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LOWER CAMBRIAN PTYCHOPARIID
TRILOBITES FROM THE CON-
GLOMERATES OF QUEBEC

(WITH 6 PLATES)

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LOWER CAMBRIAN PTYCHOPARIID TRILOBITES FROM THE CONGLOMERATES OF QUEBEC

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INTRODUCTION

In a previous paper (Rasetti, 1948) the writer described the Lower Cambrian trilobites occurring in the conglomerate boulders of the lower St. Lawrence valley, to the exclusion of the superfamily Ptychopariidea.¹ The present paper completes the description of the fossils of Early Cambrian age. The material in hand is exceptionally well preserved in limestone, and its illustration may bring a contribution to the knowledge of this difficult group of trilobites. Most of the specimens were collected by the writer during the summers of 1941 to 1946, in part with the aid of a grant from the Penrose Bequest of the Geological Society of America. Some of the species were already described on the basis of material collected by Walcott and preserved in the U. S. National Museum. Fifteen species, nine of them new, are described, and three new genera are established. In addition, six new forms are described but left unnamed. All the type material was deposited in the U. S. National Museum collections.

OCCURRENCE AND AGE OF THE FOSSILS

The fossils here described, as those illustrated in the previous paper (Rasetti, 1948), were recovered from limestone boulders in presumably Lower Ordovician conglomerates (Rasetti, 1946) outcropping at various localities on the south shore of the St. Lawrence River, from Levis to Grosses Roches in Matane County. A list of the localities

¹ There is no generally accepted ending for trilobite superfamilies. The writer successively used the endings -idea and -oidae. Until an agreement is reached among trilobite students, it seems expedient to use the same ending as in the 1948 paper.

and ages of the fossiliferous boulders was given in another paper (Rasetti, 1945a). Boulders are indicated by letters designating the locality (B=Bic, G=Grosses Roches, L=Ville Guay, M=Metis, O=Island of Orleans, SS=St. Simon) followed by a number characterizing the particular boulder.

In view of the abundance of boulders containing early Medial Cambrian fossils at most of the localities (except Bic, where Middle Cambrian boulders seem to be excessively rare), it was not always easy to ascertain the Early Cambrian age of the fossils. Since the writer (Rasetti, 1951) considers post-olenellian strata of the Appalachian and Cordilleran provinces as Medial Cambrian, boulders were considered of Early Cambrian age only if they contained olenellids, or other genera known to occur in association with olenellids, such as *Bonnia* and *Zacanthopsis*. All the boulders from which the described fossils came satisfy this criterion except boulder M-9, which supplied two species. In this case the assignment to the Lower Cambrian is probable but not absolutely certain.

All the described fossils seem referable to the late Early Cambrian *Bonnia-Olenellus* zone (Rasetti, 1951), equivalent to the *Antagmus-Onchocephalus* zone of Lochman (1947, 1952). For reasons already indicated (Rasetti, 1951), the writer prefers to avoid generalized Ptychopariid genera for faunal zone designation. Usually each boulder yielded but a few species, and the material is too meager to allow an extensive study of the associations and thereby a clear discrimination of faunules within the zone in the area. As indicated in the previous paper (Rasetti, 1948), an assemblage occurring in a darker limestone (the only kind found in the Ville Guay conglomerate at the type locality and on the Island of Orleans), characterized by species of *Pagetides*, *Periomella yorkensis* and *Periomma walcotti*, seems to constitute a distinct faunal unit, possibly somewhat younger than the faunule of the light-gray limestone predominating at Bic, Metis, and Grosses Roches. However, the presence of common species (e.g. *Bonnia laevigata*) indicates that the age difference cannot be considerable.

Table 1 lists the species collected from each boulder, including those previously described, in order to facilitate a quick survey of the faunal associations.

All the fossils described herein are well preserved in limestone and show no flattening and, at worst, a very slight degree of distortion. The test is preserved in all but a few specimens.

TABLE I.—Faunal associations in the Lower Cambrian boulders

Species	Boulder														
	B-4	B-5	B-6	G-1	G-9	G-15	G-17	G-19	G-24	G-25	G-41	L-2	M-10	O-1	O-37
<i>Antagmus elongatus</i> Rasetti.....				X			X				X				
<i>Austinivillia virginea</i> Resser.....	X			X	X										
<i>Bicella bicensis</i> (Resser).....										X				X	
<i>Eoptychoparia angustifrons</i> Rasetti.....	X														
<i>intermedia</i> Rasetti.....								X							
<i>normalis</i> Rasetti.....			X												
<i>Luxella crassimarginata</i> Rasetti.....			X												
<i>Onchocephalus sulcatus</i> Rasetti.....									X						
<i>Periomnia gaspensis</i> Rasetti.....									X						
<i>walcotti</i> Resser.....									X						X
<i>Periomnella yorkensis</i> Resser.....									X						X
<i>Bonnia brenoioides</i> Rasetti.....			X		X										X
<i>crassa</i> Resser.....															X
<i>brennus</i> (Walcott).....		X			X				X						
<i>laevigata</i> Rasetti.....				X			X		X		X				
<i>sculpta</i> Rasetti.....				X			X		X		X				
<i>tensa</i> Resser.....									X						
<i>sp. undet.</i>									X						X
<i>Dolichometopsis bicensis</i> Rasetti.....	X														X
<i>Kootenia</i> cf. <i>K. marconi</i> (Whitfield).....									X						X
<i>Pagetides amplifrons</i> Rasetti.....									X						
<i>elegans</i> Rasetti.....									X						
<i>leioptygus</i> Rasetti.....									X						
<i>minutus</i> Rasetti.....									X						X
<i>rupestris</i> Rasetti.....									X						
<i>Protypus marginatus</i> Rasetti.....	X								X						
<i>typicus</i> (Resser).....									X						X
<i>Prozacanthoides</i> , sp. undet.....								X	X						X
<i>Zacanthopsis virginea</i> Resser.....									X						X
Undetermined Olenellidae.....			X						X						

TERMINOLOGY

The terminology here employed for describing the trilobite exoskeleton is essentially the same as that proposed by Howell et al. (1947), with the modifications listed below.

Several trilobite students have pointed out the opportunity of restoring the term "fixed cheeks" to its original meaning of the entire nonaxial area of the cranidium, instead of a portion thereof. Consequently, the area designated as "fixed cheek" by Howell et al. is now called "palpebral area" and is bounded by the dorsal furrow, the ocular ridge, the palpebral furrow, and a straight line running from the posterior end of the palpebral lobe to the proximal end of the posterior marginal furrow. The term "width of the palpebral area" hence replaces "width of the fixed cheeks" as employed by Lochman (1947), indicating the transverse distance between the dorsal furrow and the palpebral furrow. This distance is often compared to the width of the glabella measured at its midlength. The length of the palpebral lobe is measured along a chord.

The term "frontal area" indicates collectively the preglabellar field, marginal furrow and border.

Terms such as "wide," "long," etc. are qualified by the abbreviations "sag." (sagittal), "exsag." (exsagittal) and "tr." (transverse) whenever the direction in which the measurement is taken might otherwise result in ambiguity.

The posterior limb is divided into a proximal portion, extending from the dorsal furrow to the palpebral lobe, and the remaining distal portion. The ratio of the widths (tr.) of the two portions supplies a useful taxonomic character. The entire width (tr.) of the posterior limb is compared to the width (tr.) of the occipital ring. The width of the posterior limb is measured along a chord, not the vertical projection.

All descriptions refer to the upper surface of the test unless otherwise indicated.

SYSTEMATIC DESCRIPTIONS

Superfamily PTYCHOPARIIDEA

Family PTYCHOPARIIDAE Matthew, 1888

The Lower Cambrian ptychopariids are notoriously difficult to classify (Lochman, 1947; Rasetti, 1951). Study of the new material further emphasizes intergrading of the established genera and the difficulty of adopting such stringent discriminatory generic characters as proposed by Lochman (1947), since adherence to this method

would result in erecting a new genus for almost every new species.

All the genera described herein seem referable to the family Ptychopariidae, containing the generalized forms of the superfamily, excepting *Rimouskia*, which stands out because of the peculiar pattern of the glabellar furrows. This genus, following Hupé, is assigned to the family Saoidae.

The genera based on Lower Cambrian Ptychopariidae of North America are listed with their type species in the order of date of publication.

Kochiella Poulsen, 1927 (*Kochiella tuberculata* Poulsen). No Lower Cambrian forms referable to the genus are known to the writer outside of Greenland. Middle Cambrian forms from the Cordilleran province resemble *Kochiella* in the cephalic features, but no definite reference is possible until a pygidium can be assigned with certainty to the genus (Rasetti, 1951).

Inglefieldia Poulsen, 1927 (*Inglefieldia porosa* Poulsen). Another Lower Cambrian genus with the essential cephalic characters of *Amecephalus* and *Alokistocare*. The writer does not know of any forms outside of Greenland referable to the genus.

Proliostracus Poulsen, 1932 (*Proliostracus strenuelliformis* Poulsen). Chiefly distinguished from similar forms by the greater length and more anterior position of the palpebral lobes. The writer agrees with Lochman in restricting the name to the Greenland species.

Billingsaspis Resser, 1935 (*Conocephalites vulcanus* Billings). Lochman remarked that the type species is based on a generically and specifically unidentifiable cranidium. Hence *Billingsaspis* is to be discarded.

Antagmus Resser, 1936 (*Antagmus typicalis* Resser). This is one of the unfortunate borderline cases, where the holotype of the type species is neither well enough preserved to ascertain the precise characters of the species nor unidentifiable to the point of requiring discarding of the genus. Since one of the species from the Quebec conglomerates seems to agree with *Antagmus typicalis* in all characters that can be observed on Resser's holotype, it is assumed that it belongs to *Antagmus* and the diagnosis of the genus is completed accordingly.

Poulsenia Resser, 1936 (*Solenopleura grönwalli* Poulsen). Although Resser based the genus on a species described from a single cranidium lacking most of the glabella, the cranidial features are fairly well known from the other species described by Poulsen. Examination of the casts of the types suggests that Poulsen's *Solenopleura borealis*, *S. bullata*, *S. grönwalli*, and *S. similis*, each based on a single cranidium, belong to one and the same species, the differences

being well within the limits of individual variability in conspecific populations observed in similar Cambrian trilobites. From the combined features of these four cranidia, it seems that *Poulsenia* is close to *Antagmus*, the chief difference being in the slight convergence of the anterior facial sutures viewed from above. No other species seem to possess the same combination of characters; hence *Poulsenia* is provisionally restricted to the Greenland species.

Syspacephalus Resser, 1936 (*Agraulos charops* Walcott). The type species is well represented and was recently refigured by the writer (Rasetti, 1951) with the descriptions of several lower Middle Cambrian species. A genus rather well characterized by the anterior position of the eyes and the slight convergence of the anterior facial sutures.

Onchocephalus Resser, 1937 (*Ptychoparia thia* Walcott). The type species is fairly well known from several cranidia (Rasetti, 1951). Intermediate forms link the genus with *Antagmus*, *Crassifimbria*, and the Lower Cambrian species which Resser incorrectly referred to *Proliostracus* and *Phychoparella*. Hence the limits of the genus are to a great extent arbitrary.

