raymond.
 1a, Cranidium of one of Raymond's paratypes;
 1b, the same x 2. Paratype, G.S.C. No. 7821d.
- Figure 2. *Bathyrurus acutus* Raymond, showing the acute tip of the pygidium. Holotype slightly magnified, G.S.C. No. 7821.
- Figure 3. *Bathyrurus spiniger* Hall, showing the base of the spine rising from the third and fourth axial ring. Plesiotype, G.S.C. No. 7747.
- Figure 4. *Bathyrurus spiniger* Hall. Restored cranidium showing the tuberculate surface and the single spine. Reprint from Pal. Minnesota, 3, 1897, p. 723, fig. 38.
- Figure 5. *Bathyrurus extans* Hall. Part of a cranidium. Plesiotype, G.S.C. No. 7938a.
- Figure 6. *Bathyrurus extans* Hall. Pygidium, showing its convexity. Plesiotype, G.S.C. No. 7938.
- Figure 7. *Bathyrurus bandifer* Sinclair, showing the two spines on the neck ring. Holotype in the private collection of G. W. Sinclair.
- Figure 8. *Bathyrurus trisponosus* n.sp. Part of the pygidium, showing the long delicate spine and the posterior knob. Paratype x 2, in the private collection of J. A. Calder.
- Figure 9. *Bathyrurus trispinosus* n.sp. Cephalon, showing the prominent eyes, the pustulose surface, and the threefold spine. Holotype, in the private collection of J. A. Calder.
- Figure 10. *Bathyrurus superbus* Raymond. Pygidium and part of the thorax, showing the broad border and flatness of the form as compared with *B. magnus* n.sp. Cotype, G.S.C. No. 7422a.
- Figure 11. *Bathyrurus superbus* Raymond. Cranidium, showing its breadth and flatness. Cotype, G.S.C. No. 7422.
- Figure 12. *Bathyrurus johnstoni* Raymond. Pygidium and part of the thorax, showing the lack of convexity and the broadly rounded pygidium outline. Cotype, G.S.C. No. 7831, not from this area.
- Figure 13. *Bathyrurus johnstoni* Raymond. Cranidium, showing the tubercles on the median and posterior part of the glabella. Cotype, G.S.C. No. 7830, not from this area.
- Figure 14. *Bathyrurus magnus* n.sp. Part of the thorax and the pygidium, showing the large size, and the narrow concave border of the pygidium with its somewhat acute posterior as compared with that of *B. superbus*. Holotype, G.S.C. No. 7744.
- Figure 15a, 15b. *Bathyrurus ingalli* Raymond.
 15a, Pygidium, showing the base of the large stout spine and fine tubercles on the axis;
 15b, the same in profile. Plesiotype, in the private collection of G. W. Sinclair.
- Figure 16. *Bathyrurus ingalli* Raymond, showing the pygidium somewhat foreshortened because buried in the matrix. The posterior slope is more abrupt than in that of figure 15a. Plesiotype, G.S.C. No. 3563, not from this area.
- Figure 17. *Bathyrurus ingalli* Raymond, showing the subquadrate outline, heavy spine, and pustulose surface. Holotype, G.S.C. No. 4318, not from this area.
- Figure 18. *Bathyrurus ingalli* Raymond, showing the breadth of the free cheek and the position of the eye. Plesiotype, G.S.C. No. 3563a, not from this area.

