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CAMBRIAN GEOLOGY AND PALEONTOLOGY

III

No. 3.—CAMBRIAN TRILOBITES

(With Plates 24 to 38)

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Descriptions of genera and species—Continued.

PLATES

INTRODUCTION

The present paper is the second of this series on Cambrian Geology and Paleontology that bears the title "Cambrian Trilobites." The first, published in 1908,[1] includes descriptions and illustrations of a number of unusual Middle Cambrian genera and species. Several subsequent papers have dealt with trilobites of a particular family or genus or from a stratigraphic view.

These include:

"*Olenellus* and other Genera of the Mesonacidæ." [Smithsonian Misc. Coll., Vol. 53, No. 6, 1910.]

"Cambrian Faunas of China." [*Idem*, Vol. 57, No. 4, 1911.]

"Middle Cambrian Branchiopoda, Malacostraca, Trilobita, and Merostomata." [*Idem*, Vol. 57, No. 6, 1912.]

"Cambro-Ordovician Boundary in British Columbia with Description of Fossils." [*Idem*, Vol. 57, No. 7, 1912.]

"The Sardinian Cambrian Genus *Olenopsis* in America." [*Idem*, Vol. 57, No. 8, 1912.]

"New York Potsdam-Hoyt Fauna." [*Idem*, Vol. 57, No. 9, 1912.]

"New Lower Cambrian Subfauna." [*Idem*, Vol. 57, No. 11, 1913.]

"*Dikelocephalus* and other Genera of the Dikelocephalinæ." [*Idem*, Vol. 57, No. 13, 1914.]

"Cambrian Faunas of Eastern Asia." [*Idem*, Vol. 64, No. 1, 1914.]

[1] "Cambrian Trilobites," Smithsonian Misc. Coll., Vol. 53, No. 2, pp. 13-52, pls. 1-6.

The memoir on the Cambrian Faunas of China[1] also contains many descriptions and illustrations of trilobites.

One of the marked features of the present paper is the description of several genera of the order Proparia: *Menomonia, Millardia, Dresbachia,* and *Norwoodia.* These taken in connection with the genus *Burlingia,*[2] of the Middle Cambrian, establish the existence of a strong group of the order in Cambrian time.

CHANGE IN STRATIGRAPHIC POSITION OF THE WEEKS FORMATION[3]

On account of the presence of *Crepicephalus texanus* Shumard in the Weeks formation, the strata forming it were referred to the Middle Cambrian. My recent studies of *C. texanus* and its stratigraphic and geographic range have led me to the conclusion that it is an Upper Cambrian species and that the formations containing it should be referred to the Upper Cambrian. This question will be considered in detail in a subsequent paper on the Upper Cambrian formations.

DESCRIPTIONS OF GENERA AND SPECIES

Order PROPARIA Beecher

Family MENOMONIDÆ, new family

Proparia of primitive aspect, with large free cheeks; eyes small. Thorax with 23 to 42 segments; pygidium small.

The genera referred to this family are *Menomonia, Millardia,* and *Dresbachia.*

MENOMONIA, new genus

General form elongate, lance-shaped, with cephalon at the broad end; strongly convex; axial and pleural lobes strongly outlined.

Cephalon transversely semicircular with rounded genal angles on the postero-lateral limbs; marginal border broad and convex on the cranidium, flattening out on the free cheeks; posterior margin strongly defined by a deep furrow that merges into the intramarginal furrow of the free cheek. Glabella truncato-conical, about one-half the length of the cranidium, and marked by three pairs of short lateral furrows; occipital ring of medium width and well defined by

[1] Research in China, Carnegie Inst. of Washington, 1913, Vol. 3, Pub. No. 54, pp. 1-276, pls. 1-24.

[2] Cambrian Trilobites, Smithsonian Misc. Coll., Vol. 53, No. 2, 1908, p. 14

[3] Nomenclature of some Cambrian Cordilleran Formations, Smithsonian Misc. Coll., Vol. 53, No. 1, 1908, p. 10.

a strong occipital furrow; frontal limb of medium width, and arching up into a broad convex frontal border. Fixed cheeks narrow and separated from the glabella by a strong, narrow furrow from which they slope upward to the small palpebral lobes, which are situated opposite the anterior end of the glabella; postero-lateral limbs large, rounded at the genal angles. Free cheek elongate, broad at anterior end, where it joins the frontal limb and border. Eye lobe small and prominent at the inner anterior angle of the cheek.

The facial suture cuts the outer postero-lateral side of the cephalon in advance of the genal angle, and passes almost directly inward to the base of the eye; arching over the eye, it passes with a slight outward curve forward to the front margin.

Thorax with 42 segments; axial lobe convex with each segment strongly rounded; pleural lobes convex with each segment carrying a strong flat furrow from the inner end nearly to the outer termination of the segment.

Pygidium very small; axial lobe well defined and broken into two or three rings and a terminal section by transverse furrows; pleural lobes smooth in cast of test, but probably marked by faint, short, backward-curving furrows.

Surface unknown except that the casts in a fine sandstone are smooth.

Dimensions.—The largest cranidium indicates that some dorsal shields had a length of at least 45 mm.

Genotype.—*Conocephalites calymenoides* Whitfield.

Stratigraphic range.—Upper Cambrian: Eau Claire formation.

Geographic distribution.—Upper Mississippi Valley in central western Wisconsin and eastern Minnesota.

Observations.—This very remarkable trilobite resembles the genus *Calymene* in the form of the cranidium and free cheeks, while the thoracic segments have the straight, strong pleural furrow of *Ptychoparia.* The great number (42) of segments is a very primitive character and gives the thorax an annelidian aspect.

MENOMONIA CALYMENOIDES (Whitfield)

Plate 26, figs. 4, 4*a-d*

Conocephalites calymenoides Whitfield, 1878, Ann. Rept. Geol. Survey Wisconsin for 1877, p. 52. (Original description.)

Conocephalites calymenoides Whitfield, 1882, Geol. Wisconsin, Vol. 4, p. 179, pl. 3, figs. 2-5. (Describes and illustrates species.)

Conocephalites calymenoides Whitfield, Chamberlin, 1883, Geol. Wisconsin, Vol. 1, p. 131, fig. 17*d*. (Reproduces fig. 2 of Whitfield in Vol. 4.)

Whitfield's description of the cranidium and thorax as far as he knew it is very full and does not need to be repeated in detail. The cranidia are abundant in the Eau Claire sandstone at Rock Falls, Wisconsin, and the associated free cheeks which appear to belong to them. One of these, illustrated by figure 4*d*, plate 26, has a small eye, and a strong marginal rim that curves backward to join the border of the postero-lateral limb in advance of the genal angle; this is rounded as seen on the right side of figure 4, plate 26.

Whitfield described an incomplete thorax having 22 segments. The specimen illustrated by figures 4*b* and 4*c* has 42 thoracic segments, the dorsal shield narrowing very gradually from the cephalon to the pygidium.

Pygidium minute; axial lobes short and divided into two or three rings and a terminal section by shallow transverse furrows; pleural lobes smooth as far as may be determined from the cast in a fine sandstone matrix.

Exterior surface unknown except that the casts in fine sandstone are nearly smooth.

A specimen of the thorax and pygidium is 25 mm. in length. A cephalon of the width to correspond to the anterior segments of the thorax has a length of 7 mm. The largest cranidium in the collection has a length of 10 mm.

Observations.—The general characters of the species are included in the description of the genus.

Formation and locality.—Upper Cambrian: (78a and 98) Eau Claire formation; near Eau Claire, Eau Claire County; (83a) Rock Falls, and (100) Menomonie, Dunn County; also from (83^4) Dresbach formation; lower beds just above the river, Trempealeau, Trempealeau County, both in Wisconsin. Also from (84) Eau Claire formation; Dresbach, Winona County, Minnesota.

MILLARDIA, new genus

General form elongate elliptical; convex; axial and pleural lobes strongly defined.

Cephalon transversely broadly elliptical with genal angles rounded; margined with a rounded distinct border and intramarginal furrow; glabella subtriangular in outline, convex, and marked by three pairs of short lateral furrows; occipital ring and furrow strongly defined; frontal limb short, slightly convex, and depressed between the glabella and the strong rounded frontal border; frontal border arched upward between the points cut by the facial sutures; fixed cheeks

narrow and elevated at the palpebral lobe; postero-lateral limbs long and retaining nearly the same width from the glabella to their outer side, which is rounded at the genal angle; palpebral lobes small, elevated, and situated opposite the anterior end of the glabella.

Free cheeks large, elongate, convex, with the eye lobe at the inner anterior angle.

The facial sutures cut the postero-lateral margin in advance of the genal angle and pass obliquely inward to the base of the small eye lobes, over which they curve before passing forward to the anterior margin.

Thorax with 23 segments; axial lobe convex, with each segment rounded and prominent; pleural lobes flat for a short distance from the dorsal furrow, and then arched downward; pleural furrows short and narrow; segments rounded at the end of their broad faceted surface.

Pygidium small, transverse; axial lobe short and divided into two or three rings by transverse furrows that are continued across the pleural lobes to their outer margin.

Surface marked with very fine granulations and a few large granules that are prominent on the glabella, frontal border, and segments of the thorax.

Dimensions.—The largest dorsal shield has a length of 9 mm. and a width of 6 mm. at the base of the cephalon.

Genotype.—*Millardia semele* Walcott.

The generic name is from Millard County, Utah.

Stratigraphic range.—*Millardia semele* occurs in the Weeks formation of the Upper Cambrian of Utah, *M. optata* in the lower part of the Upper Cambrian in the Eau Claire formation of Wisconsin, and *M. avitas* in the Upper Cambrian of Pennsylvania.

Geographic distribution.—*Millardia semele* is from Millard County, western Utah; *M. optata* is found in western Wisconsin, near Hudson, St. Croix County, and *M. avitas* is from Pennsylvania.

Observations.—The cranidium of *Millardia* is much like that of *Dresbachia* and *Menomonia* (pl. 26). It differs from both mainly in the character of the frontal limb and border, and also from *Menomonia* in having about one-half as many thoracic segments. All three genera have the facial sutures cutting the border of the cephalon in advance of the genal angle, and all agree in the eyes being situated opposite the anterior end of the glabella.

MILLARDIA AVITAS, new species

Plate 28, figs. 5, 5*a-c*

This species is represented by two very distinct cranidia. These differ in so many respects from the other species of the genus that detailed description and comparisons do not appear to be necessary. The most nearly related form is *M. optata* (see pl. 28, figs. 4, 4*a-b*) from the Upper Cambrian of Wisconsin. With a strong lens the surface is seen to be roughened by minute granules of varying size.

This species is of special interest, as it serves as a link between the Upper Cambrian fauna of the Appalachian trough in Pennsylvania and that of the Eau Claire subfauna of the Upper Cambrian of the upper Mississippian province.

Formation and locality.—Upper Cambrian: (107k) Buffalo Run[1] limestone, 2 miles (3.2 km.) north of Benore Post Office, Center County, Pennsylvania.

MILLARDIA OPTATA (Hall)

Plate 28, figs. 4, 4*a-f*

Conocephalites optatus HALL, 1863, Sixteenth Ann. Rept., New York State Cab. Nat. Hist., p. 222, pl. 5A, fig. 7. (Describes and illustrates species.)

The type specimen of this species consists of the central portion of a cranidium showing the glabella, occipital ring, frontal limb and margin, and a narrow fragment of the fixed cheeks.

Entire specimens of the cephalon show it to have been semicircular in outline, strongly convex, and with rounded genal angles. The glabella and other parts are essentially similar to those of the cranidium of *M. semele*. The differences between the two species are: the more transversely elongate outline of the cranidium of *M. semele;* the nearer approach of the posterior end of the facial suture to the genal angle in *M. optata*.

Casts of the outer surface of the test of *M. optata* indicate that it had a granular surface.

Formation and locality.—Upper Cambrian: (79c) Eau Claire formation; sandstones at Willow River Falls, a few miles from Hudson, St. Croix County; and (100a) Ettrick, Trempealeau County, both in Wisconsin. Also from (84) Eau Claire formation; Dresbach, opposite the mouth of Black River, Winona County, Minnesota.