Periomma Resser, 1937 (*Periomma typicalis* Resser). The remarks concerning *Antagmus* also apply to this case. The type species, represented by distorted cranidia lacking the test, is characterized by the elevation of the palpebral area and of the anterior border. The genus appears to be valid.

Austinvillia Resser, 1938 (*Austinvillia virginica* Resser). A valid genus, based on a well-represented species. However, a second form described by Resser does not appear congeneric with the type species, and is here used as the type of a new genus.

Litocodia Resser, 1938 (*Litocodia typicalis* Resser). Lochman commented on the poor preservation of the type material and referred the species to *Antagmus*. Even though this assignment is not definitive, the name *Litocodia* should be restricted to the type species until this becomes better known.

Periomella Resser, 1938 (*Periomella yorkensis* Resser). A distinctive genus, here described in detail.

Crassifimbria Lochman, 1947 (*Onchocephalus walcotti* Resser). The type species, represented by good limestone cranidia, seems distinct enough from *Onchocephalus* to warrant a separate genus. However, intermediate forms are known.

Piazella Lochman, 1947 (*Ptychoparia pia* Walcott). The type species is characterized by a relatively smaller glabella than most of the other mentioned genera. However, intermediate forms bridge the

gap between *Piazella pia* and species referred by Resser to *Ptychoparella*, *Antagmus*, and *Onchocephalus*.

Sombrerella Lochman, 1948 (*Sombrerella mexicana* Lochman). No species other than the type seem to possess the same combination of characters.

In addition, Lower Cambrian ptychopariids have been referred to *Ptychoparella* Poulsen, 1927, by Resser and Lochman. The writer disagrees with this use of the genus. The type species is *Ptychoparella brevicauda* Poulsen, collected from erratic boulders tentatively indicated by Poulsen as "Ozarkian," now known from the faunal associations to belong in the Middle Cambrian (presumably *Bathyriscus-Elrathina* zone). *Ptychoparella* is one of the generalized ptychopariids abundant in beds of that age, and as far as known from the scarce material available, there is little to differentiate it generically from such western forms as *Ehmaniella*, *Clappaspis*, *Pachyaspis*, etc. Possibly, when *Ptychoparella* becomes better known, one or more of these genera will fall in its synonymy. At present it seems inadvisable to abandon generic names founded on species of well-known morphology and stratigraphic position in favor of a genus based on a species of uncertain age. Hence the use of *Ptychoparella* should be confined to the type species, and it seems least of all justifiable to refer Lower Cambrian species to it.

Another genus of questionable age is *Perimetopus* Resser, 1937. The type species, *Conocephalites arenosus* Billings, was collected from beds of doubtful stratigraphic position. The type cranidium appears similar to *Elrathia*, *Ehmania*, and other Middle Cambrian genera. Use of this generic name should be restricted to the type species.

Some of the species here discussed supply information on the changes in cranidial features that occur during growth. The most general and conspicuous of these changes are the decrease in the length of the glabella relative to the entire cranidium, and the increase in the rate of tapering of the glabella. Such changes may still affect cranidia which presumably correspond to holaspis stages (see illustrations of *Periomma gaspensis* and *Periomma yorkensis*). Hence great care must be exercised in comparing the proportions of individuals of different sizes. Doubtless specific differences have been based on such growth features.

The writer must correct Lochman's (1947) statement that Lower Cambrian trilobites in general have a thinner test than later forms. While this is certainly true for the olenellids, it does not apply to the corynexochids and ptychopariids, which may have as thick tests as any later trilobites of comparable size. The species of *Bonnia* illus-

trated by the writer (Rasetti, 1948) and some of the ptychopariids discussed herein supply ample proof. Consequently, the upper and lower surfaces may differ considerably in appearance.

Subfamily ANTAGMINAE Hupé, 1953

A family to contain the most primitive ptychopariids was tentatively erected by Hupé and named after the genus *Antagmus*. The unit is here given subfamily rank since the differences between these Lower Cambrian genera and *Ptychoparia* itself do not seem of great taxonomic significance.

It does not seem possible to assign strict diagnostic features of the Antagminae, since in this difficult group of trilobites taxonomic units cannot be based on morphology alone, without due regard to stratigraphic and geographic factors. The most salient and commonly encountered cranidial features are described, with the understanding that they are not exclusive of the genera included in the subfamily.

The glabella is moderately tapered, always well defined at the sides, in some cases almost merging in front with the preglabellar field. Glabellar furrows moderately deep to obsolete; three or four pairs visible in most species; furrows of four pairs not greatly different in depth, short, straight; first two pairs directed inward and forward, last two pairs inward and backward. Occipital furrow well impressed, occipital ring usually bearing a node, never spinose. Frontal area usually well divided into preglabellar field and border by a marginal furrow; the latter frequently showing a median inbend due to expansion of the border. Palpebral area from one-half to fully as wide as the glabella; ocular ridges present; palpebral lobes elevated, set off by distinct palpebral furrows, from one-fourth to one-half as long as the glabella, situated on the level of the glabellar midpoint, or slightly more forward or backward. Posterior limbs on the average as wide (tr.) as the occipital ring, deeply furrowed. Anterior facial sutures slightly convergent to slightly divergent; frontal portion ventral-intramarginal. Surface of test almost invariably granulated.

Most of the Antagminae are known only from cranidia. However, the writer (Rasetti, 1951) described complete exoskeletons of several lower Middle Cambrian species of *Syspacephalus*. Lochman (1952) figured pygidia attributed to species of *Onchocephalus*. Resser (1938) illustrated a complete, but poorly preserved Lower Cambrian ptychopariid, "*Ptychoparella*" *buttsi*, referred by Lochman (1947) to the genus *Antagmus*. All these observations confirm that the Antagminae have a thorax of about 15 segments, with pleura bluntly ter-

minated, and a small pygidium, composed of very few segments, which is unlikely to offer generic taxonomic characters.

The writer would provisionally include in the Antagminae only the genera based on Lower Cambrian type species, *Antagmus*, *Austinvillia*, *Crassifimbra*, *Onchocephalus*, *Perionma*, *Piazella*, *Poulsenia*, *Proliostracus*, *Sombrerella*, and *Syspacephalus*; also three new genera described herein, *Eoptychoparia*, *Bicella*, and *Luxella*. Some of the above-mentioned genera are known to range into the lower Middle Cambrian, and it is possible that genera based on Middle Cambrian type species such as *Arellanella*, *Caborcella*, and several others should also be included. However, a revision of the taxonomy of the Middle Cambrian ptychopariids is a task of such proportions that the writer prefers, for the time being, to confine attention to classification of the Lower Cambrian genera alone. For analogous reasons, genera based on European, African, Australian, Asiatic, and South American forms were not taken into consideration; however, few ptychopariids are known from the Lower Cambrian of these areas.

Representative species of each of the genera described in this paper are illustrated by line drawings on plate I.

Genus *ANTAGMUS* Resser, 1936

Description.—Glabella of regular convexity, rounded in front, with three or four pairs of furrows; occipital furrow impressed. Frontal area steeply downsloping at the sides, divided into preglabellar field and border; marginal furrow with a median inbend caused by a rearward expansion of the border. Preglabellar field never completely absent medially. Palpebral area convex, on the average horizontal, from 0.5 to 0.7 times the width of the glabella at its midpoint; ocular ridges well marked; palpebral lobes one-third to one-fourth as long as the glabella, situated slightly back of the glabellar midpoint. Posterior limbs as wide (tr.) as or a little wider than the occipital ring; distal portion as wide as or somewhat narrower than the proximal portion; marginal furrow deep, reaching the distal end of the limb. Anterior facial sutures divergent at least for some distance in front of the eyes, convex outward; frontal portion marginal or slightly ventral for a considerable distance. Posterior branch directed rather definitely outward behind the eye, curving backward near the posterior margin. Surface of test usually with fine granules.

Type species.—*Antagmus typicalis* Resser.

Remarks.—The above description was based chiefly on *Antagmus gigas*, a species here described which seems extremely close to or possibly identical with the poorly represented type species.

Antagmus is difficult to separate from *Onchocephalus* and *Piazella*, as intergrading forms between all these three genera are known and the boundaries must be set arbitrarily. *Antagmus* is chiefly characterized by the strong convexity of the separate cranial parts, median expansion of the border, and divergence of the anterior facial sutures. Lochman (1947) attributed much importance to the relative transverse width of the palpebral area, a character which is affected by individual variability, stage of growth, and manner of preservation. The writer is more inclined to consider the divergence of the anterior facial sutures as the main diagnostic feature that separates *Antagmus* from *Onchocephalus*. *Piazella* differs from *Antagmus* mainly in the lack of a considerable medial expansion of the border, definitely down-sloping palpebral area, and relatively wider (tr.) posterior limbs.

ANTAGMUS GIGAS Rasetti, new species

Plate 1, figure 1; plate 2, figures 1-8

Available material.—About a dozen cranidia, most of which are fragmentary.

Description.—Entire cranium of considerable convexity. Glabella defined by a deep dorsal furrow at the sides, a shallower furrow in front, convex in both directions, moderately tapered, with slightly concave sides, rounded in front. Four pairs of glabellar furrows visible, the first pair shallow and short, the other three well impressed. Occipital furrow deep; occipital ring short (sag.), bearing a small node. Frontal area sloping down steeply at the sides; marginal furrow deep at the sides, shallower medially where it bends backward to form an obtuse angle and greatly reduce the preglabellar field. Border convex laterally, flatter and expanded backward medially. Palpebral area rising sharply above the dorsal furrow, especially in exfoliated specimens, convex transversely, on the average horizontal, 0.6 to 0.7 times the width of the glabella at its midpoint; possibly of greater relative width in smaller cranidia. Ocular ridges wide and low, almost straight. Palpebral lobes slightly less than one-third the glabellar length, slightly elevated, situated slightly back of the level of the glabellar midpoint; palpebral furrows shallow. Posterior limbs slightly wider (tr.) than the occipital ring; marginal furrow wide and deep, reaching the distal end of the limb. Anterior facial sutures divergent in front of the eyes in dorsal view, convex outward, curving gradually inward and crossing the margin well at the sides; frontal portion slightly ventral. Posterior branch directed almost straight outward and backward, curving definitely backward only near the margin.

Surface of test finely and densely granulated, showing in addition scattered larger granules. Of these, four pairs are symmetrically placed on the glabella. The surface of the internal cast appears punctate and shows faint anastomosing ridges on the preglabellar field.

Cranidia range from 8 to 20 mm. in length. This is the largest Lower Cambrian ptychopariid known to the writer.

Remarks.—The present form agrees with *Antagmus typicalis* in all characters observable on its holotype cranidium, which, however, is too poorly preserved to show specific features. Hence it would be improper to attempt identification with that species, and a new name is proposed.

Occurrence.—Boulder B-5, Bic (type locality); also boulders G-1, G-9, and G-15, Grosses Roches.