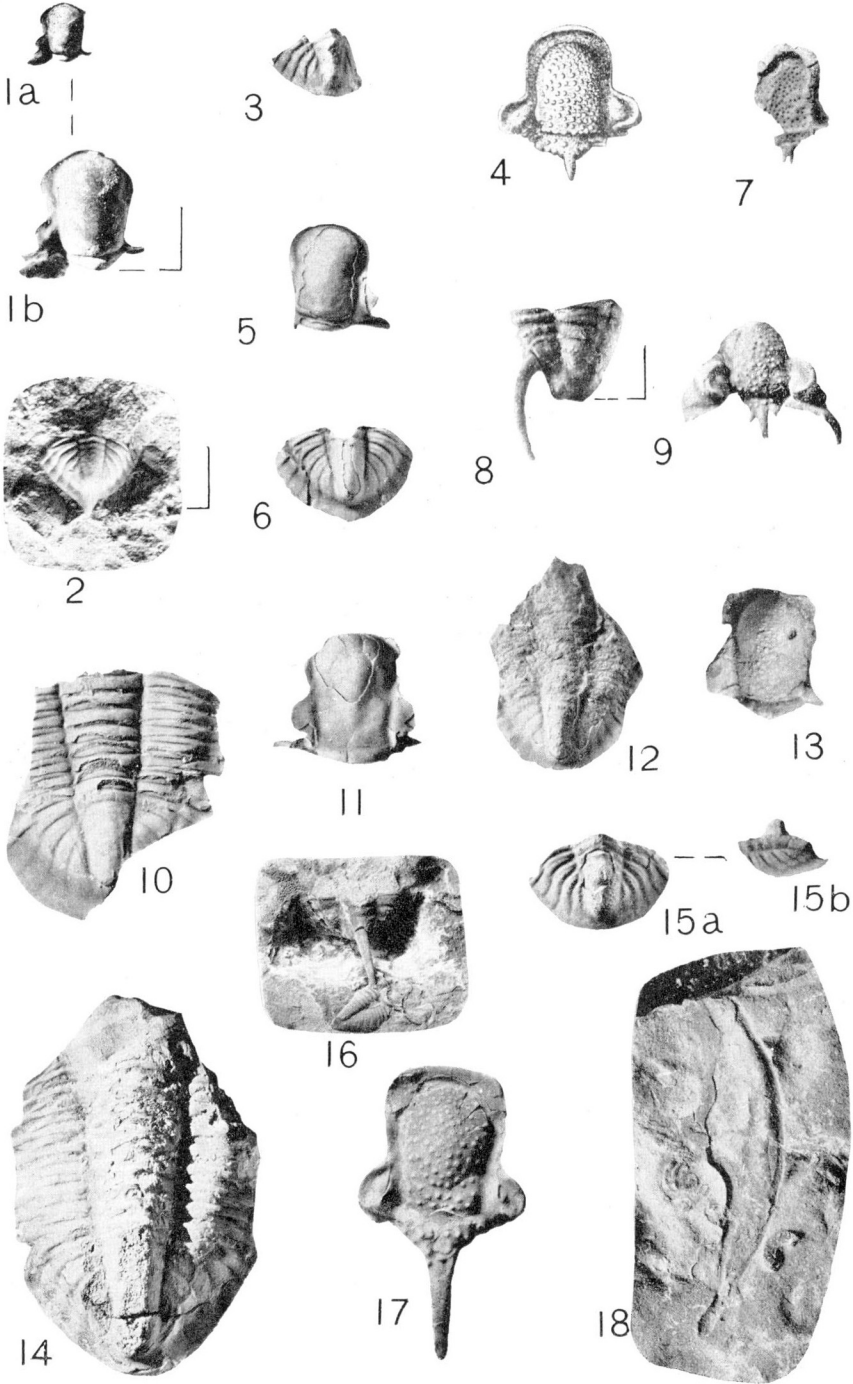


PLATE III

- Figure 1. *Isotelus maximus* Locke, showing the general outline, and the rounded posterior of the pygidium. The genal spines are broken, but the base remains on the right side. Plesio-type, G.S.C. No. 332.
- Figure 2a-2c. *Isotelus gigas* Dekay. 2a, cephalon; 2b, pygidium; 2c, profile. All same rolled specimen. Plesio-type, G.S.C. No. 5591.
- Figure 3. *Isotelus gigas* Dekay, showing the subtriangular outline of the pygidium. Plesio-type, G.S.C. No. 7750.
- Figure 4. *Isotelus iowensis* (Owen), showing the broad outline and obtuse posterior of the pygidium. Plesio-type, in the private collection of G. W. Sinclair.
- Figure 5. *Isotelus ottawaensis* n.sp. Pygidium and part of thorax, showing the convexity of the form and the evenly rounded pygidium. Paratype, G.S.C. No. 1789b.