The specimen described by James Hall is stated to have come from the "lower beds near Trempealeau," Wisconsin.

[1] A provisional name suggested by Mr. E. F. Moore.

The specimens illustrating this species were collected by Mr. W. A. Finkelnburg, of Winona, Minnesota, who presented them to the United States National Museum.

MILLARDIA SEMELE, new species

Plate 28, figs. 3, 3*a-c*

The generic description is based on this species as the type. It is represented in the collections by two nearly entire specimens of the dorsal shield and a number of cranidia, which are closely related in form to those of *M. optata*.

Formation and locality.—Upper Cambrian: (30n) Weeks formation (1*c* of section);[1] also (30 o) (1*b* of section) north side of Weeks Canyon, 4 miles (6.4 km.) south of Marjum Pass, House Range, Millard County, Utah.

DRESBACHIA, new genus

General form of cephalon transversely crescentric; the posterior margin arching forward from the lateral margins, strongly convex. Glabella subtriangular in outline and marked by three pairs of oblique, short, deep lateral furrows; occipital ring strong and sharply defined by a narrow, deep occipital furrow. The frontal limb and border appear to be represented by a narrow projection in front of the glabella that has a deep longitudinal furrow which terminates at a narrow frontal rim. The sides of the furrow appear as though the test had been folded downward, leaving only a narrow strip at the top next to the facial suture.

On a small cranidium 1 mm. in length the frontal border projects very much as in *Proampyx acuminatum* (Angelin), but, unlike the nasute projection of the latter species, it has a longitudinal furrow that extends forward from in front of the glabella, which is the beginning of the deep furrow present on cranidia 3 to 5 mm. in length.

Fixed cheeks large, elongate, and arched backward; a strong intramarginal furrow extends from the dorsal furrow beside the glabella out on the cheek, where it fades away before reaching the outer margin. The palpebral lobe has not been seen; it is probably situated by the side of the narrow projection in front of the glabella or else is very small and located toward the anterior end of the fixed cheek. As the test is not preserved, there is only the cast in fine sandstone to show details of structure.

[1] Smithsonian Misc. Coll., Vol. 53, 1908, p. 178.

Free cheeks large and shaped much like those of *Menomonia* (pl. 26, fig. 4*d*), except that they curve inward anteriorly so as to form a narrow, slightly elevated portion that fitted against the side of the projection in front of the glabella; as far as can be determined, the eye was at the interior anterior end of the free cheek; posteriorly the free cheek curves in against the fixed cheek in advance of the genal angle.

Dimensions.—A cranidium 7 mm. in length, including the narrow frontal limb, has a width of about 16 mm.

Genotype.—Dresbachia amata Walcott.

Stratigraphic range.—As far as known, the genus is found only in the sandstones of the Eau Claire and Franconia formations.

Geographic distribution.—Upper Mississippi Valley; central and western Wisconsin, and eastern Minnesota.

Observations.—Of this genus we have only the cranidium and free cheeks of one species. These indicate a type allied to *Menomonia calymenoides*, although the cranidia differ greatly in the form of the frontal limb and border and the free cheeks. The same is true of *Millardia* (pl. 28, figs. 3, 3*a*, 4, 4*a-b*) in respect to the frontal limb and border. The distinction between *Dresbachia* and *Millardia* is in the character of the frontal limb and border. *Dresbachia* is unique in the conformation of the narrow, deeply furrowed frontal limb.

DRESBACHIA AMATA, new species

Plate 26, figs. 5, 5*a-c*

The description given of the genus *Dresbachia* includes what is known of the species. It has hitherto been confused with *Millardia optata* (Hall) (pl. 28, figs. 4, 4*a-f*), as the cranidia have similar fixed cheeks and glabella, but differ very much in the form of the frontal limb and border.

The fragmentary remains of the cephalon are quite abundant at a number of localities, but thus far I have not learned of an entire dorsal shield having been found.

Formation and locality.—Upper Cambrian: (78a and 98x) Eau Claire formation; Eau Claire, Eau Claire County; (79) near Hudson, St. Croix County; (79x) Beaver Creek, north of Galesville, Trempealeau County; (100) near Menomonie, Dunn County; and (100a) at Ettrick, Trempealeau County; all in Wisconsin.

Also from (84) Eau Claire formation; Dresbach, Winona County; (84a) Franconia formation; River Junction, Houston County, Minnesota.

NORWOODIDÆ, new family

Proparia with 8 or 9 segments; strongly developed spines at genal angles; eyes small, but well developed.

This family combines primitive characters with those of a more highly developed type. The cranidium with its *Ptychoparia*-like glabella and small eyes, and the broad pleural furrows, are primitive (Calymenidæ-like), while the few segments of the thorax (9) and the relatively large pygidium suggest the subfamily Phacopinæ.

NORWOODIA, new genus

General form a broad ellipse, moderately convex, with pleural lobes more or less flattened. Cephalon semicircular with the genal angles prolonged as strong spines; cranidium elongate with narrow fixed cheeks and medium-sized palpebral lobes; glabella conical and marked with three pairs of short lateral furrows; frontal limb distinct or merging into the frontal border; postero-lateral limbs large, transverse, and carrying a strong spine at the genal angle; free cheeks large, roughly subtriangular, and with the eye lobe at the inner posterior angle.

Thorax with eight or nine transverse segments; axial lobe strong, convex; pleural lobes with each segment having a broad, strong median furrow that terminates just within the more or less bluntly falcate pointed extremity. A sharp, slender median spine similar to the occipital spine of the cephalon occurs on the third, fifth, and seventh segments of the thorax of *N. tenera,* as shown by figure *2d,* plate 28, which has the spine of the seventh segment attached to the axial lobe; the point of attachment is also shown on the axial lobe of figure *2b;* similar thoracic spines occur on *N. gracilis* (fig. *2f,* pl. *27*) and *N. simplex* (fig. *3b*).

Pygidium transverse; axial lobe strong and divided by narrow transverse furrows into two or three rings and a terminal section; pleural lobes broad and marked by backward-curving narrow furrows.

Surface minutely granular with larger scattered granules on *Norwoodia tenera,* which is the only species preserving the test in good condition.

Dimensions.—All the species of the genus are small. A dorsal shield of *Norwoodia gracilis* has a length of 11 mm. One of *N. saffordi,* 8 mm., and the largest cranidium of *N. tenera* has a length of 3.5 mm.

Genotype.—*Norwoodia gracilis* Walcott (pl. *27,* figs. *2, 2a-b*).

Stratigraphic range.—Norwoodia saffordi: Upper Cambrian; Nolichucky shale.

Norwoodia gracilis, N. simplex, and *N. ponderosa:* Upper Cambrian; Conasauga shale.

Norwoodia tenera: Upper Cambrian; Weeks formation.

The above indicates that as far as known the genus had quite a prolonged existence in Upper Cambrian time.

Geographic distribution.—Eastern Tennessee, northeastern Alabama, and the House Range of western Utah.

Observations.—As known to me now, this genus is an unusual form that has hitherto escaped observation. It probably originated in the Atlantic or the Appalachian Sea, where it attained its greatest development; one species, *N. tenera,* is a somewhat modified species from the Cordilleran area of western Utah.

The species from Alabama were collected for me in the Coosa Valley by Dr. Cooper Curtice in 1885. The stratigraphy of the Conasauga formation is so difficult to work out, owing to faulting and flexing of the shales and interbedded limestones, that the exact stratigraphic position and vertical range of each species are unknown, but I think that the genus is of Upper Cambrian age and mostly of the horizon of the upper Conasauga formation in Georgia and Alabama, and the Nolichucky shale in Tennessee.

NORWOODIA GRACILIS, new species

Plate 27, figs. 2, 2*a-g*

General form of dorsal shield a broad ellipse with large genal spines extending backward and outward nearly as far back as the pygidium.

Cephalon convex, roughly semicircular; marginal border strong, moderately convex, and continued into the strong genal spines; posterior border narrow, and separated from the fixed cheeks by a strong furrow that merges on each side near the genal angle into the strong intramarginal furrow of the cephalon. Glabella small, rounded conical, and marked by three pairs of short glabellar furrows on each side; a shallow occipital furrow defines a median occipital ring that has a long, slender spine extending back from the posterior center of the ring; frontal limb large and gently convex to the intramarginal furrow; intramarginal furrow usually clearly defined; frontal border flattened or slightly convex; postero-lateral limbs large and bearing a strong, slender, slightly curving spine at the genal angle.

Facial sutures as shown by figures *2, 2a, 2b,* plate *27.*

Thorax with 9 segments; axial lobe convex, with a shallow transverse furrow on each side that serves to define a small tubercle next to the dorsal furrow; pleural lobes wide; a strong, straight furrow extends from the inner end of each segment nearly to the rounded end, which terminates in a falcate point sloping obliquely backward. A slender, long median spine (fig. *2f*) occurs on some of the axial lobes as in *N. tenera* (pl. 28, figs. *2d-e*).

Pygidium transverse; axial lobe divided into three rings and a terminal section by shallow transverse furrows; pleural lobes large and marked by four gently backward-curving furrows; border narrow.

The outer surface of the test appears to have been minutely granulated, but as all the specimens are preserved in a fine argillaceous shale, the outer surface is so injured by compression when the test was in a plastic condition that most of the irregularities, if such existed, have become obscured.

Dimensions.—One entire dorsal shield has a length of 11 mm. Some cranidia indicate that others may have had a length of 13 to 15 mm.

Observations.—Fragments of this species are abundant in the shale, but entire dorsal shields are rare. Figure *2,* plate *27,* has been restored in part from several specimens, of which only one injured example shows the entire cephalon, thorax, and pygidium.

The cranidium of *N. gracilis* differs in so many details from the other species that a comparison of the figures on plate 27 will enable the student to readily distinguish them.

Formation and locality.—Upper Cambrian: (**90a, 91**) Conasauga shale; Cedar Bluff, (**92x, 145**) Yancey's Bend and east of Turkeytown, all three on Coosa River; and (**92xx**) from brook on road from Lydia Angles to Blaine, Center Township, all in Cherokee County, Alabama.

Upper Cambrian: (**124**) Nolichucky shales overlying limestone which rests on the Rogersville shale, on Big Creek, southeast of Harlans Knob, 4 miles (6.4 km.) northeast of Rogersville, Hawkins County; and (**106a**) east of Shooks Ridge, in Bays Mountains, 10 miles (16.1 km.) southeast of Knoxville, Knox County, both in Tennessee.

Also Conasauga formation; (**96c**) shales 4 miles (6.4 km.) northwest of Rome, Floyd County, Georgia; and (**358e**) Birmingham City, Jefferson County, Alabama.

NORWOODIA PONDEROSA, new species

Plate 28, figs. 1, 1*a-b*

This species is represented by a number of cranidia and associated pygidia. It differs from both *N. simplex* and *N. saffordi* (pl. 27) by its much larger genal spines and the narrow, strong frontal limb that appears to be without a defined frontal border. There are slight traces of two pairs of glabellar furrows and a faint defined occipital ring which has a short median spine with a strong base. Outer surface unknown.

Formation and locality.—Upper Cambrian: (90a) Conasauga shales; Cedar Bluff, Cherokee County, Alabama.

NORWOODIA SAFFORDI, new species

Plate 27, figs. 1, 1*a-f*

This species differs from *Norwoodia gracilis* in the form of the frontal limb and border, fixed cheeks, and genal spines, and in having eight instead of nine thoracic segments.

The outer surface of the test appears to have been rather strongly granulated, as shown in the matrix of the species illustrated by figure 1*d*, plate 27.

Formation and locality.—Upper Cambrian: (103, 103a) Nolichucky shale. Second shale south of the ridge of sandstone "Town Knobs" on the road from Rogersville to Dodson Ford, Hawkins County; and (107a, 107b) shales in railroad cut in Bull Run Ridge, northeast of Copper Ridge, 11 miles (17.6 km.) northwest of Knoxville, Knox County, both in Tennessee.