Types.—Holotype: U.S.N.M. No. 123853. Paratypes: U.S.N.M. Nos. 123854-5.

ANTAGMUS ELONGATUS Rasetti, new species

Plate 2, figures 11-16

Available material.—A dozen well-preserved cranidia and one free cheek.

Description.—Glabella relatively long and narrow, rounded in front, slightly tapered, with slightly concave sides, rather strongly convex transversely, moderately convex longitudinally. Second, third, and fourth pairs of glabellar furrows short, rather shallow; occipital furrow well impressed, occipital ring relatively long (sag.), bearing a node. Frontal area of same relative length (sag.) as in the type species, on the average horizontal medially, downsloping at the sides. Border wide medially, where a rearward expansion deflects backward and almost obliterates the marginal furrow; tapering at the sides on account of the strongly curved anterior outline of the cranidium. Palpebral area moderately convex, on the average slightly upsloping, 0.55 times as wide as the glabella at its midpoint. Ocular ridges wide and low, slightly curved; palpebral lobes elevated, narrow, set off by a distinct palpebral furrow, situated slightly back of the level of the glabellar midpoint; length of palpebral lobe 0.44 times the glabellar length. Distance from posterior end of palpebral lobe to posterior margin slightly less than length of palpebral lobe. Posterior limbs as wide (tr.) as occipital ring; furrow deep and wide, reaching the end. Anterior facial sutures divergent in front of the eyes, convex outward, gradually curving inward and widely rounding off the anterior angles of the cranidium. Free cheek attributed to the species

with a wide, convex border set off by a lateral marginal furrow which becomes shallower posteriorly, before joining the very deep posterior marginal furrow which is an extension of the marginal furrow on the posterior limbs of the cranium. Genal spine short, rapidly tapered. Surface covered with fine granules, among which are scattered larger granules.

Crania range in length from 2 to 7 mm. The smaller crania are characterized by relatively shorter palpebral lobes, lesser divergence of the anterior facial sutures, and lesser rearward expansion of the anterior border.

Remarks.—This species could briefly be described as differing from *Antagmus gigas* in being smaller and relatively narrower in all its cranial parts. It also has longer palpebral lobes and consequently shorter (exsag.) posterior limbs.

Occurrence.—The species, although uncommon, was recovered from a number of boulders: B-1, G-1, G-16, G-17, G-41, and M-10; one cranium collected at Bic was found in the U.S.N.M. collections. The type locality is boulder M-10, Metis.

Types.—Holotype: U.S.N.M. No. 123856. Paratypes: U.S.N.M. Nos. 123857-9.

ANTAGMUS? LONGIFRONS Rasetti, new species

Plate 6, figures 12-15

Available material.—Three well-preserved crania.

Description.—Glabella well defined by the dorsal furrow, prominent, tapered, with slightly concave sides, fairly rounded in front. Four pairs of shallow glabellar furrows; occipital furrow well impressed, occipital ring rather short (sag.), bearing a node. Frontal area well divided into preglabellar field and border by a marginal furrow which bends backward medially almost touching the dorsal furrow in front of the glabella. Border rather flat, tapering in width at the sides. Palpebral area slightly convex and downsloping, 0.50 times as wide as the glabella at its midpoint; ocular ridges straight, rather strongly oblique; palpebral 0.30 times as long as the glabella, narrow, somewhat elevated, defined by a distinct palpebral furrow, situated slightly back of the level of the glabellar midpoint. Distance from posterior end of palpebral lobe to posterior margin slightly greater than length of palpebral lobe. Posterior limbs as wide (tr.) as the occipital ring, rather slender; distal portion somewhat longer than proximal portion; furrow fairly deep, reaching the distal end. Anterior facial sutures slightly divergent in front of eyes, gradually curv-

ing inward as in other species of the genus. Posterior branch turning backward in a wide curve. Surface of test covered with fine granules with larger scattered granules both on glabella and fixed cheeks. Length of largest cranium 7.5 mm.

Remarks.—The species is assigned to *Antagmus* with a question mark because it departs from the type species in three features which might be considered of generic importance: the almost complete disappearance of the medial preglabellar field, the narrowness and downward slope of the palpebral area. Nevertheless, since the shape of the glabella, direction of the facial sutures, and structure of the frontal border are typical of *Antagmus*, the species may be provisionally placed in that genus.

The species was found associated only with an undetermined *Onchocephalus* and another undescribed form; hence the evidence for its Early Cambrian age is not entirely conclusive. However, the fact that a cranium of this species in the U. S. National Museum was collected at Bic, where boulders of other than Early Cambrian age are virtually unknown, supplies additional proof.

Occurrence.—Boulder M-9, Metis. Also an unknown boulder at Bic.

Types.—Holotype: U.S.N.M. No. 123860. Paratypes: U.S.N.M. Nos. 123861-2.

EOPTYCHOPARIA Rasetti, new genus

Description.—Glabella of regular convexity, rounded in front, showing three or four pairs of shallow glabellar furrows. Frontal area well divided into preglabellar field and border, usually of equal lengths (sag.). Marginal furrow regularly curved or with a slight median inbend caused by an expansion of the border. Palpebral area somewhat convex, horizontal to slightly downsloping, 0.5 to 0.7 times the width of the glabella. Palpebral lobes about one-third as long as the glabella, at the level of the glabellar midpoint. Posterior limbs about as wide (tr.) as the occipital ring, with furrow reaching the distal end. Anterior facial sutures slightly divergent; posterior branch as in *Antagmus*.

Type species.—*Eoptychoparia normalis* Rasetti, new species.

Remarks.—The features of the species attributed to the genus are about average for Lower Cambrian ptychopariids; hence the genus is difficult to characterize and intergrades with *Antagmus*, *Piazella*, and *Onchocephalus*. *Eoptychoparia* essentially corresponds to Reser's and Lochman's conception of *Ptychoparella* as based not on the

type species, the upper Middle Cambrian *Ptychoparella brevicauda* Poulsen, but on the supposed Lower Cambrian representatives. Besides the reasons already mentioned under the family discussion, there seem other valid ones for not referring these Lower Cambrian forms to *Ptychoparella*: (1) the position of the eyes is more posterior in *Ptychoparella* than in *Eoptychoparia*; (2) the anterior facial sutures are slightly convergent in *Ptychoparella*, slightly divergent in *Eoptychoparia*; (3) the pygidium may have more segments in *Ptychoparella*, although much weight cannot be attributed to this character as no pygidium can be assigned with certainty to either genus. The writer carefully considered whether such forms should be assigned either to *Antagmus* or *Piazella*, but the distinguishing features seem worthy of generic distinction.

Eoptychoparia differs from *Antagmus* in the lack of a strong rearward expansion of the border; from *Piazella* in the lesser width of the palpebral area and the posterior limbs, and hence in the greater relative size of the glabella compared to the fixed cheeks; from *Onchocephalus* in the generally more prominent, rounded glabella, deeper glabellar furrows, greater convexity and horizontal position of the palpebral area, and on the average more divergent course of the anterior facial sutures. It is acknowledged that these differences are not of great importance, and intermediate forms exist. However, if lack of intermediate species were required for generic separation, one would have to place most of the Ptychopariidae in a single genus.

Besides the species described herein, the writer would refer to *Eoptychoparia* two species described by Resser, *Ptychoparella taylori* and *P. minor*, although the former, possessing greater relative widths of palpebral area and posterior limbs, forms a perfect transition to *Piazella*. Some of Resser's species of *Ptychoparella* from Vermont may also belong in the genus, but most of them are too poorly preserved to warrant discussion, excepting *P. walcotti* which seems very close to the type species of *Eoptychoparia*.

EOPTYCHOPARIA NORMALIS Rasetti, new species

Plate 1, figure 2; plate 3, figures 5-11

Available material.—A dozen partly fragmentary cranidia.

Description.—Glabella prominent, fairly convex longitudinally and strongly convex transversely, slightly tapered, rounded in front. Four pairs of glabellar furrows visible on some specimens; only third and fourth pairs well impressed. Occipital ring short (sag.), bearing a prominent node. Preglabellar field downsloping, as long (sag.) as

the border; marginal furrow regularly curved, except for a slight median inbend appearing only in some individuals; border convex, tapering in width at the sides. Palpebral area slightly convex, on the average horizontal, 0.7 times as wide as the glabella; ocular ridges well marked, slightly curved; palpebral lobes slightly less than half as long as the glabella, at the level of the glabellar midpoint, somewhat elevated, set off by well-marked palpebral furrows. Posterior limbs deeply furrowed, as wide (tr.) as the glabella; distal portion almost as wide (tr.) as proximal portion. Anterior facial sutures slightly divergent in front of eyes, curving inward after crossing marginal furrow; posterior branch turning backward in wide curve. Surface of test very finely granulated. Length of largest cranidium 9 mm.

Remarks.—The illustrations show the variability observed among cranidia of this species (all recovered from the same boulder) in the rate of tapering of the glabella and the presence of a more or less definite inbend of the marginal furrow. The latter is usually more apparent in smaller cranidia.

Occurrence.—Boulder B-6, Bic.

Types.—Holotype: U.S.N.M. No. 123863. Paratypes: U.S.N.M. No. 123864.

EOPTYCHOPARIA ANGUSTIFRONS Rasetti, new species

Plate 3, figures 1-4

Available material.—A dozen cranidia.

Description.—The species is so similar to *E. normalis* that only the distinguishing features are described. The glabella is proportionately narrower and in most specimens shows slightly concave sides on account of the anterior part tapering less rapidly than the posterior part. The marginal furrow is more regularly curved, as there is almost no trace of a median inbend, and the border is of more even width. The surface granulation is somewhat more apparent than in *E. normalis*. Cranidia range in length from 2 to 6 mm.

Remarks.—In the shape of the glabella this species is almost identical with *E. taylori* (Resser), which, however, has proportionately wider palpebral area and posterior limbs.

Occurrence.—Boulder B-4, Bic.

Types.—Holotype: U.S.N.M. No. 123865. Paratypes: U.S.N.M. No. 123866.

EOPTYCHOPARIA INTERMEDIA Rasetti, new species

Plate 3, figures 12-15

Available material.—Nine crania.

Description.—This species also can be described by pointing out the differences from *E. normalis*. The glabella is less rounded in front, presenting a slightly truncate appearance, and is also less prominent. The anterior border is somewhat more elevated. The palpebral area is on the average slightly downsloping instead of horizontal. The anterior facial sutures from the palpebral lobe to the marginal furrow are on the average parallel instead of divergent. Crania range from 2 to 5 mm. in length.

Remarks.—It is apparent from the description that this species is intermediate between *Eoptychoparia* and *Onchocephalus*, or more precisely between *Eoptychoparia normalis* and *Onchocephalus sulcatus*. This fact shows the close relationship between the two genera.

Occurrence.—Boulder G-19, Grosses Roches.

Types.—Holotype: U.S.N.M. No. 123867. Paratypes: U.S.N.M. No. 123868.