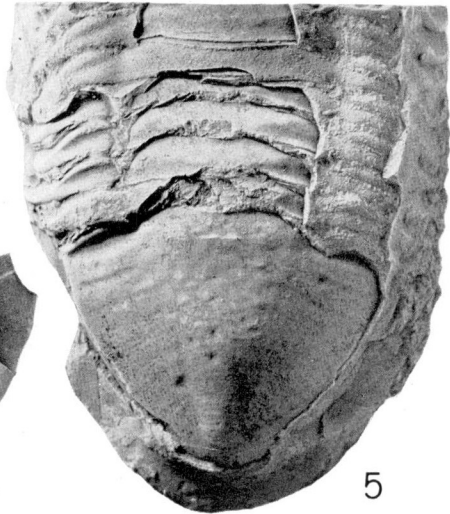
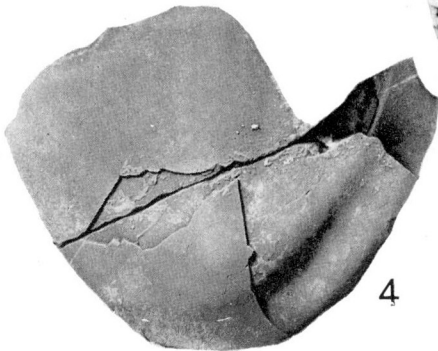
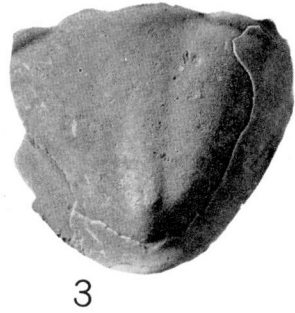
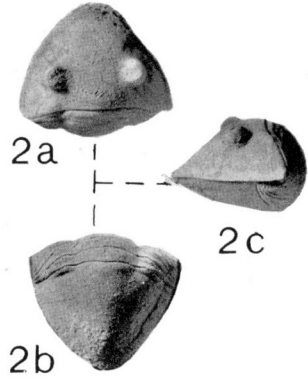
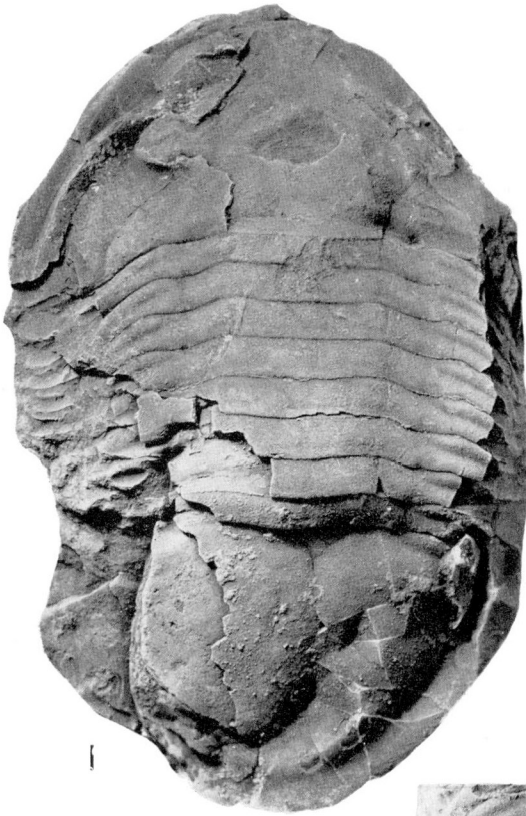


PLATE IV

Isotelus iowensis (Owen). Specimen slightly enlarged, showing the general outline, the spines, and obtuse pygidium. Reprint from Mus. Comp. Zool. 58, No. 5, 1914, Pl. 3, fig. 1.

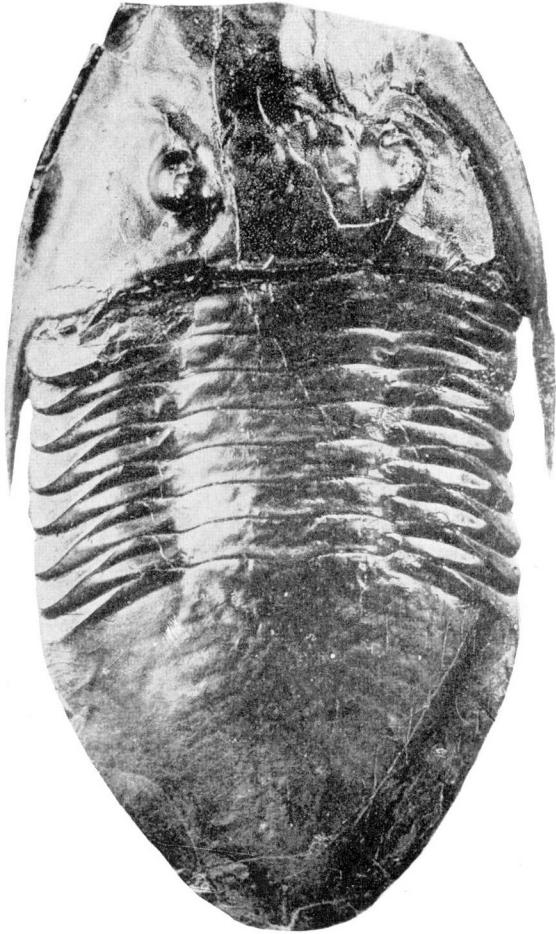