NORWOODIA SIMPLEX, new species

Plate 27, figs. 3, 3*a-b*

This species differs in its cranidium, genal spines, and number of thoracic segments from *N. gracilis;* it has also a rounded appearance not seen in other species. The number of thoracic segments is eight, which is the same as in *N. saffordi.* The pygidium is nearly smooth, the furrows on the axial and pleural lobes being little more than incised lines.

Surface apparently finely granulated.

One entire dorsal shield has a length of 10 mm.

Formation and locality.—Upper Cambrian: (90a, 91) Conasauga shale; Cedar Bluff; also (145) bluffs of Coosa River, east of

Turkeytown, both in Cherokee County; and (138) shale in street northeast of Printuf House, Gadsden, Etowah County, all in Alabama.

Upper Cambrian: (124, 124a) Nolichucky shales overlying the limestone that is above the Rogersville shales, on Big Creek, southeast of Harlans Knob, 4 miles (6.4 km.) northeast of Rogersville, Hawkins County; also (117) Nolichucky shale; on the road north from Greeneville; and (117c) Buckingham Ford, Hollis Creek, 5 miles (8 km.) southeast of Greeneville, Greene County, all in state of Tennessee.

Also (138d) Conasauga shale; 3 miles (4.8 km.) west of Rome, Floyd County, Georgia.

NORWOODIA TENERA, new species

Plate 28, figs. 2, 2a-g

In general form the dorsal shield of this species resembles that of *N. simplex* (pl. 27, figs. 3, 3a), but in details it is quite distinct. It has eight thoracic segments, the pleural lobes of which have a very narrow pleural furrow and slightly falcate ends; a slender median spine occurs on the third, fifth and seventh segments of the axial lobe, as shown by figure 2e, plate 28.

Surface minutely granular with a few larger scattered granules on the cephalon, thoracic segments, and pygidium.

The largest entire specimen has a length of 3.5 mm.

Cranidium	1.5 mm.
Thorax	1.5 mm.
Pygidium	0.5 mm.

The largest cranidium in the collection has a length of 4 mm., which on the basis of the entire dorsal shield mentioned would give a total length of about 9.5 mm.

This small, neat species is abundant on two or three thin layers of shaly limestone of the Weeks formation.

Formation and locality.—Upper Cambrian: (30n) Weeks formation (1c of section),[1] also (30 o) (1b of section); north side of Weeks Canyon, 4 miles (6.4 km.) south of Marjum Pass, House Range, Millard County, Utah.

[1] Smithsonian Misc. Coll., Vol. 53, 1908, p. 178.

Order OPISTHOPARIA Beecher

Genus AGRAULOS Corda

AGRAULOS STATOR, new species

Plate 36, fig. 6

Dorsal shield elongate, suboval in outline, moderately convex, and with a narrow, strongly defined axial lobe. Cephalon transversely semicircular, marginal rim narrow, genal angles rounded. The facial sutures cut the rounded genal angle and extend inward with a sigmoid curve to the base of the small eye lobes; in front of the eye lobes they curve outward a very little and then inward so as to cut the anterior rim of the cephalon on a line with the base of the eyes. Glabella truncato-conical, a little more than one-half the length of the cephalon, and marked by three pairs of shallow furrows separated by a narrow, faint median ridge; occipital furrow and ring narrow and clearly defined; fixed cheeks broad and merging anteriorly into the broad and long, moderately convex and rounded frontal limb; posteriorly the fixed cheeks merge into their postero-lateral limbs, which extend outward from the base of the palpebral lobe to the genal angles; a rather strong furrow outlines a narrow posterior border which merges into the outer rim of the cephalon at the genal angles; palpebral lobes small, situated nearly opposite the anterior end of the glabella and with a narrow palpebral ridge extending inward across the broad free cheek to the strong dorsal furrow about the glabella; free cheeks of medium size and separated from the fixed cheeks only by a small, short eye.

Thorax with 22 nearly transverse segments; axial lobe narrower than the pleural lobes, and with a well-defined node near the dorsal furrow on each side; pleural lobes with a strong, narrow furrow extending from near the dorsal furrow along the central part of the segment nearly to its rounded end; the anterior half of each segment has a smooth faceted surface which greatly facilitated the rolling up of the animal.

Pygidium small and marked only by one or two rings on the large axial lobe. Surface apparently minutely punctate.

Dimensions.—The relative size of the various parts of the dorsal shield is shown by the figures. The largest specimen has a length of 13 mm. for the cranidium and a total length of 38 mm.

Observations.—Comparing this species with the genotype, *Agraulos ceticephalus* Barrande, we find that it is similar in general form and in having a nearly smooth glabella, a large number of thoracic segments, and very small pygidium.

The species is unusually well represented. The first and best specimens were discovered by Mrs. Helena B. Walcott in 1907 at the south base of Mount Bosworth.

Formation and locality.—Lower Cambrian: Mount Whyte formation: (35c) drift blocks of siliceous shale supposed to have come from the Mount Whyte formation, found on the south slope of Mount Bosworth, about 500 feet (152 m.) northwest of the Canadian Pacific Railway track between Stephen and Hector, eastern British Columbia; and (35m) (*Albertella* zone) 3 miles (4.8 km.) southwest of the head of Lake Louise, on east slope of Mount Whyte, Alberta.

Genus ACROCEPHALITES Wallerius

Acrocephalites Wallerius, 1895, Unders. Zonen med *Agnostus lævigatus* i Vestergötland, Lund, Sweden, pp. 52-53.

The following is the Swedish diagnosis of the genus:

Head agrees in form with *Conocoryphe*. Shell finely and regularly granulated. The glabella is slightly conical, bounded on all sides by deep furrows, provided with side furrows. In front of it is found a knob-shaped elevation. The anterior margin is broad with a deep intramarginal furrow. The fixed cheeks are broad. The palpebral lobes are of medium size, situated about in the middle of the cheeks. The facial sutures diverge considerably from the anterior margin to the palpebral lobes, from the latter onward they also continue outward, though somewhat less divergent, to the posterior edge. The movable cheeks are somewhat triangular, provided with spines at the angles. The other parts of the body are unknown.

As previously pointed out, *Acrocephalites* occupies about the same position to *Solenopleura, Conocephalites* (*Ptychoparia*), etc., as *Ctenocephalus* to *Conocoryphe*. Thus in *Acrocephalites,* too, it is the tubercle in front of the forehead that is the most striking characteristic. But furthermore, other characters are found here, which justify the establishment of the new genus. As only one species is at hand, it is impossible to determine definitely what characteristics are to be regarded as generic and what as specific; hence the dividing line between these becomes more or less arbitrary, and the two must accordingly complement each other.

Genotype.—Solenopleura ? stenometopa Angelin, 1851, Pal Scand., p. 28, pl. 19, fig. 4.

To the preceding description of the cephalon we may now add the following:

The boss or swelling in front of the glabella is confined to the area of the frontal limb and does not extend into the frontal border. The boss may vary greatly in the same species, as is shown by *A. haynesi* (pl. 24, figs. 4, 4*a*). The fixed cheeks may be narrow as in

A. stenometopus (pl. 24, fig. 1), or broad as in *A. americanus* (pl. 24, fig. 2). *Acrocephalites haynesi* (pl. 24, fig. 4) has a strong occipital spine.

Thorax with 17 to 25 segments of the type of those occurring in *Ptychoparia striata* (Emmrich), narrow, and with an almost straight pleural furrow that begins to narrow at the genal angle of the segment.

Pygidium small and with three or four narrow transverse rings that extend out on the pleural lobes as rather faint lines.

The surface of all known species of the genus is more or less strongly tuberculated.

Stratigraphic range.—The type species occurs in the *Agnostus lævigatus* zone of the Middle Cambrian. The American species occur as follows:

Acrocephalites vulcanus, Lower Cambrian.
Acrocephalites americanus, Middle Cambrian.
Acrocephalites aoris, Middle Cambrian.
Acrocephalites insignis, Middle Cambrian.
Acrocephalites ? majus, Middle Cambrian.
Acrocephalites multisegmentus, Middle Cambrian.
Acrocephalites tutus, Middle Cambrian.
Acrocephalites aster, Upper Cambrian.
Acrocephalites haynesi, Upper Cambrian.
Acrocephalites ? glomeratus, Upper Cambrian.

Geographic distribution.—Sweden, eastern United States in the states of Georgia, Alabama, and Vermont; western United States or Cordilleran area; in the Grand Canyon, Arizona; in Utah, and Montana.

Observations.—Wallerius illustrates with rather indifferent figures the cranidium and a free cheek of *A. stenometopus.* Through the kindness of Dr. Joh. Chr. Moberg I have had the opportunity of having an enlarged photograph made of the type specimen now in the collection of the University of Lund (pl. 24, fig. 1). The cranidium of *A. aster* (pl. 26, figs. 9, 9*a-c*) is closely related to that of *A. stenometopus,* but the nearest complete American species is *A. americanus* (pl. 24, figs. 2 and 3), which is fortunately represented by nearly entire specimens. The thorax has 27 segments and a small pygidium. The free cheek has a postero-lateral spine, in this respect being similar to the free cheek of *A. stenometopus* as illustrated by Wallerius. The thorax of *A. multisegmentus* has 25 or more segments (pl. 24, fig. 5*a*).

Acrocephalites ? majus (pl. 26, fig. 1) is doubtfully referred to *Acrocephalites*. It is slightly distorted, but there appears to have been a boss in front of the glabella that was crossed transversely by the narrow ridge that serves to separate the frontal limb and rim.

Comparison of genera.—*Acrocephalites* differs from *Alokistocare* (pl. 25) in having the boss in front of the glabella limited to the frontal limb, and in having a more or less tuberculated outer surface of the dorsal shield. The outer surface of *Alokistocare* is more or less punctate in the type species, *A. subcoronatum* (pl. 25, fig. 2). The typical species of each genus are readily distinguished, but there are such species as *Alokistocare labrosum* (pl. 25, figs. 5, 5*a*), which have the *Acrocephalites* form of cranidium with the punctate test surface of *Alokistocare*.

Comparing the cranidium of *Acrocephalites* with that of *Ctenocephalus exsulans* Linnarsson, we find that both have a tuberculated outer surface, rounded boss before the glabella within the frontal limb and similar form of glabella. The absence of free cheeks and eyes on the dorsal surface of *Ctenocephalus* is the essential difference between the two genera. In *Ctenocephalus* the advance of the facial suture and eye from the ventral to the dorsal surface appears to have been retarded during the entire development and growth of the cephalon.

Some of the forms referred to *Inouyia*[1] have a rounded boss on the frontal limb, but they differ so much in the appearance of the cranidium as a whole that, with the possible exception of *Inouyia titiana* (Walcott), there is little risk of confusing them with species of *Acrocephalites*.

Comparison of species.—The cranidium of *Acrocephalites stenometopus* (pl. 24, fig. 1) is nearer in form to that of *A. haynesi* (pl. 24, figs. 4, 4*a*) than to other species of the genus. It may have an occipital spine, but of this we have no positive information. *Acrocephalites tutus* (pl. 24, figs. 6, 6*a*) is also to be compared with the two mentioned species, but as the specimens representing it are flattened in the shale, the element of convexity must be restored when comparisons are made. *Acrocephalites insignis* (pl. 25, figs. 1, 1*a*) has the narrow fixed cheeks and frontal limb of *Acrocephalites stenometopus,* but owing to the compressed and more or less macerated condition of the test it is not possible to draw detailed comparisons.

[1] Research in China, Carnegie Institution of Washington, Vol. III, 1913, pl. 14.

Acrocephalites americanus differs from *Acrocephalites insignis* (pl. 25, figs. 1, 1*a*) in its longer frontal limb and rim, proportionally broader fixed cheeks, and 17, instead of 21, thoracic segments. It is a much larger form than the genotype *A. stenometopus* (pl. 24, fig. 1), and differs in its longer and flatter frontal limb and less elevated boss on the frontal limb.

Acrocephalites ? aster (pl. 26, figs. 9, 9 *a-c*) has a frontal boss much like that of *A. stenometopus*.