Genus ONCHOCEPHALUS Resser, 1937

Description.—Glabella sloping down to a low anterior end, straight-sided, truncated in front, with four pairs of shallow furrows. Frontal area divided into preglabellar field and border; marginal furrow usually with median inbend. Palpebral area slightly convex, usually downsloping, 0.6 to 0.8 times as wide as the glabella. Palpebral lobes about one-third as long as the glabella, at the level of the glabellar midpoint. Posterior limbs about as wide (tr.) as occipital ring; distal portion narrower (tr.) than proximal portion; marginal furrow reaching distal end of limb. Anterior facial sutures slightly convergent or parallel in front of the eyes, then curving inward and rapidly converging; posterior branch curving backward to posterior margin.

Type species.—*Ptychoparia thia* Walcott.

Remarks.—*Onchocephalus* is chiefly characterized by the downsloping, truncated glabella, lack of divergence of the anterior facial sutures, and the usually downsloping, at most horizontal, palpebral area. Forms with less convergent facial sutures and horizontal palpebral area intergrade with *Antagmus* or *Eoptychoparia*; species with narrower palpebral area approach *Crassifimbria*; and forms with proportionately smaller glabella link the genus to *Luxella*.

The writer would include in the genus, in addition to the species described by Rasetti (1951) and Lochman (1952), *Antagmus soli-*

tarius Lochman and *Proliostracus goodwini* Resser. Lochman excluded the latter species from *Onchocephalus* on the basis of the slightly lesser width of the palpebral area, a character which the writer does not consider of generic importance.

One new species and several unnamed forms are described herein.

ONCHOCEPHALUS SULCATUS Rasetti, new species

Plate 1, figure 3; plate 3, figures 16-19

Available material.—Two well-preserved cranidia.

Description.—Glabella of moderate elevation, straight-sided, fairly truncated in front; dorsal furrow fairly deep at the sides, shallow anteriorly. Four pairs of glabellar furrows visible, but only third and fourth pairs moderately well impressed. Occipital ring bearing a node. Preglabellar field shorter (sag.) than border medially. Border strongly convex, elevated, expanded medially, causing a slight median inbend of the marginal furrow. Palpebral area convex, on the average almost horizontal, 0.7 times as wide as the glabella. Palpebral lobes strongly elevated, 0.4 times as long as the glabella; distance from posterior end of palpebral lobe to posterior margin about equal to length of palpebral lobe. Posterior limbs as wide (tr.) as occipital ring; distal portion appreciably narrower (tr.) than proximal portion. Anterior facial sutures parallel for a short distance in front of the eyes, appreciably convergent at the level of the marginal furrow; posterior branch reaching margin with a wide curve. Length of holotype cranidium 6 mm. Surface finely granulated.

Remarks.—The species is typical of *Onchocephalus* and closely resembles *O. buelnaensis* Lochman and *O. mexicanus* Lochman, differing mainly in the greater prominence of the anterior border and convexity of the palpebral area.

Occurrence.—Boulder G-41, Grosses Roches.

Types.—Holotype: U.S.N.M. No. 123869. Paratype: U.S.N.M. No. 123870.

ONCHOCEPHALUS, species undetermined No. 1

Plate 3, figure 20

Available material.—One cranidium.

Description.—This form is characterized by an almost unfurrowed glabella with slightly concave side outline. Preglabellar field half as long (sag.) as border on median line. Border very convex, not appreciably expanded backward medially. Palpebral area slightly con-

vex and upsloping, about 0.8 times as wide as glabella; palpebral lobes not preserved. Surface of test granulated. Length of cranium 5 mm.

Remarks.—Although this form is distinctive, it does not seem proper to base a specific name on one cranium. The closest described species is *Antagnus solitarius* Lochman, which the writer would rather include in *Onchocephalus* on account of the slight convergence of the anterior facial sutures. The present form has shorter (sag.) border and wider palpebral area.

Occurrence.—Boulder M-10, Metis.

Disposition of material.—U.S.N.M. No. 123871.

ONCHOCEPHALUS, species undetermined No. 2

Plate 3, figure 22

Available material.—One perfect cranium.

Description.—Glabella with slightly concave side outline, sharply truncated in front; four pairs of faint glabellar furrows visible. Occipital ring rather long (sag.), rounded in outline. Preglabellar field very short (sag.) medially; border very prominent, convex; marginal furrow of uniform curvature, lacking a median inbend. Palpebral area slightly upsloping, 0.6 times as wide as glabella; palpebral lobes half as long as glabella, elevated; distance from posterior end of palpebral lobe to posterior margin less than length of palpebral lobe. Posterior limbs with deep, straight furrow. Anterior facial sutures parallel for the short distance between palpebral lobes and marginal furrow; posterior branch as in other species of genus. Surface of test finely granulated. Length of cranium 4 mm.

Remarks.—This distinctive form differs from typical species of *Onchocephalus* in the slightly upsloping rather than downsloping palpebral area and somewhat longer palpebral lobes. The former character brings it somewhat close to *Perionmma* (e.g., cf. *Perionmma gaspensis*, pl. 4, fig. 15). As the only known cranium is small, it is possible that some of its features are due to immaturity.

Occurrence.—Boulder G-41, Grosses Roches.

Disposition of material.—U.S.N.M. No. 123872.

ONCHOCEPHALUS, species undetermined No. 3

Plate 3, figure 21

Available material.—One cranium.

Description.—Glabella straight-sided, moderately truncated in front, sloping down to low anterior end; three pairs of glabellar furrows fairly well impressed. Occipital ring long (sag.). Length (sag.) of

frontal area average for the genus; border prominent, highly convex; marginal furrow regularly curved, with but a trace of a median in-bend. Palpebral area 0.8 times as wide as the glabella, slightly upsloping; palpebral lobes half as long as the glabella, elevated; distance from posterior end of palpebral lobe to posterior margin less than length of palpebral lobe. Surface of test punctate. Length of cranidium 4.8 mm.

Remarks.—This form agrees with *Onchocephalus* in the shape of the glabella and structure of the frontal area, but differs in the slightly upsloping palpebral area and the greater length of the palpebral lobes. In the last characters and general aspect the species approaches the new genus *Luxella*.

Occurrence.—Boulder B-11, Bic; associated with *Bonnia brennus* (Walcott), *Protypus* sp.

Disposition of material.—U.S.N.M. No. 123873.

Genus **CRASSIFIMBRA** Lochman, 1947

CRASSIFIMBRA, species undetermined No. 1

Plate 3, figure 23

Available material.—One cranidium.

Description.—Glabella of low convexity, with slightly concave side outline, fairly truncated in front, showing four pairs of very shallow furrows; occipital ring not well preserved. Preglabellar field almost vanishing medially; border of moderate width (sag.), with barely a trace of a median rearward expansion. Palpebral area definitely downsloping, slightly convex, half as wide as the glabella; palpebral lobes not preserved, apparently about one-third the glabellar length. Posterior limbs slightly narrower (tr.) than occipital ring. Anterior facial sutures slightly convergent from eye to marginal furrow; posterior branch as in typical species of *Onchocephalus*. Surface of test finely granulated. Length of cranidium 4 mm.

Remarks.—This species, intermediate in several features between *Onchocephalus* and *Crassifimbria*, is referred to the latter genus on account of the narrowness of the palpebral area. It differs from *Crassifimbria walcotti* (Resser) in the greater relative length of the glabella, deeper dorsal and marginal furrows, elevated and narrow border, and granulated surface.

Occurrence.—Boulder SS-1, St. Simon; associated with *Protypus reticulatus* Rasetti.

Disposition of material.—U.S.N.M. No. 123874.

CRASSIFIMBRA, species undetermined No. 2

Plate 2, figures 9, 10

Available material.—One well-preserved cranidium.

Description.—Glabella of low convexity, straight-sided, with fairly sharp anterior angles; almost merging with the slope of the preglabellar field in front. Occipital ring bearing a node. Preglabellar field greatly reduced medially; border convex, strongly expanded medially, causing a slight inbend of the marginal furrow. Palpebral area slightly convex, horizontal, half as wide as the glabella; ocular ridges not greatly elevated. Palpebral lobes half as long as the glabella, narrow, elevated; distance from posterior end of palpebral lobe to posterior margin somewhat less than length of palpebral lobe. Posterior limbs as wide (tr.) as occipital ring, well rounded distally; distal portion somewhat narrower (tr.) than proximal portion. Anterior facial sutures slightly convergent from eyes to marginal furrow; posterior branch directed straight outward behind eye. Surface of test finely granulated. Length of cranidium 6 mm.

Remarks.—This distinctive species does not exactly fit the characters of any described genus. It seems best placed in *Crassifimbria* on account of the narrowness of the palpebral area. It differs from *Crassifimbria walcottii* in the depth of the dorsal and marginal furrows, horizontal palpebral area, prominence of the anterior border, long palpebral lobes, and granulated surface.

Occurrence.—Boulder B-1, Bic; associated with *Bonnia laevigata* Rasetti, *Protypus* sp., *Zacanthopsis* sp.

Disposition of material.—U.S.N.M. No. 123875.

LUXELLA Rasetti, new genus

Description.—Glabella straight-sided, tapered, not greatly elevated, well defined by the dorsal furrow at the sides, truncated and poorly delimited in front, occupying half the cranidial length. Preglabellar field long (sag.), slightly downsloping; border wide (sag.), slightly convex. Palpebral area flat, horizontal, as wide as the glabella; ocular ridges visible; palpebral lobes elevated, almost half the glabellar length, at the level of the glabellar midpoint. Posterior limbs somewhat wider (tr.) than the occipital ring, well furrowed, with distal part bent downward. Anterior facial sutures divergent in front of the eyes for a considerable distance, curving inward in crossing the border; frontal portion slightly ventral. Posterior branch directed first straight outward, then curving backward to posterior margin.

Type species.—*Ptychoparia lux* Walcott.

Remarks.—The type species has been misplaced in several genera. *Luxella* is obviously a close relative of *Onchocephalus*, as evidenced by an intermediate form illustrated herein (*Onchocephalus*, species undetermined No. 3), showing widening of the palpebral area, lengthening of the frontal area, and increasing size of the palpebral lobes. In *Luxella lux* these changes have reached a point where they justify generic distinction. From these features, it is obvious that *Luxella* resembles *Inglefieldia*, *Amecephalus*, and *Alokistocare*, and may well be in the ancestral line of some of these trilobites. The chief difference is in the shape of the posterior limbs, which in all these genera have a longer, horizontal distal portion, whereas in *Luxella lux* the distal portion is shorter and sharply turned downward, indicating a thorax with pronounced geniculation in place of the flat pleura of the *Amecephalus* type. Hence the species is not referred to *Inglefieldia*, which it otherwise resembles except in the greater width of the palpebral area.

An additional species from Quebec is referred to *Luxella*.

LUXELLA LUX (Walcott)

Plate 1, figure 4; plate 6, figures 9-11

Ptychoparia lux WALCOTT, Smithsonian Misc. Coll., vol. 67, No. 3, pl. 12, fig. 5, 1917.