PLATE V

- Figures 1a, 1b. *Isotelus ottawaensis* n.sp.
1a, showing the rounded anterior, the convexity—the rounded posterior is broken;
1b, the same specimen with the top lifted off and reverse, showing the appendages
and hypostoma. Holotype, G.S.C. No. 1789.

PLATE V

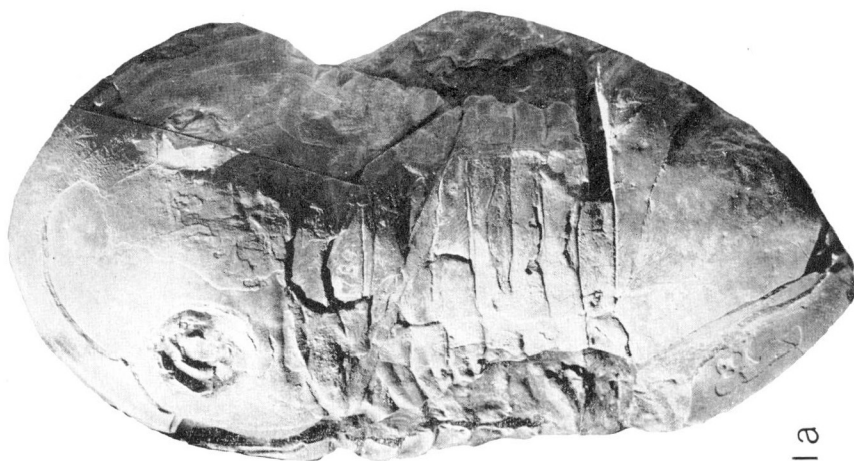


PLATE VI

Isotelus latus, Raymond, showing its breadth, and the broad pygidium with the wide flat border. Holotype, G.S.C. No. 1788.