Comparing the thorax of those species in which it is preserved, we have the following result:

Acrocephalites americanus (pl. 24, fig. 3), 18 thoracic segments.

Acrocephalites insignis (pl. 25, fig. 1*a*), 21 thoracic segments.

Acrocephalites multisegmentus (pl. 24, fig. 5*a*), 25 thoracic segments.

The three species all have very small pygidia, and the same type of thoracic segment and pleural furrow, although the pleural lobe is much narrower in *A. multisegmentus*.

The surface of the test of *A. multisegmentus* is more evenly granulated than that of *A. haynesi*.

Under previous conceptions of the genus most of the species now referred to *Acrocephalites* and *Alokistocare* would have been included in *Ptychoparia*.

ACROCEPHALITES AMERICANUS, new species

Plate 24, figs. 2, 2*a-b*, 3, 3*a-b*

This species is represented by beautiful specimens of the cranidium preserved as silicified casts of the test attached to siliceous nodules that occur in argillaceous shales. With one exception the specimens of the dorsal shield are from the shale; they are flattened by compression, and the fine surface characters of the silicified specimens are lost except for traces of the larger tubercles.

Thorax with 27 transverse, narrow segments; palpebral furrow narrow, rounded, and continued well towards the outer end of the segment. Pygidium small; axial lobe with three rings outlined by transverse furrows.

Surface marked by strong, scattered tubercles with a minutely granular surface between.

The largest cranidium has a length of 10 mm., and belonged to a dorsal shield that was about 40 mm. in length.

For comparison with other species, see notes under description of genus.

Formation and locality.—Middle Cambrian: (89x) Conasauga formation. In argillaceous shale and on and in siliceous nodules imbedded in the shale, Livingston, Coosa Valley, Floyd County, Georgia.

Also from (90) Conasauga shales; on Edwards farm, near Craigs Mountain, about 10 miles (16.1 km.) southeast of Center; (90x) about 5 miles (8 km.) east of Center; (112) shales in which siliceous nodules of 90x are imbedded; (16d) shales one mile (1.6 km.) east of Moshat and 5 miles (8 km.) east-southeast of Center on southeast bank of a small brook; and (95) shales on Cowan Creek, 0.5 mile (0.8 km.) above Center road ford, all in Coosa Valley, Cherokee County, Alabama.

ACROCEPHALITES AORIS, new species

Plate 26, figs. 3, 3*a-b*

The cranidium of this species is much like that of *A. tutus* (pl. 24, figs. 6, 6*a*). It differs in having narrower fixed cheeks; wider and stronger frontal border. The outer surface is finely tuberculated with minute depressions between them that indicate that the test is probably punctate. The form of the glabella is similar to that of *A. americanus* (pl. 24, figs. 2, 2*a*), but other parts of the cranidium are quite different.

Formation and locality.—Middle Cambrian: (107d) Limestone; 1 mile (1.6 km.) north of Henrietta, Blair County, Pennsylvania.

ACROCEPHALITES ? ASTER, new species

Plate 26, figs. 9, 9*a-c*

This is a very distinct species. The narrow median swelling on the frontal limb is much like that of *Acrocephalites stenometopus* (pl. 24, fig. 1), and unlike the boss on other species referred to the genus.

The occipital spine is broken off the specimen represented by figure 9*b*, but it is finely shown as a cast in the shale matrix, where it has been removed by solution.

Formation and locality.—Upper Cambrian: (358e) Conasauga formation; buff-colored shales near street car barns, Birmingham City, Alabama; (107c) Maryville limestone, west base of Copper Ridge, 11 miles (17.7 km.) northwest of Knoxville, Knox County; and (15) Nolichucky shale, on Buckingham Ford road, 1.5 miles (2.4 km.) south of Greeneville, Greene County, both in Tennessee.

ACROCEPHALITES ? GLOMERATUS, new species

Plate 26, figs. 7, 7*a*

This species, like *A. ? majus* (pl. 26, fig. 1), is represented by a cranidium that except for the boss on the frontal limb in front of the glabella would be referred to *Ptychoparia*. As in the case of *Acrocephalites haynesi* (pl. 24, figs. 4, 4*a*), there are associated cranidia that are similar to the one with the boss on the frontal limb except that they do not have the boss. The cranidia are preserved in a coarse ferruginous sandstone, and nothing remains of the test or its outer surface.

In view of the above statement the species is tentatively referred to *Acrocephalites*. The largest cranidium in the collection has a length of 20 mm.

Formation and locality.—Upper Cambrian: (340c) Dark reddish brown sandstone, Rawlins, Carbon County, Wyoming.

ACROCEPHALITES HAYNESI, new species

Plate 24, figs. 4, 4*a-b*

This species is distinguished by strongly defined glabella, fixed cheeks, palpebral lobes, and frontal rim of the cranidium; also by the variability of the length of the frontal limb and the size of the boss in front of the glabella, accompanied by a coarsely granulated outer surface. It differs also in having a strong occipital spine.

The larger cranidia average 8 mm. in length.

This species is named after Mr. W. P. Haynes, who collected all the specimens known of it.

Formation and locality.—Upper Cambrian: Meagher limestone; on Pole Creek, a tributary of Cherry Creek, about 4 miles (6.4 km.) east of Madison River, Madison County, Montana.

Type in Museum of Comparative Zoölogy, Cambridge, Massachusetts.

ACROCEPHALITES INSIGNIS, new species

Plate 25, figs. 1, 1*a-b*

All of the numerous specimens of this species were flattened and more or less macerated in the mud now forming the argillaceous shale in which they occur. The species is characterized by the narrow fixed cheeks, strong palpebral lobes, and the ridges into which they merge on the fixed cheeks. The width of the frontal limb and the size of its median boss are variable, but not as much so as in *A. haynesi* (pl. 24, figs. 4, 4*a*). There is no trace of an

occipital spine, but one specimen of the thorax has a median spine on the sixth and seventh segments, and another has a similar spine on the seventh, eighth, and ninth segments. The specimen illustrated has 21 thoracic segments. The surface is strongly granulated where well preserved.

Formation and locality.—Middle Cambrian: (112, 112a) Conasauga formation shales; about 5 miles (8 km.) east of Center, Cherokee County, Alabama.

ACROCEPHALITES ? MAJUS, new species

Plate 26, fig. 1

This species is represented by a single specimen of the cranidium that is flattened in an argillaceous shale. It was referred in my field notes to *Ptychoparia,* but the presence of the rounded boss on the frontal limb in advance of the glabella and coarse granulations on the outer surface serve to place it nearer *Acrocephalites* than to *Ptychoparia.* The granulated surface has been greatly obscured by the pressure to which the test has been subjected. In form the cranidium is similar to that of *A. tutus* (pl. 24, fig. 6) and compressed specimens of *A. americanus* (pl. 24, fig. 3*a*). A small median node occurs near the posterior margin of the occipital ring. The generic reference will remain doubtful until more and better preserved specimens are found.

Formation and locality.—Middle Cambrian: (4g) Wolsey shale; 5 miles (8 km.) east-northeast of Logan, and 1 mile (1.6 km.) north of forks of East and West Gallatin Rivers, Gallatin County, Montana.

ACROCEPHALITES MULTISEGMENTUS, new species

Plate 24, figs. 5, 5*a*

This small and very distinct species has narrow pleural lobes, strongly granulated surface, and 25 thoracic segments. The pleural furrows of the thoracic segments are very narrow, short, and rather insignificant when compared with those of *A. americanus* (pl. 24, fig. 3*a*), and less so with those of *A. insignis* (pl. 25, fig. 1*a*). The frontal border and rim are somewhat similar in form to those of *A. ? majus* except in the upward curvature of the frontal rim and the broader base of the glabella of *A. insignis.*

Formation and locality.—Upper Cambrian: (30n, 30 o) Weeks formation; 2 miles (3.2 km.) south of Millard Pass, House Range, Utah.

The horizon of 30 o is 170 feet above that of 30n in the stratigraphic section.

ACROCEPHALITES STENOMETOPUS (Angelin)

Plate 24, figs. 1, 1*a-b*

Solenopleura ? stenometopa ANGELIN, 1851, Pal. Scand., p. 28, pl. 19, fig. 4.
Acrocephalites stenometopus (Angelin) WALLERIUS, 1895, Unders. Zonen med *Agnostus lævigatus* i Vestergötland, p. 53.

The type specimen of this species, a cranidium, was sent to me from the Museum at Lund. It has the front rim, the greater part of the fixed cheeks, and the palpebral lobes broken off. The descriptions and illustrations of Wallerius were evidently added to by observations on other specimens.

A photograph of the type specimen is reproduced as figure 1, plate 24. All its characters are included in the description of the genus. The frontal limb is finely shown with its large, rounded central tubercle, but nothing is seen of the broad, anterior margin with a deep intramarginal furrow. These features were probably preserved on other specimens, as they are represented in the somewhat diagrammatic figures of Angelin and Wallerius.

The back side of the occipital ring is broken away in the specimen illustrated by figure 1, but it may have had a spine similar in character to that of *A. ? aster* (see pl. 26, figs. 9, 9*a*).

The description by Wallerius is very detailed, and I can add nothing for the use of the student except figures based on photographs of the specimens of the cranidium and free cheeks.

Formation and locality.—Middle Cambrian: (309n) *Agnostus lævigatus* zone, Gudhem and Djupadal, Skaraborg, Vestergötland, Sweden.

ACROCEPHALITES TUTUS, new species

Plate 24, figs. 6, 6*a*

The specimens of this species, like those of *A. americanus* preserving thoracic segments (pl. 24, figs. 3, 3*a*), have had the test softened and then compressed during the progress of the deposition and consolidation of the mud that formed the fine argillaceous shale, except that the compression and flattening were not so complete as for *A. americanus*. This is shown by the slight convexity of the species and the preservation of the granulated outer surface of the test.

Comparisons of this species with other species of the genus are given under observations on the genus.

Formation and locality.—Middle Cambrian: (141) Conasauga shale; on roadside near cemetery 1 mile (1.6 km.) northeast of Cave Spring, Floyd County, Georgia.

ACROCEPHALITES ? VULCANUS (Billings)

Plate 26, fig. 2

Conocephalites vulcanus BILLINGS, 1861, Rept. Geol. Vermont, Vol. 2, p. 952, fig. 357. (Original description and figure.)

Conocephalites vulcanus BILLINGS, 1863, Geol. Canada, 1863, p. 286, fig. 296. (Original description and illustration repeated.)

Conocephalites vulcanus BILLINGS, 1865, Pal. Fossils Canada, Vol. 1, p. 14, fig. 17. (Pamphlet of 1861 republished.)

Ptychoparia vulcanus (Billings) WALCOTT, 1886, Bull. U. S. Geol. Survey, No. 30, p. 198, pl. 26, figs. 4, 4*a*. (Republished Billings's description with comment and gives two figures.)

Ptychoparia vulcanus (Billings) WALCOTT, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 653, pl. 96, figs. 4, 4*a*. (Republished figures of 1886.)

Numerous more or less distorted casts of the cranidium of this species occur in a fine decomposed ferruginous and slightly calcareous sandstone. The matrix of the casts suggests a granulated surface, but this may result from its fine sandy character. Although the median boss on the frontal limb suggests a reference to *Acrocephalites,* the nearly smooth glabella and strong frontal rim point to some other genus that may be the representative of *Acrocephalites* in the Lower Cambrian formations. Both Mr. Billings and I failed to note the boss in front of the glabella. It is well defined in four specimens before me and quite small on two others.

The largest specimen of the cranidium has a length of 6 mm.

Formation and locality.—Lower Cambrian: (25) Sandstone just above Parkers Quarry, near Georgia; also (26) northeast of the Corman farm buildings, east of Highgate Springs, both in Franklin County, Vermont.

Genus ALOKISTOCARE Lorenz

Alokistocare LORENZ, 1906, Zeitschr. deutsch. geol. Gesellsch., Bd. 58, p. 62.