Kochina? lux (Walcott), RESSER, Smithsonian Misc. Coll., vol. 97, No. 10, p. 33, 1938.

Crassifimbria lux (Walcott), RASETTI, Smithsonian Misc. Coll., vol. 115, No. 5, p. 82, 1951.

Available material.—The type lot includes the holotype and several paratype crania. Among several topotype crania collected by the writer is the almost perfect one illustrated herein.

Description.—Most of the characters of the species were mentioned in the generic diagnosis and are not repeated. The glabella shows two very faint pairs of furrows at the sides. Occipital furrow distinct, occipital ring moderately long (sag.), anterior border somewhat narrower (sag.) than the preglabellar field medially; marginal furrow well impressed at the sides but shallow medially owing to a slight rearward extension of the median portion of the border. Posterior limbs appearing as wide (tr.) as the occipital ring in dorsal view, actually somewhat longer because the distal, downturned portion appears shortened. Distal portion of limb half as wide (tr.) as proximal portion. Distance from posterior end of palpebral lobe to posterior margin appreciably less than length of palpebral lobe. Surface of test finely punctate. Length of figured cranium 6 mm.

Occurrence.—The species is known only from the type locality (U.S.N.M. locality 61d; author's locality P22m): St. Piran sandstone (Peyto limestone member), about 110 feet above base of member; on west ridge of Mount Schaffer, 0.4 miles W. 30° S. of the summit; Yoho National Park, British Columbia. Associated with olenellids, *Bonnia fieldensis* (Walcott) and *Zacanthopsis*.

Types.—Holotype and paratypes: U.S.N.M. No. 64387. Plesio-type: U.S.N.M. No. 123876.

LUXELLA CRASSIMARGINATA Rasetti, new species

Plate 6, figures 7, 8

Available material.—Two cranidia, one of which is poorly preserved.

Description.—Glabella tapered in the posterior three-fifths, parallel-sided in the anterior two-fifths, hence with concave side outline; sloping down to a low anterior end but still well delimited in front. Four pairs of very short and shallow glabellar furrows visible; occipital furrow deep; occipital ring rather long (sag.), bearing a node. Preglabellar field one-third as long (sag.) as the border medially; border upsloping, slightly convex, very long (sag.) at the midline, tapering at the sides; marginal furrow not greatly curved, with barely a trace of a median inbend. Palpebral area horizontal, flat, fully as wide as the glabella; palpebral lobes not preserved, but evidently long; posterior limbs not entirely preserved. Surface of test punctate. Length of cranidium 7 mm.

Remarks.—This distinctive species appears worth naming although represented by imperfect material. It differs from *L. lux* chiefly in the different proportions of the preglabellar field and border, concave lateral outline, and better definition of the glabella.

Occurrence.—Boulder B-6, Bic.

Types.—Holotype: U.S.N.M. No. 123885. Paratype: U.S.N.M. No. 123886.

Genus AUSTINVILLIA Resser, 1938

Description.—Glabella tapered, straight-sided, not greatly elevated, moderately rounded in front, faintly furrowed at the sides. Occipital ring short (sag.). Dorsal furrow not very deep. Frontal area of average length (sag.), faintly arched transversely, divided by a faint marginal furrow into a short (sag.) preglabellar field and a long (sag.), convex border. Palpebral area slightly convex, horizontal; ocular ridges of average strength; palpebral lobes narrow, elevated,

about one-third the glabellar length, situated at the level of the glabellar midpoint. Width of palpebral area somewhat over half the glabellar width. Posterior limbs as wide (tr.) as the occipital ring, with a deep furrow reaching the extremity. Anterior facial sutures slightly divergent for some distance in front of the eyes, curving inward after crossing the marginal furrow; frontal portion slightly ventral. Posterior branch first directed straight outward, then curving backward to posterior margin.

Type species.—*Austinvillia virginica* Resser.

Remarks.—The cranidium of *Austinvillia* resembles *Onchocephalus* in the general proportions and convexity but differs in the structure of the frontal area and the slight divergence of the facial sutures. The structure of the frontal area and the lesser convexity of the various parts also distinguish *Austinvillia* from *Antagmus*, *Eoptychoparia*, and *Piazella*.

The type species is the only described form that can be assigned to the genus. However, a closely similar species is common in leached dolomite at the base of the Parker shale three-fourths of a mile southwest of Parker Cobble, near Georgia, Vt.

AUSTINVILLIA VIRGINICA Resser

Plate 1, figure 5; plate 4, figures 8-10

Austinvillia virginica RESSER, Geol. Soc. Amer. Spec. Pap. 15, p. 61, pl. 3, figs. 8-10, 1938.

Available material.—The type lot includes the holotype and two paratypes preserved in limestone. An additional, perfect cranidium was collected by the writer.

Description.—Only details not mentioned in the generic diagnosis are included. The glabella shows four pairs of short furrows of increasing strength. The furrows of the first, third, and fourth pairs start from the dorsal furrow, while the second pair is located somewhat more inward. This feature is common to a great number of both ptychopariid and corynexochid Cambrian trilobites, and its significance is obscure. The occipital ring bears a node. Palpebral lobes slightly exceeding one-third the glabellar length; distance from posterior end of palpebral lobe to posterior margin equal to length of palpebral lobe. Surface finely and rather indistinctly granulated. Length of largest cranidium 14 mm.

Remarks.—The cranidium from Quebec here figured differs slightly from the holotype and paratype illustrated by Resser in the lesser convexity of the border, while it seems identical with a third, un-

figured specimen in the type lot. Hence the small differences may be attributed to intraspecific variability.

Occurrence.—The types are from U.S.N.M. locality 23j: Shady (?) limestone, 1 mile northeast of Austinville, Va. The specimen here figured is from boulder G-25, Grosses Roches.

Types.—Holotype and paratypes: U.S.N.M. No. 94742. Plesio-type: U.S.N.M. No. 123878.

Genus PERIOMMA Resser, 1937

Description.—Glabella conical, more or less truncated in front, faintly furrowed at the sides, high posteriorly, not greatly elevated anteriorly. Dorsal furrow very deep laterally. Occipital furrow well impressed, occipital ring rounded. Frontal area consisting of preglabellar field, often with median boss, and strongly convex, swollen border. Palpebral area slightly convex, on the average upsloping; ocular ridges distinct; palpebral lobes slightly raised, about one-fourth the glabellar length, at the level of the glabellar midpoint. Width of palpebral area about three-fourths width of glabella. Posterior limbs about as wide (tr.) as, or slightly wider than, occipital ring; distal portion narrower (tr.) than proximal portion. Posterior marginal furrow deep, but not extending to the end of the limb, indicating that it does not continue onto the free cheek. Anterior facial sutures slightly convergent; frontal portion slightly ventral. Posterior branch first directed outward, gradually curving backward to posterior margin. Test thick; upper surface may be finely granulated.

Type species.—*Periomma typicalis* Resser.

Remarks.—The characters of the genus, based on the poorly represented type species, have been supplemented from two other species, *P. walcotti* Resser and *P. gaspensis* described herein, both appearing to be definitely congeneric with *P. typicalis*. The genus is fairly well characterized by the elevation of the palpebral area, which chiefly distinguishes it from more generalized ptychopariids. However, transitional forms seem to link *Periomma* to *Onchocephalus*.

PERIOMMA WALCOTTI Resser

Plate I, figure 6; plate 5, figures 9-14

Periomma walcotti RESSER, Geol. Soc. Amer. Spec. Pap. 15, p. 92, pl. 3, figs. 14, 15, 1938.

Available material.—The type lot includes the holotype and a paratype. The U.S.N.M. collections include several other topotype

crania. Several additional crania were collected by the writer, also from the type locality.

Description.—Glabella fairly tapered, straight-sided, not too sharply truncated in front. Three and sometimes four short, shallow glabellar furrows visible at the sides. Occipital furrow almost straight; occipital ring expanded medially, obtusely subtriangular, bearing a node. Preglabellar field somewhat shorter (sag.) than the border on the outer surface, lacking a boss. Border convex, prominent, swollen medially, tapering in width at the sides on account of the straight course of the marginal furrow and the curved anterior outline of the cranidium. Ocular ridges wide and low on outer surface; palpebral lobes set off by a shallow palpebral furrow and not greatly elevated. Width of palpebral area about 0.8 times width of glabella. Posterior limb about as wide (tr.) as occipital ring. Surface with rather indistinct granules. The unusually thick test of this species results in a great difference in the appearance of exfoliated crania, where the glabella appears proportionately narrower and the preglabellar field longer (sag.), and all furrows are accentuated.

Remarks.—An exact comparison with the type species cannot be made, since the latter is represented by distorted sandstone casts. The chief difference seems to be the lack of a preglabellar boss in *P. walcotti*.

Occurrence.—All the known specimens are from boulders of the Ville Guay conglomerate. The figured crania collected by the writer are from boulder O-24, Island of Orleans. Found also in boulder L-2, Ville Guay.

Types.—Holotype and paratype: U.S.N.M. No. 23529. Plesiotypes: U.S.N.M. No. 123879.

PERIOMMA GASPENSIS Rasetti, new species

Plate 4, figures 11-15

Available material.—Eight crania ranging from 3 to 7 mm. in length.

Description.—Most of the characters of this species are either included in the generic diagnosis or are the same as in *P. walcotti*. The chief differences from the latter species are the somewhat shorter (sag.) border, the shallowness of the median portion of the anterior marginal furrow due to the presence of a preglabellar boss, and the greater width (tr.) of the posterior limb, which somewhat exceeds the width of the occipital ring. Surface indistinctly granulated.

A feature observed on this species is the increased rate of tapering

of the glabella with the size of the individual, as clearly shown by the three illustrated cranidia. Note also the resemblance of the smallest cranidium (pl. 4, fig. 15) to *Onchocephalus*, species undetermined No. 2 (pl. 3, fig. 22).

Occurrence.—Boulder G-24, Grosses Roches.

Types.—Holotype: U.S.N.M. No. 123880. Paratypes: U.S.N.M. No. 123881.

BICELLA Rasetti, new genus

Description.—Glabella tapered, straight-sided, sharply truncated in front, defined by a deep dorsal furrow. Glabellar furrows shallow; occipital furrow well impressed; occipital ring expanded medially. Frontal area poorly differentiated into preglabellar field and a wide (sag.), swollen border. Palpebral area convex and somewhat up-sloping, less than half as wide as the glabella. Ocular ridges strong, extended into prominent, convex palpebral lobes situated at the level of the glabellar midpoint and one-third as long as the glabella. Posterior limbs as wide (tr.) as occipital ring; distal portion equal to proximal portion. Marginal furrow deep but not attaining the end. Anterior and posterior facial sutures similar to *Periomma*.

Type species.—*Austinvillia bicensis* Resser.