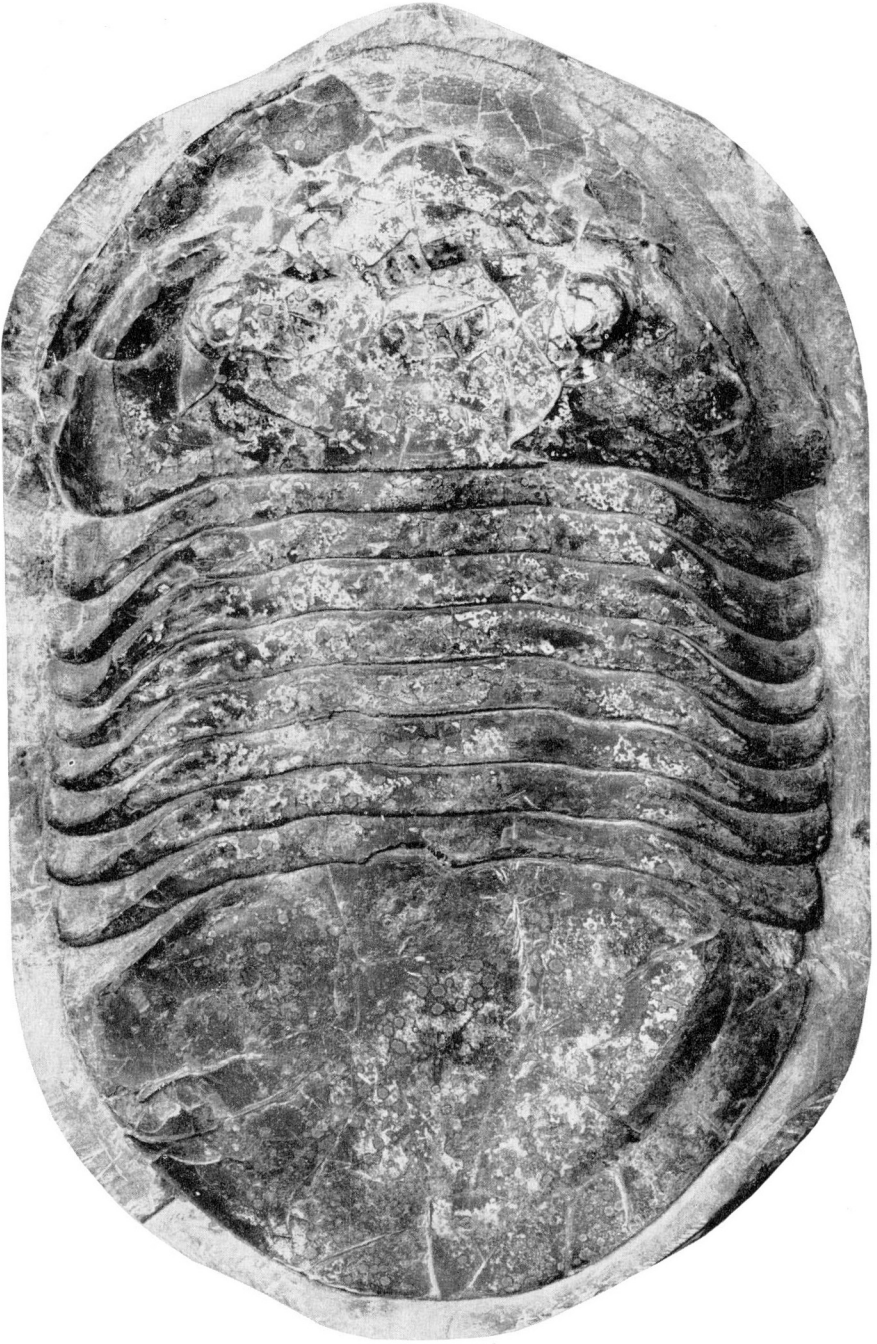


PLATE VII

- Figures 1a, 1b. *Bumastus milleri* (Billings).
 1a, showing thorax and pygidium;
 1b, showing cephalon. Holotype, G.S.C. No. 1319b.
- Figures 2a, 2b. *Vogdesia sinclairi* n.sp.
 2a, cephalon, showing the broad, rounded outline;
 2b, the same in profile, showing the prominence of the eye. Holotype, in the private collection of G. W. Sinclair.
- Figure 3. *Illaenus americanus* Billings, Cephalon, showing the general shape and the deep but short dorsal furrows. Plesiotype, G.S.C. No. 7757.
- Figure 4. *Illaenus americanus* Billings. Pygidium, showing the broad axis and the broad rounded border. Plesiotype, G.S.C. No. 7758.
- Figure 5. *Illaenus latiaxiatus* Raymond, showing outline of cephalon. Reprint from Ann. Carnegie Mus. 4, 1908, Pl. 60, fig. 8.
- Figure 6. *Illaenus latiaxiatus* Raymond. Pygidium, showing the axis broader, the margin more broadly curved, and the convexity greater than in the pygidium of *I. americanus*. Reprint from Ann. Carnegie Mus. 4, 1908, Pl. 60, fig. 6.
- Figure 7. *Bumastus porrectus* Raymond, showing broad rounded cephalon from the posterior. The exfoliation shows the dorsal furrows more deeply entrenched than they are on the outer shell. Plesiotype, G.S.C. No. 7760.
- Figure 8. *Bumastus porrectus* Raymond. Profile of another cephalon showing its great convexity. Plesiotype, G.S.C. No. 7759.
- Figure 9. *Bumastus porrectus* Raymond, showing the length of the pygidium as compared with that of *B. milleri*. Plesiotype, in the private collection of G. W. Sinclair.
- Figure 10. *Illaenus angusticollis* Billings. Cephalon, showing the narrowness of the posterior of the glabella, slightly tilted to show the position of the eye. Holotype, G.S.C. No. 1314b x 3.
- Figure 11. *Illaenus angusticollis* Billings. Pygidium showing faint segmentation of axis and minute pustules. Paratype, G.S.C. No. 1314d x 3.
- Figure 12. *Bumastus indeterminatus* Raymond, showing the broad anterior curve and the eyes set far apart. Exfoliation exaggerates the depth of the dorsal furrows. Plesiotype, in the private collection of G. W. Sinclair.
- Figure 13. *Bumastus billingsi* Raymond and Narraway, showing its large size. Plesiotype, G.S.C. No. 331.
- Figure 14. *Illaenus conradi* Billings. Cephalon showing the base of the glabella as compared with that of *I. angusticollis*. Holotype, G.S.C. No. 1320a.
- Figure 15. *Illaenus conradi* Billings. Pygidium, showing the axial lobe less differentiated and the whole larger than that of *I. angusticollis*. Paratype, G.S.C. No. 1320.
- Figure 16a, 16b. *Thaleops ovata* Conrad.
 16a, from the anterior showing the divergence of the free and fixed checks;
 16b, the same, from the top. Plesiotype, G.S.C. No. 1321.