General form of the dorsal shield elongate-oval, narrowing gradually from the rather large cephalon to the small pygidium.

Cephalon with flattened marginal rim produced into spines at the genal angles. A low rounded boss occurs in front of the glabella that usually extends across the frontal limb onto the frontal rim so as to interrupt the furrow delimiting the two. On *A. labrosum* (pl. 25, figs. 5, 5*a*) the boss does not extend onto the frontal limb, and on *A. ? prospectense* (fig. 8) and *A. linnarssoni* (figs. 7, 7*a*) it only partially interrupts the indistinct frontal furrow. Palpebral lobe and eye of medium size; palpebral ridge strongly outlined across the relatively broad free cheek. Glabella defined by strong dorsal furrows

and marked by two or three pairs of short lateral furrows. Free cheeks of medium size.

Thorax with 17 to 19 narrow segments; axial lobe narrow; pleural lobes broad and with well-defined furrows that extend from the dorsal furrow outward to the backward-bending genal angle, where they narrow and disappear on the smooth slope of the outer section of the segment.

Pygidium small; axial lobe rather prominent and divided into about three rings by shallow, transverse furrows; pleural lobes small and marked by one or two transverse furrows.

Surface slightly roughened by shallow pits when enlarged by a strong lens.

Genotype.—*Conocephalites subcoronatus* Hall and Whitfield.

Stratigraphic range.—The genotype occurs in the lower portion of the Middle Cambrian. *Alokistocare althea, A. labrosum, A. linnarssoni, A. pomona,* and *A. prospectense* occur in the Middle Cambrian, and *A. althea* in the Upper Cambrian.

Geographic distribution.—Species of the genus occur in northern Arizona, central Nevada, western and northern Utah, and northern central Montana. It appears to have been limited to the interior seas of the western portion of North America.

Observations.—Dr. Lorenz compares the genus with his *Macrotoxus* and assigns to it *A. subcoronatum* (Hall and Whitfield) as the genotype, stating that it has long, bow-shaped eyes, punctate shell, and strong dorsal furrows about the glabella. He gained his impression of the long eyes (palpebral lobes) from Hall and Whitfield's illustration, but this was somewhat in error, as the palpebral lobes are not over one-sixth the length of the cranidium on the type specimen of the species now in the United States National Museum collections (pl. 25, fig. 2). Lorenz did not compare it with the closely related genus *Acrocephalites,* owing probably to the fragmentary specimens and incomplete illustrations of the latter genus. Comparison between the two genera is made in this paper under observations on *Acrocephalites.*

Alokistocare althea (pl. 25, fig. 4*a*) has 19 thoracic segments, and *A. pomona* (pl. 25, fig. 6), 18 thoracic segments. The segments are of the same type as those of *Ptychoparia striata*[1] and of *Acrocephalites americanus* (pl. 24, fig. 3*a*). The upward-curving frontal rim or border of the type species (pl. 25, fig. 2) occurs in most of

[1] Research in China, Carnegie Inst. of Washington, Vol. 3, Pub. No. 54, 1913, pl. 2, fig. 4.

the species now referred to the genus, but this character is not distinct in *A. labrosum* (pl. 25, fig. 5), *A. linnarssoni* (pl. 25, figs. 7, 7*a*), and *A. ? prospectense* (pl. 25, fig. 8). This may be owing partly to the conditions of preservation of the cranidia, as the associated free cheek of *A. linnarssoni* (pl. 25, fig. 7*a*) indicates a frontal rim not unlike that of *A. subcoronatum* (pl. 25, fig. 2).

As far as known to me, the outer surface of the test is smooth to the unaided eye and minutely roughened and apparently pitted or porous when examined with a strong lens.

ALOKISTOCARE ALTHEA, new species

Plate 25, figs. 3, 3*a*, 4, 4*a*

This species is represented by casts of several specimens of the cranidium that are preserved in a fine sandstone matrix. Nothing is known of the surface of the test, and only indistinct traces of the glabellar furrows are to be seen. The most nearly related cranidium is that represented by figures 4, 4*a*, plate 25, which differs in details of frontal rim and boss. The two forms are, however, closely related and may belong to the same species, the apparent differences being caused by the condition of preservation of the specimens. *Alokistocare althea* occurs in a fine sandstone matrix, and the variety in a sandy shale; the two beds are separated stratigraphically by 200 to 300 feet in thickness of sandy shale.

The specimens preserving the thorax (figs. 4, 4*a*) are from the Bright Angel shale, and the cranidia represented by figures 3 and 3*a* I collected in 1882 in the upper part of the Tapeats sandstone, about 200 feet below the horizon in the shale. The latter are casts preserved in a fine sandstone matrix.

Formation and locality.—Middle Cambrian: (74) Tapeats sandstone; at the head of Nunkoweap Valley, Grand Canyon of the Colorado River; and

Middle Cambrian: (74e) Bright Angel shale 100 feet (30.4 m.) above Tapeats sandstone; on west side of Cameron trail about 0.5 mile (0.8 km.) north of Indian Garden spring; south side Grand Canyon of the Colorado River, both from Coconino County, Arizona.

Collected and presented by Niles J. Cameron, 1911.

ALOKISTOCARE ? LABROSUM, new species

Plate 25, figs. 5, 5*a*

This species is represented by numerous specimens of the cranidium that have very strongly marked characters which serve to

make the species an intermediate form between *Conocephalites, Alokistocare,* and *Menomonia,* as far as comparison may be made with the cranidia. The frontal limb with its median boss and strong, rounded frontal rim suggests *Acrocephalites;* the broad fixed cheeks and slightly pitted outer surface, *Alokistocare,* and the strongly defined subtriangular glabella and occipital ring, *Menomonia.* Nothing more is known to me of the species than is shown by the illustrations. The test usually adheres to the matrix so as to show its interior surface; small fragments indicate that its outer surface is pitted or punctate, which may account for its adhesion to the matrix. The largest cranidium has a length of 12 mm.

Formation and locality.—Middle Cambrian: (5f) limestone interbedded in the Wolsey shale, Meagher County, on the road to Wolsey, about 4 miles (6.4 km.) south of the divide at the head of Sawmill Creek, and 11 miles (17.7 km.) south of Neihart, Little Belt Mountains, Cascade County, Montana.

ALOKISTOCARE LINNARSSONI (Walcott)

Plate 25, figs. 7, 7*a*

Ptychoparia ? linnarssoni Walcott, 1884, Monogr. U. S. Geol. Survey, Vol. 8, p. 47, pl. 9, figs. 18, 18*a*. (Description and illustrations of typical cranidia of the species.)

This is a fine species known only by its cranidium and free cheeks, which are well shown by the illustrations. The outer surface of the test has been more or less injured by weathering, but it indicates that it was originally minutely pitted or punctate. The character of the frontal margin of the cranidium is indicated by the flat rim of the associated free cheek, except that the rim thickens and is separated by a scarcely perceptible depression from the frontal limb. The largest cranidium in the collection has a length of 11 mm.

The most nearly related species, *A. ? prospectense,* occurs 3,000 feet lower down in the Eureka district section. They both have a rounded frontal limb and rim, but that of *A. ? prospectense* is shorter, and the palpebral lobes are larger and further back on the fixed cheeks.

Formation and locality.—Middle Cambrian: (58) shaly limestones in upper beds of the Secret Canyon shale; east side of New York and Secret Canyons, Eureka District, Eureka County, Nevada.

Upper Cambrian: (15j) Orr formation; southwest part Fish Spring Range; and (15t) near south end Fish Creek Range, both in Toole County, Utah.

ALOKISTOCARE POMONA, new species

Plate 25, fig. 6

General form elongate, with broad cephalon and thorax converging rather uniformly to the small, narrow pygidium. The cephalon is characterized by its relatively narrow glabella and fixed cheeks and broad free cheeks. One only of the species shows the median boss of the frontal limb crossing the transverse frontal furrow. The genal angles are produced into spines that extend backward some distance beyond the ends of the thoracic segments.

Thorax with 19 narrow segments; axial lobe strongly defined by its convexity; pleural lobes with the geniculation of the segments at about two-thirds the length of the segment, where rather strong straight pleural furrows bend backward and narrow to a sharp point.

Pygidium small, but details of structure unknown.

Surface, as shown by casts in fine argillaceous shale, slightly roughened by shallow pits.

The only nearly entire dorsal shield has a length of 6 mm. for cranidium, and 10 mm. for thorax.

Observations.—This fine species differs from other species referred to *Alokistocare* by its narrow fixed cheeks; broad free cheeks; narrow postero-lateral limb, and elongate, narrow glabella with its faint lateral furrows. With our present information it is placed under this genus pending further discovery of closely allied forms.

Formation and locality.—Middle Cambrian: (159f) Wolsey shale; below Sixteen Station in Sixteen Mile Canyon, Meagher County, Montana.

Collected and presented to U. S. National Museum by M. Collen.

ALOKISTOCARE ? PROSPECTENSE (Walcott)

Plate 25, fig. 8

Ptychoparia ? prospectensis Walcott, 1884, Monogr. U. S. Geol. Survey, Vol. 8, p. 46, pl. 9, fig. 20. (Description and illustration of type specimen of cranidium.)

Ptychoparia ? prospectensis Walcott, 1886, Bull. U. S. Geol. Survey, No. 30, p. 202, pl. 27, fig. 5. (Reprint of previous description and a poor reproduction of illustration.)

There is nothing to add to the original description of the type cranidium except to note that I now think that the "finely granulose" surface is produced by the minute ridges between shallow pits, and that the surface is characterized by shallow pits rather than fine

granulations. The resemblance to the cranidium of *A. linnarssoni* is mentioned in the note on that species.

Formation and locality.—Middle Cambrian: (52a) Prospect Mountain formation; shale interbedded in limestone 500 to 600 feet (152 to 182.8 m.) down northeast slope of Prospect Mountain, Eureka district, Eureka County, Nevada.

ALOKISTOCARE SUBCORONATUM (Hall and Whitfield)

Plate 25, fig. 2

Conocephalites subcoronatus HALL and WHITFIELD, 1877, Geol. Explor. Fortieth Par., Vol. 4, p. 237, pl. 2, fig. 1. (Original description and illustration.)

Ptychoparia subcoronata (Hall and Whitfield) WALCOTT, 1886, Bull. U. S. Geol. Survey, No. 30, p. 205, pl. 28, fig. 4. (Reprints original description and figure, and comments on species.)

Ptychoparia subcoronata (Hall and Whitfield) WALCOTT, 1891, Tenth Ann. Rept., U. S. Geol. Survey, p. 652, pl. 96, fig. 6. (Notes occurrence of species in Lower Cambrian of New York, and reproduces figures of Hall and Whitfield.)

There is little to add to the original description of Hall and Whitfield. Additional collections have afforded only the cranidia and shown that the outer surface is roughened slightly by shallow pits and possibly by punctæ.

The cranidium of *A. subcoronatum* may be compared with that of *A. althea* (pl. 25, figs. 3*a*, 4*a*), which is most nearly related to it.

Other species have some strong points of resemblance, such as wide fixed cheeks, boss in front of the glabella, flat, slightly upward-curving frontal rim, and small to medium-sized palpebral lobes.

The largest cranidium has a length of 8 mm.

Formation and locality.—Middle Cambrian: Type specimens from Ute limestone, base of Ute Peak, Wasatch Range; (31c, 54 o) Ute formation; 1*b* of section,[1] Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

ALOKISTOCARE TICIDA, new species

Plate 26, figs. 6, 6*a*

This species is characterized by having a glabella about half as long as the cranidium; an elongate boss on the frontal limb crossing the frontal furrow; high and relatively narrow fixed cheeks; eyes posterior to the center of the cranidium; rather broad and upward-curving frontal rim, and rather short postero-lateral limbs. The glabella shows traces of three short furrows on each side.

[1] Smithsonian Misc. Coll., Vol. 53, 1908, p. 196.

Surface more or less roughened by small, shallow and deep pits, some of which result from weathering of the surface.

A cranidium 17 mm. in length has a width of about 14 mm. at the palpebral lobes.