Remarks.—The type species was assigned to *Austinvillia* on the basis of two imperfect cranidia available to Resser. Much better material now extant shows that this form bears little resemblance to *Austinvillia* and cannot be assigned to any described genus. *Bicella* is probably closest to *Periomma*, from which it differs in the lack of a deep anterior marginal furrow, narrow palpebral area, and larger palpebral lobes. *Bicella* differs from *Austinvillia* in the convergence of the anterior facial sutures, rounded anterior outline of the cranidium, narrowness and convexity of the palpebral area, larger palpebral lobes, deeper dorsal furrow, truncated glabella, and posterior marginal furrow not extending to the end of the posterior limb.

BICELLA BICENSIS (Resser)

Plate 1, figure 7; plate 4, figures 1-7

Austinvillia bicensis RESSER, Geol. Soc. Amer. Spec. Pap. 15, p. 61, pl. 3, figs. 6, 7, 1938.

Austinvillia bicensis Resser, RASETTI, Amer. Journ. Sci., vol. 243, p. 317, pl. 2, figs. 1-4, 1945.

Available material.—The type lot includes the two syntypes, both incomplete, exfoliated cranidia. About a dozen additional cranidia

collected by the writer show the outer surface and all other cranidial features.

Description.—Glabella tapered, truncated in front, strongly convex transversely, with four pairs of very shallow, short furrows visible in some of the specimens. Dorsal furrow deep, especially wide at the sides. Occipital furrow slightly convex backward, somewhat shallower medially; occipital ring expanded medially, bearing a node. Frontal area vaguely divided into preglabellar field and a convex, elevated border in the smaller cranidia, almost undifferentiated in the larger specimens where it shows an almost uniform longitudinal convexity along the midline. At the sides the frontal area has a concave longitudinal profile determined by the steep slope in front of the ocular ridges. Ocular ridges wide and strong, extended into the palpebral lobes without sharp change in direction or elevation; palpebral lobes convex, elevated above the palpebral area. Distance from posterior end of palpebral lobe to posterior margin somewhat shorter than length of palpebral lobe. Anterior facial sutures appearing parallel in dorsal view for a short distance, then gradually converging and widely rounding off the anterior outline of the cranidium; frontal portion ventral-intramarginal. Surface densely covered with granules, larger on the elevated portions and smaller in the depressions. Test thick. Length of largest cranidium 10 mm.

Remarks.—Notwithstanding the imperfect type material, the writer considers the better cranidia illustrated herein unquestionably conspecific. No other known form seems referable to the genus.

Occurrence.—The types are from a conglomerate boulder at Bic. The additional specimens here illustrated were collected from boulder O-1, Island of Orleans. The species is also known from Lower Cambrian beds in place at Ville Guay, Quebec (Rasetti, 1945b).

Types.—Syntypes: U.S.N.M. Nos. 65015-6. Plesiotypes: Laval Univ. Nos. 308a-d, 309a-b; U.S.N.M. No. 123882.

ANTAGMINAE, genus and species undetermined

Plate 6, figures 16-18

Available material.—One well-preserved cranidium.

Description.—Glabella moderately tapered, straight-sided, rounded in front, fairly convex, well delimited by the dorsal furrow. Four pairs of shallow glabellar furrows; occipital furrow well marked; occipital ring rather long (sag.). Frontal area on the average down-sloping; border convex, about twice as long (sag.) as the preglabellar field on the midline. Marginal furrow almost regularly curved, medi-

ally somewhat shallower and with a slight inbend. Palpebral area slightly convex and definitely downsloping, 0.4 times as wide as the glabella at its midpoint. Ocular ridges not greatly elevated; palpebral lobes slightly less than 0.3 times as long as the glabella; distance from posterior end of palpebral lobe to posterior margin twice length of palpebral lobe; position of palpebral lobes somewhat in advance of glabellar midpoint. Posterior limbs three-fourths as wide (tr.) as the occipital ring, furrowed to the distal end. Anterior facial sutures approximately parallel from eye to marginal furrow, then curving inward and becoming ventral-intramarginal. Posterior branch directed straight outward and backward for a considerable distance, curving backward close to posterior margin. Upper surface of test faintly punctate. Length of cranium 7.5 mm.

Remarks.—This species does not possess the characters of any described Lower Cambrian genus. However, it does not seem proper to erect a species, and much less a genus, on a single individual. Possibly a new genus could include this form and the somewhat similar associated species *Antagmus? longifrons*.

Occurrence.—Boulder M-9, Metis.

Disposition of material.—U.S.N.M. No. 123877.

PERIOMMELLINAE Rasetti, new subfamily

The aberrant genus *Periomella* seems to warrant a separate subfamily.

Ptychopariidae with very wide fixed cheeks, palpebral area folded down vertically in front and at the sides, causing the eyes to be concealed in dorsal view. Posterior limbs not extending farther laterally than the palpebral area. Pygidium unknown, presumably very small. Known only from the upper Lower Cambrian of the Appalachian province.

Genus PERIOMMELLA Resser, 1938

Description.—Cranidium proportionately wide and short. Glabella truncatoconical, high posteriorly, sloping down anteriorly, of low longitudinal convexity; glabellar furrows indistinct, occipital furrow impressed, occipital ring long (sag.), elevated. Dorsal furrow very deep at the sides, narrower and shallower in front. Frontal area consisting of short (sag.) preglabellar field and prominent, convex border. Preglabellar area with tendency to develop a median boss. The border may be strongly arched transversely (*P. roddyi*). Palpebral area flat, upsloping, twice as wide as the glabella, folded down vertically in

front and at the sides. Ocular ridges first directed forward and curving backward. Palpebral lobes poorly differentiated within the lateral vertical slope, situated near the level of the glabellar midpoint (*P. yorkensis*) or farther back (*P. roddyi*). Posterior limb not extending laterally beyond the palpebral area, with a deep, wide furrow not reaching the end of the limb. Anterior facial sutures strongly convergent in front of the eyes; frontal portion somewhat ventral-intramarginal. Posterior branch first directed inward, then slightly outward, and inward again before reaching posterior margin. Free cheeks very narrow, dorsally consisting of wide, convex border and small ocular platforms. Test thick; upper surface granulated.

Type species.—*Periomella yorkensis* Resser.

Remarks.—Lochman (1947) gave a diagnosis based on material described herein. Notwithstanding the aberrant features, the similarity in the structure of the glabella, frontal area, and posterior limbs indicates relationship to *Periomma*.

PERIOMMELLA YORKENSIS Resser

Plate 1, figures 8, 9; plate 5, figures 1-8

Periomella yorkensis RESSER, Geol. Soc. Amer. Spec. Pap. 15, p. 93, pl. 3, figs. 35, 36, 1938.

Available material.—The type lot consists of the holotype and two paratypes, all poorly preserved as internal casts in weathered sandstone. Numerous excellent cranidia and a few free cheeks in limestone are extant.

Description.—Features included in the generic diagnosis are omitted. Glabella with a trace of four pairs of furrows visible on whitened specimens. Relative lengths (sag.) of preglabellar field and border about equal in average cranidia 6 mm. long. Marginal furrow straight, deeper at the sides, shallow medially on account of a median preglabellar boss that becomes more pronounced in larger individuals. Border very convex, slightly arched transversely, underfolded in front so that the frontal portion of the facial suture has a ventral course. Palpebral area flat and slightly upsloping, but not reaching the level of the glabella; ocular ridges directed outward and forward from the glabella, wide and poorly defined on the upper surface, turning backward in a regular curve and fading out along the margin of the sharp vertical drop of the palpebral area along its anterior edge. Palpebral area also turned down vertically at the sides, so that its lateral margin is concealed in dorsal view. Palpebral lobes hardly differentiated as the marginal portion of the downfolded palpebral area, invisible from

above, delimited only by the sharp turn of the facial suture at either end. Facial suture in front of palpebral lobe directed strongly inward; posterior branch starting from the palpebral lobe inward and backward, then backward and very slightly outward, finally turning backward and inward again before reaching the posterior margin. Posterior marginal furrow deep, terminating in a distal depression, not extending onto free cheeks. Free cheek narrow, with wide, convex border extending into a short, conical genal spine; marginal furrow weakly impressed only in median portion, setting off the small ocular platform rising vertically to the eye. The visual surface has not been observed, and if developed at all it was probably narrow and poorly differentiated.

Surface of test densely covered with very fine granules.

Cranidia ranging from 1.1 to 15 mm. in length supply interesting information on the changes taking place in development. The smallest cranidium (pl. 5, fig. 6) does not show the remarkable specialized features of the adult but is essentially similar to a meraspid cranidium of a generalized ptychopariid. The glabella is parallel-sided and reaches the anterior marginal furrow, the glabellar furrows are fairly well impressed at the sides, and the fixed cheeks lack the peculiar features described above. Cranidia 2 mm. long already show to a considerable degree the characters of the adult, except that the glabella is less tapered and the preglabellar field relatively shorter (sag.). The two last mentioned changes continue to occur even in presumably holaspid cranidia between the lengths of 6 and 15 mm. Note the strongly tapered glabella and great longitudinal extent of the preglabellar field in the largest cranidium (pl. 5, fig. 8).

Occurrence.—The types are from U.S.N.M. locality 48f: Kinzers formation, Smith's Lime Kiln, near York, Pa. The species is common in the boulders of the Ville Guay conglomerate at Ville Guay and the Island of Orleans, and occurs more rarely at Grosses Roches. The illustrated specimens are from boulders O-37, Island of Orleans, and G-24, Grosses Roches.

Types.—Holotype: U.S.N.M. No. 65002. Paratype: U.S.N.M. No. 65003. Plesiotypes: U.S.N.M. Nos. 123883-4.

Family SAOIDAE Hupé, 1953

Genus RIMOUSKIA Resser, 1938

Description.—Glabella relatively long, very prominent, slightly tapered, well rounded in front. Second to fourth pairs of glabellar furrows deep, straight, transverse, of equal length (tr.); occipital

furrow deeper laterally, occipital ring bearing a node or short spine. Frontal area on the average concave, indistinctly divided into preglabellar field and border. Palpebral area downsloping, narrower than glabella; ocular ridges strong; palpebral lobes one-third as long as the glabella, obliquely situated, at level of anterior third of glabella. Posterior limbs with wide furrow; posterior margin with sharp geniculation. Anterior facial sutures convergent; posterior branch directed outward and backward without much curvature. Test coarsely granulated.

Type species.—*Rimouskia typica* Resser.

Remarks.—*Rimouskia* differs from *Sao* in the less tapered, longer glabella, lack of a definite sagittal glabellar furrow, straight posterior branch of the facial suture, stronger and more distally located geniculation of the posterior cephalic border.

The genus is known exclusively from the Lower Cambrian of Quebec.

RIMOUSKIA TYPICA Resser

Plate 1, figure 10; plate 6, figures 1-6

Rimouskia typica RESSER, Geol. Soc. Amer. Spec. Pap. 15, p. 98, pl. 3, figs. 20-22, 1938.

Rimouskia spinosa RESSER, Geol. Soc. Amer. Spec. Pap. 15, p. 98, pl. 3, fig. 19, 1938.

Available material.—The holotype and a paratype, plus several additional topotype crania. Also the holotype of *Rimouskia spinosa*.