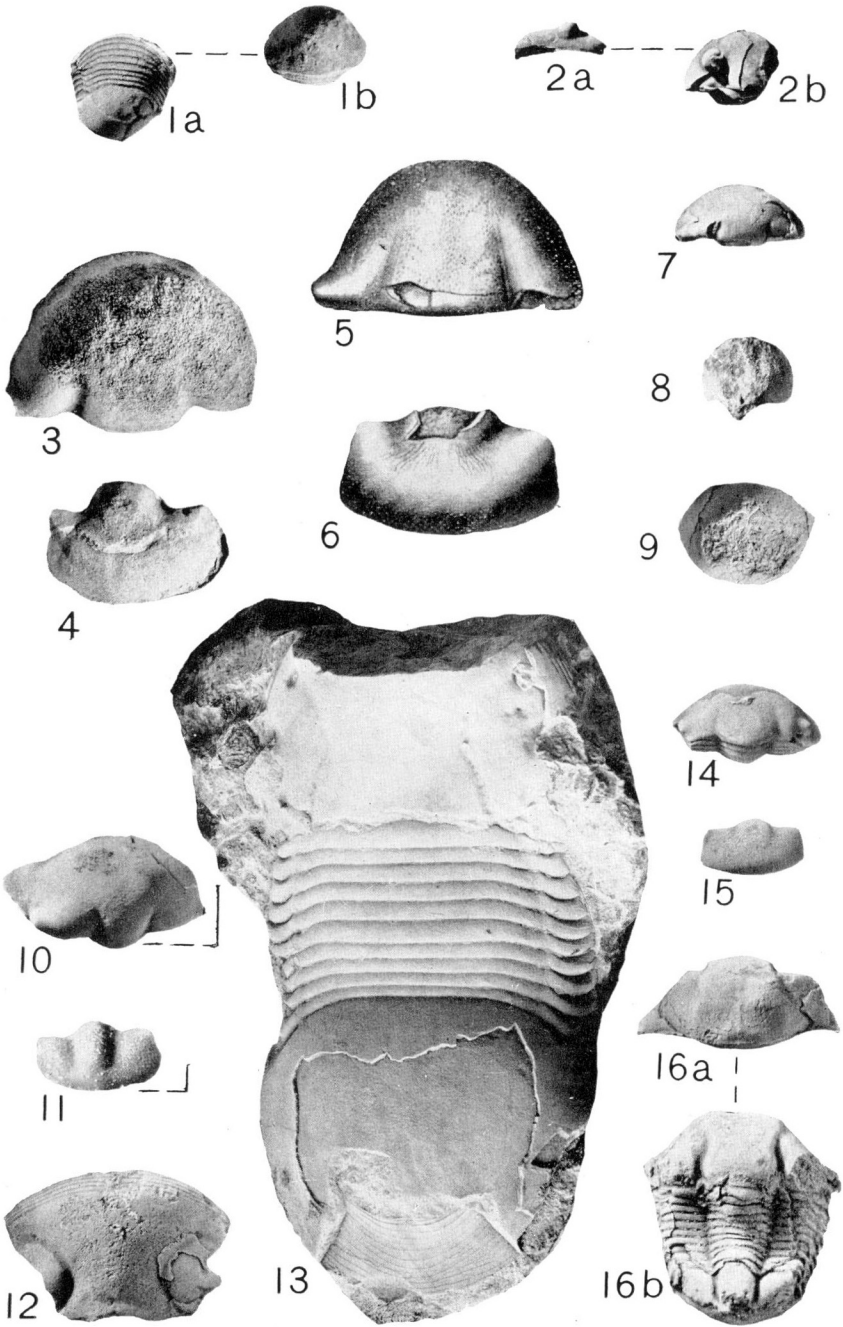


PLATE VIII

- Figure 1. *Acrolichas cucullus ottawaensis* Foerste. Cephalon showing the protuberant glabella. Cotype in the Royal Ontario Museum, Toronto, Ontario.
- Figure 2. *Acrolichas cucullus ottawaensis* Foerste. Pygidium, showing the concave flange on the outer right-hand rib. Cotype, in the Royal Ontario Museum, Toronto, Ontario.
- Figure 3. *Acrolichas narrawayi* Foerste. Pygidium, showing it smaller than and having more rounded ribs than the pygidium of *A. cucullus ottawaensis*. Cotype, in the Royal Ontario Museum, Toronto, Ontario.
- Figure 4a, 4b. *Otarion wilsonae* Sinclair.
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 4b, the same, showing the glabellar furrows. Holotype x 2, in the private collection of G. W. Sinclair.
- Figure 5. *Encrinurus trentonensis* Walcott. Pygidium, showing the complete segmentation of the axis. Plesiotype x 2, in the private collection of G. W. Sinclair.
- Figure 6. *Encrinurus cybeleformis* Raymond. Pygidium, showing the unsegmented portion of the axis. Holotype, G.S.C. No. 3385 x 2, not from this area.
- Figure 7. *Hemiarges paulianus* (Clarke), showing some unusually coarse tubercles. Plesiotype x 2, in the private collection of J. A. Calder.
- Figure 8. *Hemiarges paulianus* (Clarke). Cephalon, showing most of the five lobes. Plesiotype x 2, in the private collection of G. W. Sinclair.
- Figure 9. *Cybeloides ella* (Raymond and Narraway), showing the confluent second and third glabellar furrow, and the long pleural ribs. Holotype x 7, in Royal Ontario Museum, Toronto, Ontario. Reprint from Ann. Carnegie Mus. 3, 1906, p. 598, fig. 1.
- Figure 10. *Eobrontes lunatus* (Billings). A re-illustration of Billings' type, showing the suture line and anterior expansion of the glabella. Holotype, G.S.C. No. 1781.
- Figure 11. *Eobrontes lunatus* (Billings). One of the paratypes, showing the shallow glabellar furrows accentuated, fine pustules on the glabella and wrinkles on the pygidium. Paratype, G.S.C. No. 1781a x 2.