The cranidium is similar to that of *A. pomona* (pl. 25, fig. 6) in having narrow fixed cheeks and palpebral lobes back of the center of the cranidium. It differs from *A. subcoronatum* in its narrow fixed cheeks, large size, and elevated palpebral lobes. Stratigraphically it occurs about 1,200 feet above *Alokistocare subcoronatum* in the Blacksmith Fork section.[1]

Formation and locality.—Middle Cambrian: (55s) Bloomington formation; *2b* of section;[2] about 9 miles (14.4 km.) above the mouth of Blacksmith Fork Canyon, and 15 miles (24 km.) east of Hyrum, Cache County, Utah.

Genus LONCHOCEPHALUS Owen

Lonchocephalus Owen, 1852, Rept. Geol. Wis., Iowa, Minn., p. 575. (Description.)

Lonchocephalus Hall, 1863, Sixteenth Ann. Rept. New York State Cab. Nat. Hist., pp. 147, 160. (Quotes Owen's description and groups species belonging to several genera under *Lonchocephalus*, p. 160.)

Lonchocephalus Shumard, 1863, Trans. Acad. Sci. St. Louis, Vol. 2, p. 104. (Considers *Lonchocephalus chippewaensis* the type of the genus, but considers the genus synonymous with *Conocephalites*.)

Lonchocephalus Hall, 1867, Trans. Albany Inst., Vol. 5, p. 129. (Reprint of remarks of 1863.)

Lonchocephalus Owen, Miller, 1889, North Amer. Geol. and Pal., p. 555.

Original description by Owen. "In this small and singular genus the highly arched glabella is either undivided, or has only two very obscure furrows. A spine of greater or less length projects backwards from the base of the glabella, in the median line of the body over the thoracic segments (fig. 12, pl. 1A). The pygidium found associated in the same beds is semilunar, with little or no border, and has four segments on the axial lobe."

Following the above description is the description of *Lonchocephalus chippewaensis*. The generic description points clearly to this species, but the figure referred to is that of *L. hamulus*. The author also illustrates three cranidia of *L. chippewaensis* (pl. 1, figs. 6, 14; pl. 1A, fig. 9), which come within the generic description much more nearly than the cranidium of *L. hamulus*. The species most nearly related to *L. hamulus* is that illustrated and named by Owen *Crepicephalus ? wisconsensis* (pl. 1, fig. 13).

[1] Smithsonian Misc. Coll., Vol. 53, 1908, pp. 194-196.

[2] Idem, p. 194.

Dr. James Hall (1863, pp. 147, 148) considers *Lonchocephalus* a synonym of *Conocephalites,* although realizing that to unite *Crepicephalus* and *Lonchocephalus* with the typical form of *Conocephalites* is difficult (p. 148).

To the general description of Owen we may now add that the thorax has seven segments and that the dorsal shield is convex with an elongate oval outline. The only entire specimen has a length of 4.25 mm. Surface of the type species unknown, as all specimens are preserved as casts in a fine-grained sandstone. Specimens of *L. minutus, L. pholus, L. plena,* and *L. appalachia* have a more or less granulated surface with a shallow pitting in places.

Genotype.—*Lonchocephalus chippewaensis* Owen.

Stratigraphic range and geographic distribution.—*Lonchocephalus chippewaensis, L. minor,* and *L. sospita* occur in the Upper Cambrian Eau Claire formation, of Wisconsin and Minnesota; *L. bunus* in the Franconia formation, Minnesota; *L. minutus* in the Potsdam sandstone, eastern New York; *L. appalachia* in the Maryville limestone, Alabama; *L. pholus* and *L. plena* in the Weeks formation, western Utah, all Upper Cambrian.

Observations.—I think the species referred to *Lonchocephalus* should be characterized as having a short convex glabella, short frontal limb, and narrow frontal border, median spine on the occipital ring, six or seven thoracic segments, and a relatively large, well-developed pygidium with continuous border and strong axial lobe. As restricted, there are seven species now known to me: *L. chippewaensis* Owen, *L. minor* (Shumard), *L. minutus* (Bradley), *L. bunus* Walcott, *L. sospita* Walcott, *L. pholus* Walcott, and *L. plena* Walcott. The second species referred to *Lonchocephalus* by Owen, *L. hamulus,* is placed under the new genus *Saratogia.*

Of named and described genera *Lonchocephalus* is most nearly related to *Liostracus* Angelin, 1854.[1] With only the cranidia for comparison, the difference between them is in the frontal limb and rim, and the absence of well-defined glabellar furrows in *Liostracus.* The typical species of the latter occurs in the Middle Cambrian *Paradoxides oelandicus* zone of Sweden, and *Lonchocephalus* is an Upper Cambrian genus as far as known in America.

The specific name *Lonchocephalus fecundus* is mentioned by Safford in a list of fossils from the Knox shale,[2] but the species was not described or illustrated.

[1] Pal. Scand., p. 27.

[2] Geology Tennessee, 1869, p. 212.

LONCHOCEPHALUS APPALACHIA, new species

Plate 35, figs. 6, 6*a-e*

This is a fine large species more nearly related in some aspects to *Saratogia* than to *Lonchocephalus*. Its conical glabella with rounded front, short frontal limb, and strong frontal border all suggest *Lonchocephalus*.

The largest cranidium has a length of 15 mm. exclusive of the occipital spine.

Surface roughened by minute granulation that appears to be formed of very irregular ridges with shallow pits between them. On some places the granulation appears to predominate, and on others the pitting.

Formation and locality.—Upper Cambrian: (123a) Maryville limestone; 4 miles (6.4 km.) northeast of Rogersville, Hawkins County, Tennessee; (139a) Conasauga formation in thin layer of interbedded limestone, near Chepultepec, Jefferson County, Alabama.

LONCHOCEPHALUS BUNUS, new species

Plate 34, figs. 9, 9*a*

This species differs from *L. chippewaensis, L. minor,* and *L. minutus* in its longer and more conical glabella and form of frontal rim. In the latter species the rim widens in front of the glabella, with the widening forming a blunt point extending inward towards the glabella; in *L. bunus* the inner side of the rim is uniformly curved and the outer side projects slightly, the rim narrowing laterally.

The largest cranidium in the collection has a length of 6 mm. Outer surface unknown.

Lonchocephalus bunus appears to be the representative of the genus in the Franconia formation.

Formation and locality.—Upper Cambrian: (99) Franconia formation; Minneiska, on the Mississippi River, near the line between Wabasha and Winona Counties, Minnesota.

LONCHOCEPHALUS CHIPPEWAENSIS Owen

Plate 34, figs. 3, 3*a;* plate 37

Lonchocephalus chippewaensis Owen, 1852, Rept. Geol. Wis., Iowa, Minn., p. 576, pl. 1, figs. 6, 14?; pl. 1A, fig. 9. (Description and illustration of the cranidium and pygidium.)

Conocephalites chippewaensis Shumard, 1863, Trans. St. Louis Acad. Sci., Vol. 2, p. 104. (Discusses species and considers it the type of the genus *Lonchocephalus*.)

Conocephalites minor HALL, 1863, Sixteenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 149, pl. 8, figs. 1-4. (Describes and illustrates typical forms of *L. chippewaensis* as *C. minor.*)

Conocephalites minor HALL, 1867, Trans. Albany Inst., Vol. 5, p. 132, pl. 3, figs. 1-4. (Reprint of paper of 1863.)

The type specimens of this species were from near Menomonie, Dunn County, Wisconsin, where later collections show the cranidia and pygidia in abundance, associated with *Crepicephalus iowensis* and *Menomonia calymenoides,* which are so characteristic of the Eau Claire formation. These two species are also associated with *L. chippewaensis* at Dresbach, opposite the mouth of Black River, where Shumard's specimens of *Conocephalites minor* came from. Shumard states that Owen's species, *Conocephalites chippewaensis* (= *Lonchocephalus*), is associated with his *C. minor.* I do not find them associated at either locality of *L. minor,* although the range of variation in the glabella of *L. chippewaensis* sometimes brings the shorter forms of the glabella close to the glabella of *C. minor.*

After examining a large series of specimens from various localities and studying the descriptions of *L. chippewaensis* by Owen and his illustrations, also those of Hall, I am convinced that Hall described and illustrated Owen's species under the impression that he was working with *L. minor* of Shumard. It is interesting to note that he does not refer to Owen's species *L. chippewaensis,* although the two forms are so much alike. He speaks of a specimen sent him by Shumard as being more rotund and with a proportionally shorter glabella. These characters constitute the differences between *L. minor* and *L. chippewaensis.* It would seem that Owen's species was overlooked at that time.

In the vicinity of Eau Claire the species is very abundant and ranges through the middle and upper beds of the Eau Claire formation; fine specimens are also abundant at Rock Falls, Dunn County.

Some of the cranidia have a slight longitudinal furrow on the frontal limb in front of the glabella and a tendency of the frontal rim to thicken and extend inward opposite the furrow.

By a fortunate find at St. Croix Falls, by Dr. Samuel Weidman, we now have an entire dorsal shield. This shows seven segments and clearly indicates that *Lonchocephalus* differs materially from other genera of the Olenidæ in having a convex cranidium with an occipital spine and a less number of thoracic segments. By using the somewhat abraded dorsal shield as a base and more perfect specimens of the cephalon and cranidium, a restoration has been made as shown by figure 3*a,* plate 34.

Lonchocephalus pholus (pl. 34, figs. 1, 1*a-b*) from western Utah is much like this species, and is its representative in the Cordilleran region.

Formation and locality.—Upper Cambrian: Eau Claire formation; (84) Dresbach, opposite the mouth of Black River, Winona County, Minnesota.

(82) On the bank of St. Croix River, at St. Croix Falls, Polk County; (82a) 25 feet (7.6 m.) above the water level near the Knapp, Stout & Co.'s building, Menomonie; (80) 0.66 miles (1.1 km.) southwest of the railway station, Menomonie; (134) banks of Red Cedar River opposite Menomonie; also (83a) Rock Falls, Dunn County; (78a and 98x) upper beds and (98) middle beds on Mount Washington, near Eau Claire, Eau Claire County; and (100a) Ettrick, Trempealeau County; all in Wisconsin.

LONCHOCEPHALUS MINOR (Shumard)

Plate 34, figs. 8, 8*a-b*

Conocephalites minor SHUMARD, 1863, Trans. St. Louis Acad. Nat. Sci., Vol. 2, p. 105. (Describes but does not illustrate species.)

Ptychoparia minor WALCOTT, 1884, Monogr. U. S. Geol. Surv., Vol. 8, p. 91. (Species referred to *Ptychoparia*.)

Not *Conocephalites minor* HALL, 1863, Sixteenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 149, pl. 8, figs. 1-4.

Not *Conocephalites minor* HALL, 1867, Trans. Albany Inst., Vol. 5, p. 132, pl. 3, figs. 1-4.

Original description.—"Very small; glabella well defined by linear dorsal furrows, subcircular, much elevated above the cheeks, regularly convex, slightly longer than wide, marked on either side with two short, deep lateral furrows, which are directed obliquely backwards and reach not quite one-third the distance across; neck furrow linear, distinctly but not deeply impressed, sinuate, arched forward in the middle; neck segment short triangular, gently convex, not elevated, posterior angle terminating in a delicate acicular spine, which is prolonged backwards, its length unknown; front margin narrow, convex; cheeks rounded, having very delicate ocular ridges, which pass from the eyes in a short curve to reach the glabella, a short distance in advance of the anterior glabellar furrow.

"Length of head, 0.10 of an inch; length of glabella, 0.08.

"The glabella of this species has the form and convexity of *C.* (*Monocephalus*) *globosus* of Billings; but the latter is destitute of lateral furrows, and the neck segment is not triangular as in our species."[1]

[1] Shumard, Trans. St. Louis Acad. Nat. Sci., Vol. 2, p. 105.

Lonchocephalus minor differs from *L. chippewaensis* in having a proportionally shorter more rotund glabella, almost no frontal limb, and usually with a slight incurving of the frontal furrow toward the longitudinal axis of the glabella.