Description.—Glabella very strongly convex transversely, almost flat longitudinally excepting the anterior part which drops steeply to the preglabellar field. Glabellar furrows deeply impressed on the lateral thirds of the glabella, in some crania showing a tendency to connect between the various pairs through shallow longitudinal extensions of the furrows at their inner ends. Occipital furrow deep in the lateral thirds, shallow medially; occipital ring bearing a short spine, more developed in the smaller crania, directed upward. Sagittal length of frontal area 0.30 times the length of the glabella. Concave preglabellar field gradually changing into convex border. Lateral portions of preglabellar field steeply inclined in front of prominent, curved ocular ridges. Palpebral lobes oblique, one-third as long as the glabella, elevated, set off by distinct palpebral furrows; distance from posterior end of palpebral lobe to posterior margin almost twice the length of palpebral lobe. Posterior limbs 1.3 times as wide (tr.) as occipital ring, very broadly furrowed. Posterior border with sharp ge-

niculation at midwidth; distal portion turned downward and forward. Anterior facial sutures strongly convergent in front of eyes, widely rounding off anterior cranial outline; posterior branch straight, showing little change in direction from anterior branch in dorsal view. Surface of test covered with granules of various sizes. Length of largest (holotype) cranidium 8 mm.

Remarks.—Upon examination of the material in the U. S. National Museum, it appears that the cranidium which Resser singled out as the type of *Rimouskia spinosa* does not differ specifically from *R. typica*. The smaller cranidia seem to possess, on the average, a more pronounced and almost horizontal occipital spine, whereas in the larger cranidia the spine is relatively smaller and almost vertically directed. There is variability in this respect even among cranidia of the same size. The other presumed differential characters are even less valid.

Occurrence.—Known only from conglomerate boulders at Bic. Association with olenellid fragments is conclusive proof of the Early Cambrian age of the species.

Types.—Holotype and paratype: U.S.N.M. No. 64998. Holotype of *Rimouskia spinosa*: U.S.N.M. No. 94748.

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EXPLANATION OF PLATES

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Crania of nine genera of Lower Cambrian ptychopariid trilobites

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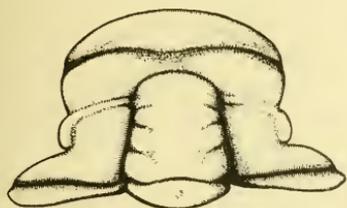
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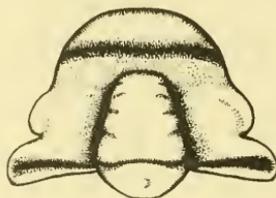
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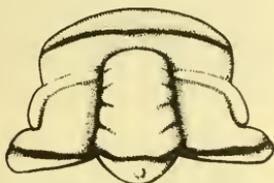
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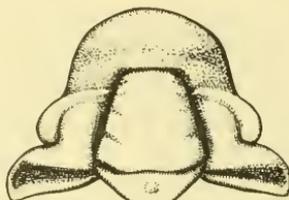
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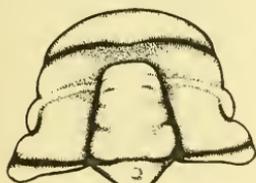
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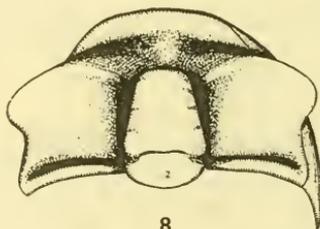
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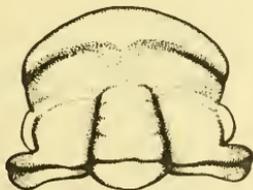
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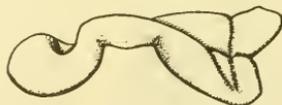
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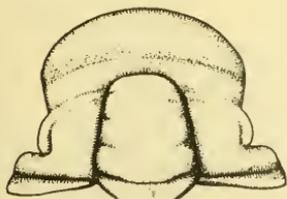
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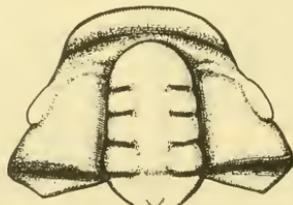
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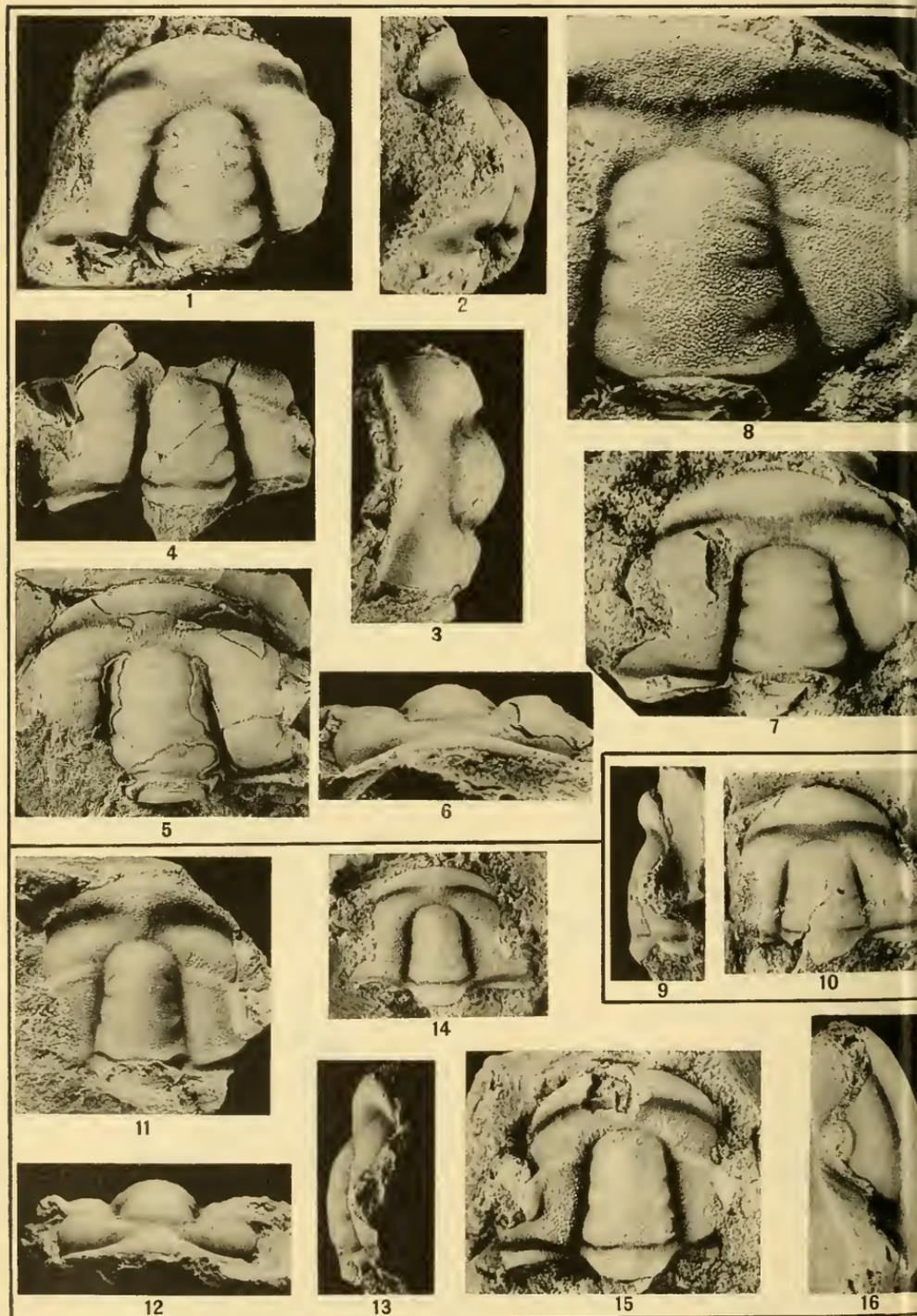
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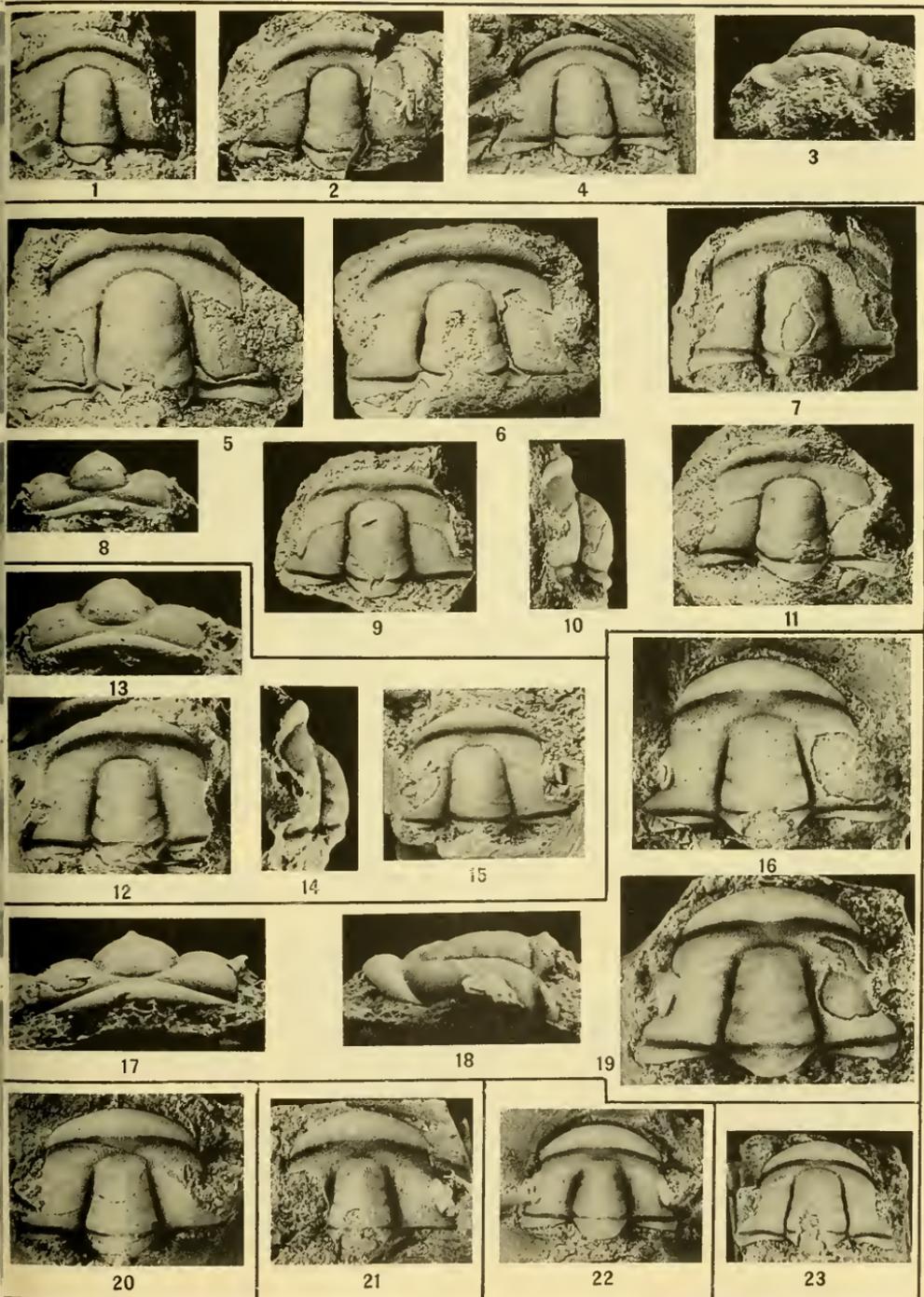
CRANIDIA OF NINE GENERA OF LOWER CAMBRIAN PTYCHOPARIID TRILOBITES

(SEE EXPLANATION OF PLATES AT END OF TEXT.)