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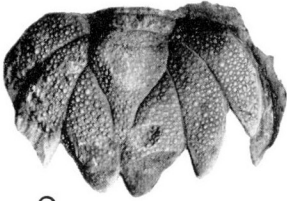
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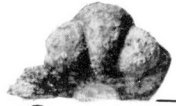
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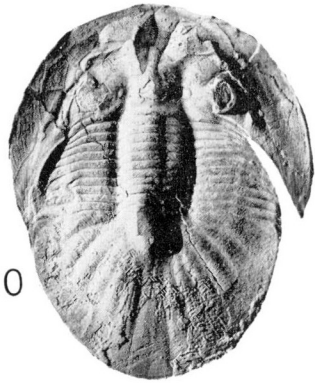
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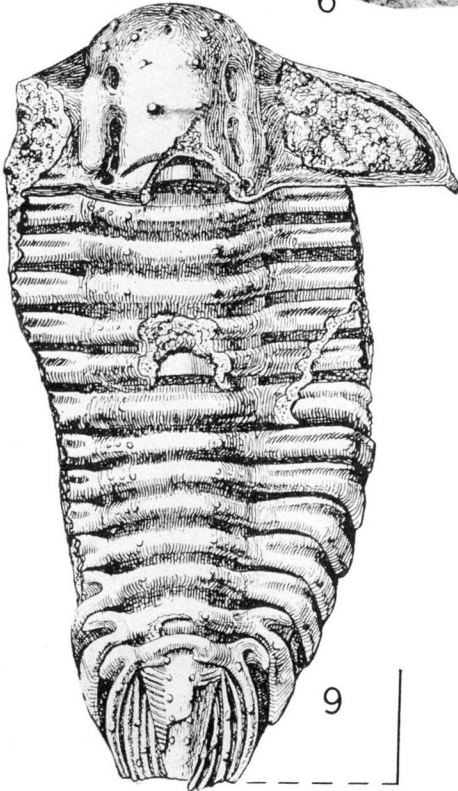
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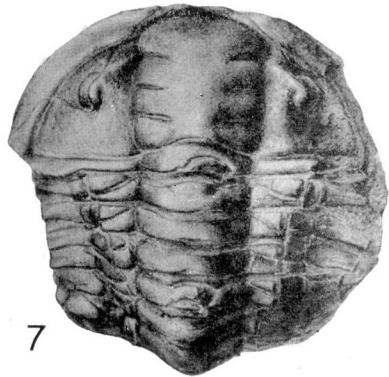
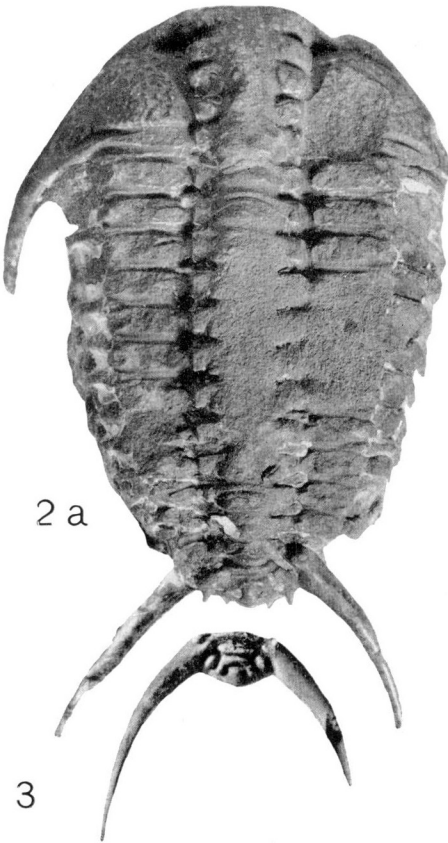
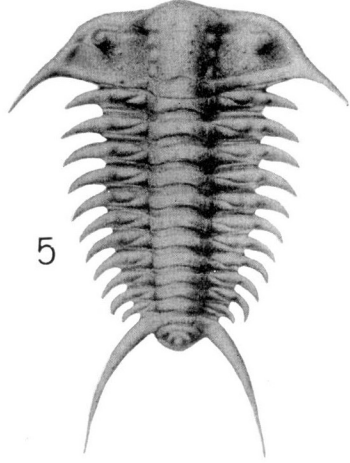
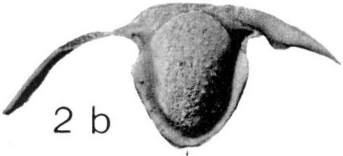
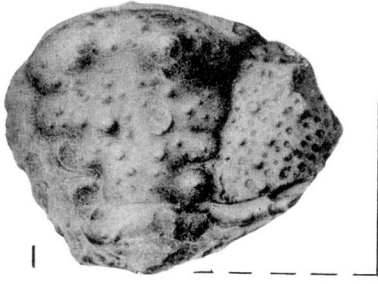
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PLATE IX

- Figure 1. *Ceraurus bispinosus* Raymond and Narraway. x 1½. Reprint from Mus. Comp. Zool. 54, 1913, Pl. 1, fig. 4.
- Figures 2a, 2b. *Ceraurus dentatus* Raymond and Barton.
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 2b, the same specimen, showing the hypostoma. Holotype, G.S.C. No. 1775.
- Figure 3. *Ceraurus pleurexanthemus* Green. Pygidium, showing the smooth posterior between the two long spines, as compared with the spines of *C. dentatus*. Plesiotype, G.S.C. No. 7763.
- Figure 4. *Ceraurus pleurexanthemus* Green. Cephalon. Plesiotype, in the private collection of J. A. Calder.
- Figure 5. *Ceraurus pleurexanthemus* Green. Restoration. Note position of the eye. Reprint from Mus. Comp. Zool. 54, 1913, Pl. 1, fig. 1.
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- Figure 7. *Ceraurinus marginatus* Barton. A more complete Canadian specimen, not from these beds nor from this area. Reprint from Mus. Comp. Zool. 54, No. 21, 1913, Pl. 1, fig. 1.