Formation and locality.—Upper Cambrian: (84) Eau Claire formation; Dresbach, opposite the mouth of Black River, Winona County, Minnesota.

This is the type locality of the species.

Also from (79x) Eau Claire formation; near flour mill on Beaver Creek, north of Galesville, Trempealeau County, Wisconsin.

LONCHOCEPHALUS MINUTUS (Bradley)

Plate 34, figs. 4, 4*a-g*

Conocephalites minutus BRADLEY, 1860, American Journ. Sci., 2d ser., Vol. 30, pp. 241-242, text figs. 1-3. (Detailed description of species, with note by E. Billings.)

Conocephalites minutus BILLINGS, 1860, *Idem,* pp. 242-243 (discussion of species), and pp. 337-338, text figs. 4*a-c*. (Additional data on species and further discussion of it.)

Conocephalites minutus BRADLEY, 1860, Can. Nat. and Geol., Vol. 5, pp. 420-421, and text figs. 1-3. (Reprint of paper in American Journal of Science noted above.)

Conocephalites minutus BILLINGS, 1860, *Idem,* pp. 422-425, and text figs. 4*a-c*. (Reprint of two notes in American Journal of Science noted above.)

Conocephalites minutus BRADLEY, 1861, Proc. American Assoc. Adv. Sci., Vol. 14, pp. 161-163, and text figs. 1-3. (Reprint of paper mentioned in first reference.)

Conocephalites minutus BILLINGS, 1861, *Idem,* pp. 163-166, and text figs. 4*a-c*. (Reprint of his two notes mentioned in the second reference.)

Conocephalites minutus HALL, 1863, Sixteenth Ann. Rept., New York State Cab. Nat. Hist., pp. 150-151, pl. 8, figs. 5-7. (Describes species and compares it with *C. minor*.)

Conocephalites minutus HALL, 1867, Trans. Albany Inst., Vol. 5, pp. 134-135, pl. 3, figs. 5-7. (Reprint of the preceding reference, with same figures.)

Ptychoparia minutus WALCOTT, 1884, Monogr. U. S. Geol. Surv., Vol. 8, p. 91. (Refers to species and places it under *Ptychoparia*.)

Ptychoparia minuta WALCOTT, 1912, Smithsonian Misc. Coll., Vol. 57, No. 9, pp. 267-268, pl. 43, figs. 20-24. (Observations and illustrations.)

The study of the genus *Lonchocephalus* has led to its restriction to the form closely related to the type species *L. chippewaensis,* and this brings Bradley's species *minutus* under *Lonchocephalus*.

It is a small form represented by cranidia and pygidia, and it very closely resembles *L. chippewaensis*. One of the points of difference is its flattened frontal rim.

Formation and locality.—Upper Cambrian: Potsdam sandstone formation; (77) near the water level below the falls at the high bridge and also at several horizons in the section above, the highest point being 70-75 feet (21.3 to 22.9 m.) above the water, Ausable Chasm, near Keeseville, Essex County: (136a) in sandstone on a large brook at a point on the Mineville Railroad at the turning of the first Y near Port Henry, Essex County; (109) in sandstone 25 feet (7.6 m.) above the Archean, 1.5 miles (2.4 km.) south of Deweys Bridge on the Champlain Canal, Washington County; (110a) in sandstone a little above and east of the canal road, north end of town of Whitehall, Washington County; and (111) at the top of the Potsdam sandstone on Marble River, 1 mile (1.6 km.) south of Chateaugay, Franklin County; all in New York.

LONCHOCEPHALUS PHOLUS, new species

Plate 34, figs. 1, 1*a-b*

This species is known only from the cranidium. It differs from *L. chippewaensis* Owen and *L. minutus* (Bradley) in details of the glabella, fixed cheeks, and frontal limb. The cranidium is less convex and the occipital spine stronger than in the species mentioned.

The surface appears to be finely granulated as in *L. plena,* and also to have shallow pits scattered over it. The associated *L. plena* (pl. 33, fig. 2) has a shorter frontal limb and a convex and evenly rounded glabella.

The largest cranidium has a length of 6 mm. exclusive of the occipital spine.

Formation and locality.—Upper Cambrian: (30n) Weeks formation (1*c* of section),[1] also (30 o) (1*b* of section); north side of Weeks Canyon, 4 miles (6.4 km.) south of Marjum Pass, House Range, Millard County, Utah.

LONCHOCEPHALUS PLENA, new species

Plate 34, figs. 2, 2*a*

This species is represented by a cephalon and several cranidia. It differs from the associated *L. pholus* in the outline of the glabella, short frontal limb, and very narrow fixed cheek.

Surface of test apparently finely granulated and with shallow pits scattered irregularly on it.

The largest cranidium has a length of 3.5 mm. exclusive of the occipital spine.

[1] Smithsonian Misc. Coll., Vol. 53, 1908, p. 178.

Formation and locality.—Upper Cambrian: (30 o) Weeks formation (1*b* of section); north side of Weeks Canyon, 4 miles (6.4 km.) south of Marjum Pass, House Range, Millard County, Utah.

LONCHOCEPHALUS SOSPITA, new species

Plate 36, figs. 1, 1*a*

This species is represented by several small cranidia on a fragment of sandstone as shown by figure 5. The broadly rounded, nearly transverse front of the conical glabella, swollen frontal limb, and very narrow, thread-like frontal rim serve to distinguish it from other species of the genus. The largest cranidium has a length of 4 mm. Surface unknown.

Formation and locality.—Upper Cambrian: (339k) Eau Claire formation; near Winona, Winona County, Minnesota.

Specimen collected and presented to the United States National Museum by Mr. W. A. Finkelnburg, of Winona.

SARATOGIA, new genus

This genus is known only by the cranidia and free cheeks of the cephalon, fragments of the thoracic segments, and the pygidium.

The cranidium and free cheeks are not unlike those of *Crepicephalus iowensis* Owen and *Ptychoparia diademata* except that the fixed cheeks are narrow in *Saratogia* and there is a long spine on the occipital ring. The pygidia associated with *Saratogia calcifera* and *S. wisconsensis* and referred to those species are small and similar in type to the pygidium of *Ptychoparia kochibei*.[1]

The surface of the test of *Saratogia calcifera* is thickly studded with small, low granules.

The cranidia of the species referred to the genus indicate a length of from 40 to 45 mm. for the dorsal shield.

Genotype.—*Conocephalites calciferous* Walcott (1879, Thirty-second Ann. Rept. New York State Mus., pp. 129-130).

Stratigraphic range and geographic distribution.—*Saratogia calcifera* is found in the Upper Cambrian Hoyt limestone of New York; *S. arses* in the Nolichucky formation, Tennessee; *S. wisconsensis* and *S. volux* in the Eau Claire formation; *S. hamulus* and *S. hera* in the Franconia formation of Wisconsin, and *S. tellus* in the Middle Cambrian, Kiu-lung group of Shantung, China.

Observations.—The genus *Saratogia* differs from *Ptychoparia*[2] in the form of the glabella, narrow fixed cheeks, large eyes, and the

[1] Research in China, Carnegie Institution of Washington, 1913, Vol. 3, Pub. No. 54, pl. 12, figs. 5, 5*a*.

[2] Syst. Sil. du Bohême, Vol. 1, 1852, pl. 29, fig. 39.

concave curvature of the frontal limb and border. It has very little in common with *Lonchocephalus chippewaensis,* the genotype of the genus *Lonchocephalus,* under which all the species now included under *Saratogia* have been included.

The species now referred to *Saratogia* are:

Saratogia arses, n. sp. (pl. 35, figs. 4, 4*a-b*).
Saratogia aruno, n. sp. (pl. 35, figs. 5, 5*a-b*).
Saratogia calcifera (Walcott) (pl. 33, figs. 6, 6*a*).
Saratogia hamulus (Owen) [Sixteenth Ann. Rept. New York State Cab. Nat. Hist., 1863, pl. 7, figs. 43, 44].
Saratogia hera, n. sp. (pl. 35, figs. 3, 3*a-b*).
Saratogia tellus (Walcott) [Research in China, Carnegie Institution of Washington, No. 3, Vol. 54, 1913, pl. 14, fig. 1].
Saratogia volux, n. sp. (pl. 34, fig. 3).
Saratogia wisconsensis (Owen) (pl. 34, figs. 5, 5*a-c*) [See Hall, Sixteenth Ann. Rept. New York State Cab. Nat. Hist., 1863, pl. 7, figs. 39-41; pl. 8, figs. 22, 23, 24, 27, 28. Walcott].

The occurrence of *Saratogia hamulus* (Owen) in the Yellowstone National Park is quite probable, but not proven by reliable specimens.[1]

SARATOGIA ARSES, new species

Plate 35, figs. 4, 4*a-b*

This is a small species represented by a cranidium about 4 mm. in length exclusive of the occipital spine. It differs from the somewhat similar species *S. aruno* (pl. 35, fig. 5) and *S. wisconsensis* (pl. 34, fig. 5) in form of glabella and in the greater convexity of the glabella. The outer surface of the test appears to be nearly smooth.

The occurrence of this species in one of the thin gray limestone layers in the Nolichucky shale is interesting, as it serves to connect the Upper Cambrian fauna of the Appalachian region and that of the upper Mississippian area.

Formation and locality.—Upper Cambrian: (173) Nolichucky formation; Maryville, Blount County, Tennessee.

SARATOGIA ARUNO, new species

Plate 35, figs. 5, 5*a-b*

This small species is represented by a cranidium that is very much like that of *Saratogia wisconsensis* (pl. 34, fig. 5), and it may be that with more and better specimens it will be decided that the two are specifically identical.

[1] Monogr. 32, U. S. Geol. Survey, 1899, p. 461.

The cranidium illustrated has a length of 3 mm. exclusive of the occipital spine, and occurs in a fine argillaceous shale.

Formation and locality.—Upper Cambrian: (128) Conasauga formation; 1.5 miles (2.4 km.) southwest of Cleveland, Bradley County, Tennessee.

SARATOGIA CALCIFERA (Walcott)

Plate 34, figs. 6, 6*a-e*

Conocephalites calciferous Walcott, 1879, Thirty-second Ann. Rept. New York State Mus., pp. 129-130. (Description of species.)

Ptychoparia calcifera (Walcott), 1886, Bull. U. S. Geol. Surv., No. 30, p. 21. (Name in list of species.)

Ptychoparia calcifera (Walcott) Dwight, 1887, Trans. Vassar Bros. Inst., Vol. 4, pp. 207-208. (Species mentioned in text.)

Ptychoparia calcifera (Walcott) Lesley, 1889, Geol. Surv. Pennsylvania, Rept. P 4, Dictionary of Fossils, Vol. 2, p. 831. (Text fig. 1 reproduced from drawing sent him by Walcott.)

Ptychoparia calcifera Weller, 1903, Geol. Surv. New Jersey, Rept. on Pal., Vol. 3, The Paleozoic Faunas, pl. 1, fig. 14. (Illustrates a fragment doubtfully referred to this species.)

Lonchocephalus calciferus (Walcott), 1912, Smithsonian Misc. Coll., Vol. 57, No. 9, pp. 270-272, pl. 43, figs. 7-10. (Repeats earlier description and adds further observations.)

This species has been recently described in this series of papers. The illustrations are reproduced for comparison with the type species of the genus *Lonchocephalus* (pl. 34, figs. 3, 3*a-b*).

Saratogia calcifera is made the genotype of *Saratogia* on account of its being in a much better state of preservation than other species referred to the genus.

Formation and locality.—Upper Cambrian: Hoyt limestone; (76) arenaceous limestone at Hoyts quarry, 4 miles (6.4 km.) west of Saratoga Springs, Saratoga County; (76a) in a railroad quarry, 1 mile (1.6 km.) north of Saratoga Springs, Saratoga County; and in arenaceous limestone, 2 miles (3.2 km.) south of Poughkeepsie, Dutchess County; all in New York.

SARATOGIA HERA, new species

Plate 35, figs. 3, 3*a-b*

This is essentially similar to *S. wisconsensis* with a glabella of the *Conaspis shumardi* form. Only the cranidia are preserved, along with scattered thoracic segments bearing a long, slender, backward-extending spine on the axial lobe.