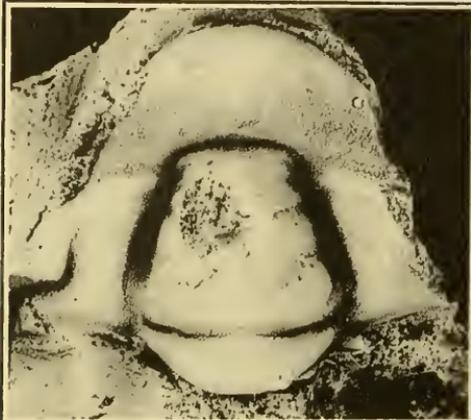
ANTAGMUS AND CRASSIFIMBRA

(SEE EXPLANATION OF PLATES AT END OF TEXT.)

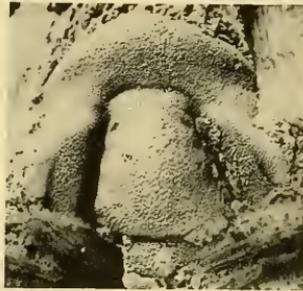


EOPYCHOPARIA, ONCHOCEPHALUS, AND CRASSIFIMBRA

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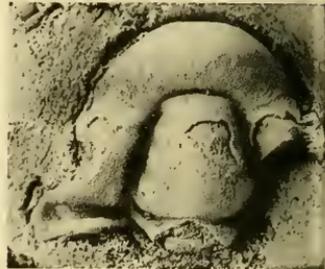
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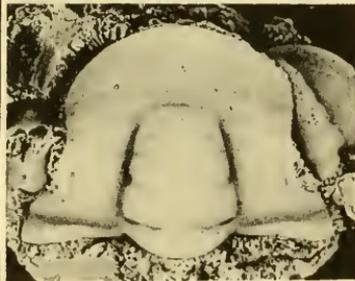
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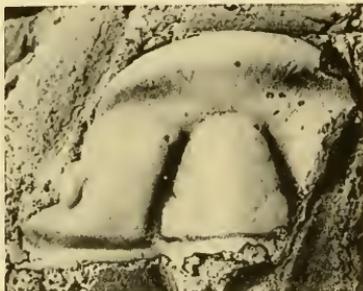
9



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12



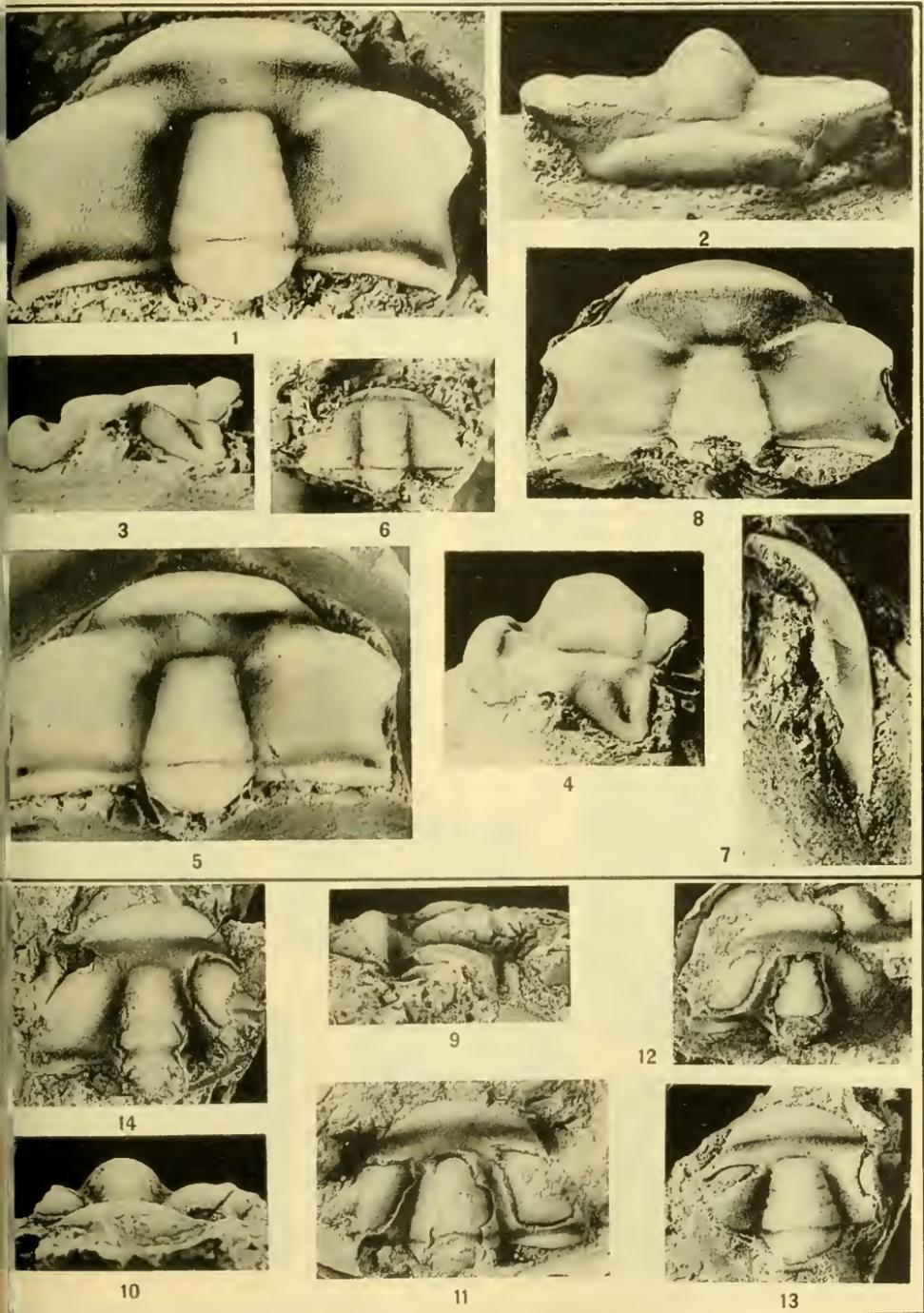
13



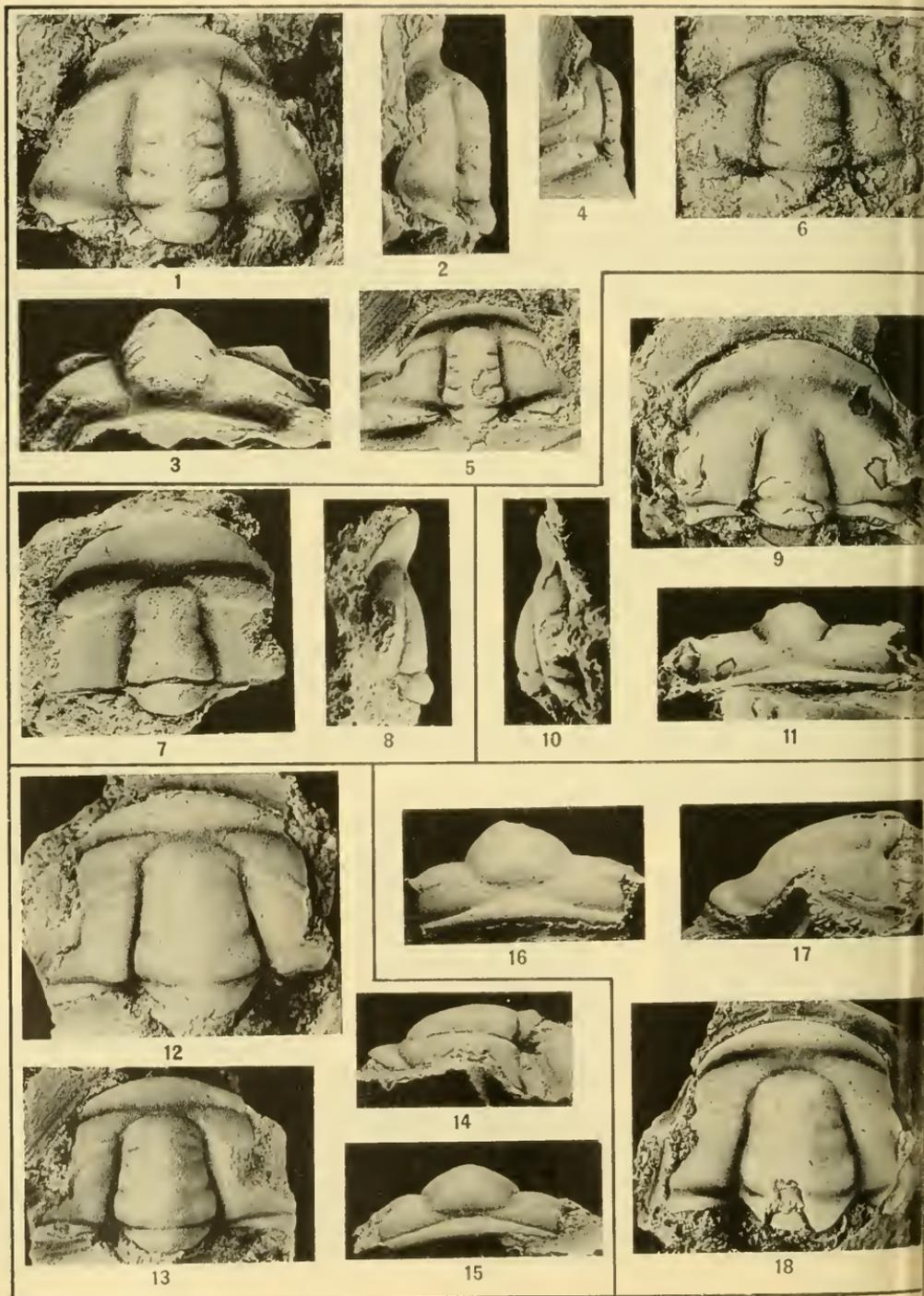
14



15



PERIOMMELLA AND PERIOMMA
(SEE EXPLANATION OF PLATES AT END OF TEXT.)



RIMOUSKIA, LUXELLA, AND ANTAGMUS (?)

(SEE EXPLANATION OF PLATES AT END OF TEXT.)