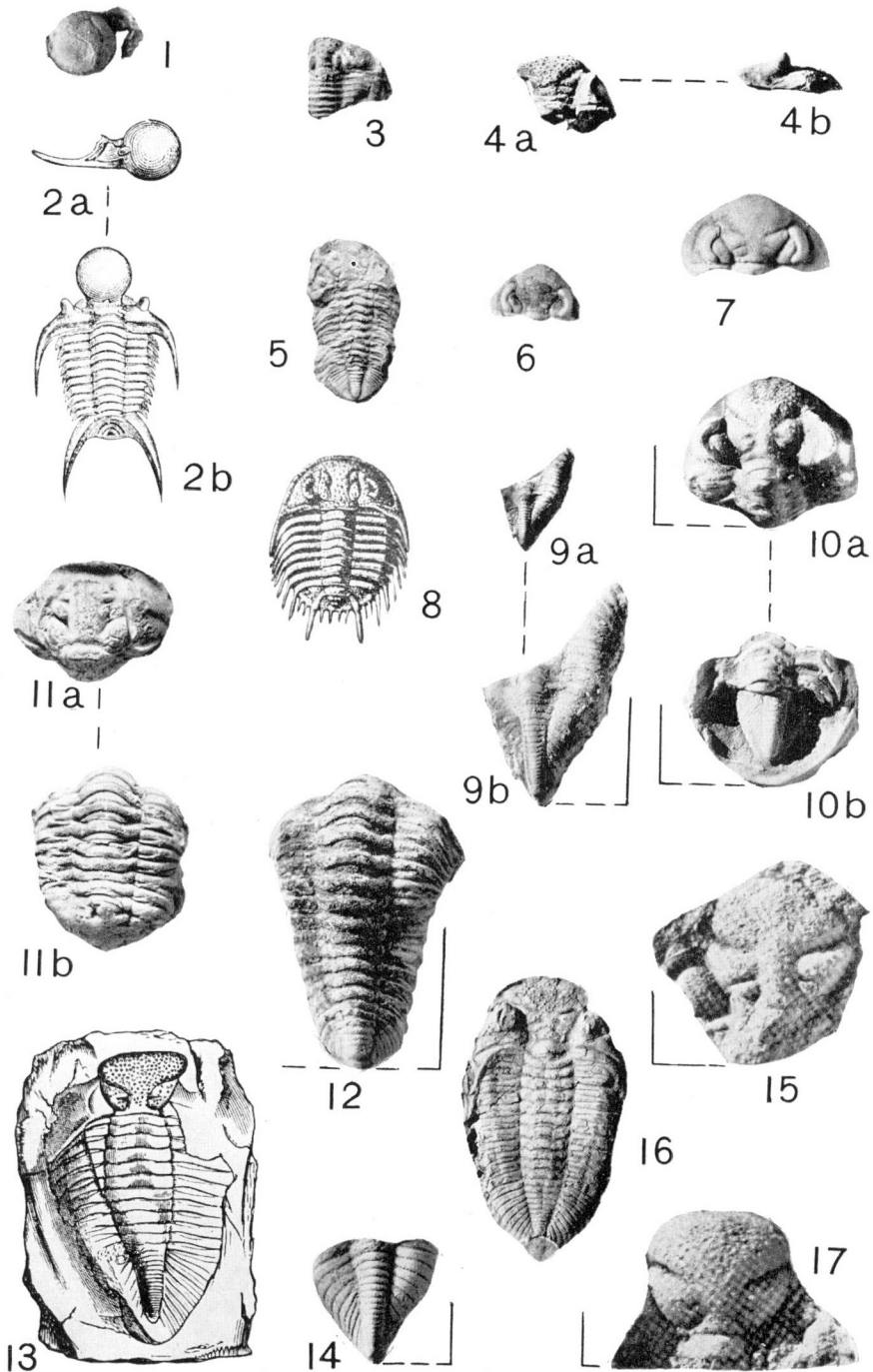


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PLATE X

- Figure 1. *Sphaerocorphe robusta* Walcott. Part of a cephalon, showing the bulbous central lobe. Plesiotype, in the private collection of G. W. Sinclair.
- Figures 2a, 2b. *Sphaerocorphe robusta* Walcott. Reprint of restorations after Walcott, from Cincinnati Quart. Jour. Sci., 2, 1875, p. 274, figs. 18a and 18b.
- Figure 3. *Cybeloides plana* Sinclair. Parts of cephalon and thorax, showing the two long, narrow basal glabellar lobes. Holotype, in the private collection of G. W. Sinclair.
- Figures 4a, 4b. *Pteryogometopus billingsi* (Sinclair).
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- Figure 5. *Calliops callicephalus* (Hall), showing the broadly rounded pygidium. Plesiotype, G.S.C. No. 8009.
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- Figure 7. *Calliops narrawayi* Okulitch. Cephalon, showing large size and relatively small glabellar, frontal lobe. Plesiotype, in the private collection of G. W. Sinclair.
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- Figures 9a, 9b. *Calyptalaux calderi* n.sp.
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