Surface unknown. The largest cranidium has a length of 14 mm. exclusive of the occipital spine.

Formation and locality.—Upper Cambrian: (98a) Franconia formation; Marine Mills, Washington County, Minnesota.

SARATOGIA VOLUX, new species

Plate 35, figs. 2, 2a

This species is known only by the cranidium. It is associated with *Lonchocephalus chippewaensis* Owen, but the nearest related form is *Saratogia wisconsensis* (Owen). It differs from the latter in having a more conical glabella, shorter frontal limb, proportionally wider frontal border, and shorter median spine on the occipital ring. The palpebral lobes are about one-fourth the length of the cranidium.

Surface unknown. The largest cranidium has a length of 8 mm. exclusive of the occipital spine.

Formation and locality.—Upper Cambrian: (78a) Eau Claire formation; upper quarry on Mount Washington, near Eau Claire, Eau Claire County, Wisconsin.

SARATOGIA WISCONSENSIS (Owen)

Plate 34, figs. 5, 5a-c

Crepicephalus ? wisconsensis Owen, 1852, Rept. Geol. Surv. Wis., Iowa, Minn., pl. 1, fig. 13. (Illustrates a cranidium.)

Conocephalites wisconsensis Hall, 1863, Sixteenth Ann. Rept. New York State Cab. Nat. Hist., p. 164, pl. 7, figs. 39-41 (42); pl. 8, figs. 22-24, 27, 28; p. 147 (*obiter*). (Describes and illustrates species.)

Conocephalites wisconsensis Shumard, 1863, Trans. Acad. Sci. St. Louis, Vol. 2, p. 103. (Comments upon and gives additional information, but not as complete as Hall.)

Dikelocephalus latifrons Shumard, 1863, *Idem*, p. 101. (Describes a broken cranidium subsequently referred to *Conocephalites wisconsensis* by Hall.)

Conocephalites latifrons Hall, 1863, Sixteenth Ann. Rept. New York State Cab. Nat. Hist., p. 122 (gen. ref.), p. 165, pl. 7, fig. 40. (Refers species to *C. wisconsensis*, and illustrates type specimen of Shumard.)

Conocephalites wisconsensis Hall, 1867, Trans. Albany Inst., Vol. 5, p. 130 (*obiter*), p. 151, pl. 2, figs. 39-41; pl. 3, figs. 23-24, 27, 28. (Reprint of description and illustrations of 1863.)

Anomocare wisconsensis (Hall) Dames, 1883, Richthofen's China, Berlin, Vol. 4, p. 15 (gen. ref.). (Refers Hall's *Conocephalites wisconsensis*, 1863, pl. 7, fig. 39; pl. 8, figs. 22-24, 27, 28, to *Anomocare*.)

Conocephalites wisconsensis (Owen) Chamberlin, 1883, Geol. Wis., Vol. 1, p. 131. (Reproduces figures of cranidium and free cheek after Hall, 1863.)

Ptychoparia (*Lonchocephalus*) *wisconsensis* (Owen) WALCOTT, 1899, Monogr. U. S. Geol. Surv., Vol. 32, Pt. 2, p. 461, pl. 64, figs. 1, 1*a-b*. (Notes occurrence in Wyoming, and illustrates. By error a pygidium of *Ptychoparia ? diademata* Hall is referred to this species, pl. 64, fig. 1*c*, and a cranidium of *Saratogia hamulus* (Owen), fig. 1*b*.)

Ptychoparia (*Lonchocephalus*) *wisconsensis* (Owen) Walcott, GRABAU and SHIMER, 1910, North American Index Fossils, Vol. 2, p. 277. (Notes occurrence of species.)

This species is known only by the cranidium, free cheeks, and possibly pygidium. In the Franconia formation of Wisconsin and Minnesota it occurs in the form of casts in fine-grained sandstone, and its outer surface is not preserved, and the same is true of the specimens from the Yellowstone National Park, which are slightly eroded as they occur on the limestone slabs. *Saratogia wisconsensis* differs from *S. calcifera* in many details of the cranidium, notably in the frontal limb and rim. It is quite unlike *S. hamulus* (Hall).

Formation and locality.—Upper Cambrian: (151e) Gallatin limestone; north side of Soda Butte Creek, below saddle on ridge between Pebble Creek and Soda Butte Creek, Crowfoot section, northeastern corner of Yellowstone National Park, Wyoming.

Also (79) Eau Claire formation; Hudson, St. Croix County; (99a) Franconia formation; near Pilot Knob, Adams County; (83[3]) Trempealeau, Trempealeau County; all in Wisconsin.

Also Franconia formation; (97) Reeds Landing, foot of Lake Pepin, Wabasha County; and (339g) near Winona, Winona County; both in Minnesota.

And (86c) Eau Claire formation; Lansing, Allamakee County, Iowa. Southeast of city at low-water mark.

This species occurs at other localities in Wisconsin and Minnesota, but at present I do not have specimens before me for identification except from those given above.

Family CERATOPYGIDÆ

Genus CREPICEPHALUS Owen

Crepicephalus OWEN, 1852, Rept. Geol. Surv. Wis., Iowa, Minn., p. 576, pl. 1, fig. 8, tab. A1, figs. 10, 16, 18. (Describes genus and refers to figures of cranidium and pygidium of the species *C. iowensis*.)

Crepicephalus HALL, 1863, Sixteenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 147. (Reprints Owen's description, and comments on genus. Refers species *C. iowensis* to *Conocephalites*.)

Crepicephalus SHUMARD, 1863, Trans. Acad. Sci. St. Louis, Vol. 2, p. 103. (Considers *Crepicephalus* as identical with *Conocephalites*.)

Crepicephalus HALL, 1867, Trans. Albany Inst., Vol. 5, p. 130. (Reprint of paper of 1863.)

Crepiccphalus HALL and WHITFIELD, 1877, U. S. Geol. Expl. 40th Parl., Vol. 4, p. 209. (Discuss *Crepicephalus* as a possible synonym of *Loganellus* Devine, and refer a new species of *Ptychoparia* named *haguei* to *Crepicephalus* (*Loganellus*), also the new species *nitidus, granulosus, maculosus, unisulcatus, simulator, anytus,* and *angulatus,* none of which belong to *Crepicephalus.*)

Crepicephalus WALCOTT, 1884, Bull. U. S. Geol. Surv., No. 10, p. 35. (Calls attention to placing of species referred to *Crepicephalus* (*Loganellus*) by Hall and Whitfield under *Ptychoparia* and remarks on *Crepicephalus.*)

Crepicephalus WALCOTT, 1886, *Idem,* No. 30, p. 206. (Quotes Owen's description and remarks, and concludes that *Dikelocephalus ? iowensis* should be taken as the genotype.)

Crepicephalus Owen, MILLER, 1889, North Amer. Geol. and Pal., p. 540. (Gives a generic description and refers to *C. iowensis* Owen as the type of the genus, also includes many species of other genera under *Crepicephalus.*)

Crepicephalus VOGDES, 1890, Bull. U. S. Geol. Surv., No. 63, p. 105. (Concludes that Owen described a true *Ptychoparia* and not a new generic form.)

Crepicephalus VOGDES, 1893, Cal. Acad. Sci., Occ. Pap., Vol. 4, p. 293. (Reprint of comments of 1890.)

Crepicephalus WALCOTT, 1899, Monogr. U. S. Geol. Surv., Vol. 32, Pt. 2, p. 459. (Gives reasons for using *C. iowensis* as the type of the genus, and illustrates an entire dorsal shield of an allied species, *C. texanus* (pl. 55, fig. 5).)

Crepicephalus Owen, GRABAU and SHIMER, 1910, North American Index Fossils, Vol. 2, p. 283. (Brief diagnosis of genus.)

The cephala of the species referred to *Crepicephalus* vary in details, but all have the elongate glabella with sides converging towards the front, and two or three pairs of more or less distinctly defined short glabella furrows; the occipital ring may have a strong median spine, *C. tripunctatus magnispinus,* or a minute node at its center, *C. iowensis.* The frontal limb may be short and convex, *C. iowensis,* or broad and depressed, *C. texanus;* the frontal furrow may be narrow and simple, *C. iowensis,* or broad and marked by three relatively large pits; the frontal border may be narrow and wire-like, *C. iowensis,* or broad and flattened, *C. texanus.* In all species the eyes are of medium size, centrally placed, and with a narrow ridge crossing the fixed cheek from the palpebral lobe to the dorsal furrow near the anterior end of the glabella.

The free cheeks all have a rather strong genal spine. The course of the facial suture is similar to that of *Ptychoparia.*

The thorax has from 12 to 14 transverse segments; pleural furrows well defined, and termination of pleural lobes of each segment slightly falcate.

The pygidia may be arranged in two groups: First, the *C. iowensis* group, in which the postero-lateral margin of the pygidium extends backward on each side from a broad base into a sharp narrow spine. Second, the *C. texanus* group, in which the postero-lateral spines are long, slender, and attached to the side of the pleural lobe above the margin. The latter appears to be the oldest form, as it occurs with *C. augusta* and *C. liliana* (pl. 29) of the upper beds of the Lower Cambrian, and also with the Middle Cambrian species of China, *C. convexus*.[1] One of the Chinese species, *C. damia,* has an associated pygidium [2] that is similar in appearance to the pygidium of *C. texanus*.

The surface of the *C. iowensis* group of species is smooth to the unaided eye, but slightly roughened by fine pitting when seen with a strong lens. The *C. texanus* group of species all have a more or less decided granulation. The test of all known species of the genus in which it is preserved is pitted and apparently punctate.

The various species now referred to *Crepicephalus* may be grouped as follows:

Crepicephalus iowensis group: Test nearly smooth, probably punctate, frontal furrow of cranidium narrow and simple; pygidium transverse with border extended into broad-based sharp postero-lateral spines. Species: *C. iowensis* (pl. 29), *C. camiro* (pl. 32), *C. convexus* (China), *C. coosensis* (pl. 32), *C. dis* (pl. 32), *C. magnus* (China), *C.* undt. spp. (pl. 32, figs. 4 and 4*a*).

Crepicephalus texanus group: Test granulated, probably punctate; frontal furrow of cranidium usually broad and strong, with three marked pits in front of the glabella; pygidium slightly transverse with a narrow, long spine coming out of the pleural lobe on each postero-lateral side. Species: *C. texanus* (pl. 30), *C. comus* (pl. 31), *C. coria* (pl. 33), *C. damia* (China), *C. texanus danace* (pl. 29), *C. texanus elongatus* (pl. 29), *C. thoosa* (pl. 31), *C. tripunctatus* (pl. 33), *C. tripunctatus magnispinus* (pl. 33), *C. tumidus* (pl. 31).

The species *C. tripunctatus* and variety *magnispinus* differ from all other known species of the genus in having a strong occipital spine.

Genotype.—Dikelocephalus? iowensis Owen.[3]

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[1] Research in China, Carnegie Institution of Washington, Vol. 3, 1913, pp. 140-142, pl. 13, fig. 16*b*.

[2] *Idem,* pl. 13, fig. 14*b*.

[3] Rept. Geol. Surv. Wis., Iowa, Minn., 1852, p. 575, pl. 1, fig. 4; pl. 1A, fig. 13.

Dr. Owen describes the genus *Crepicephalus* (1852), but does not mention a species as the type species or apply the name to the form which he describes generically. He refers in his generic description to several figures; the first is figure 16 of plate 1A. This has in it two pygidia and two cranidia of *C. iowensis*. He also refers to figures 10 and 18 of the same plate, both of which have a cranidium of *C. iowensis* on the rock.

The associated pygidia that he refers to and illustrates by figure 8 of plate I and figure 16 of plate IA both belong to *C. iowensis*. Apparently by error, Dr. Owen placed the species *C. iowensis* under the genus *Dikelocephalus* and in the description of the plate as *Dikelocephalus ? iowensis*.

In view of the references to the figures in the generic description, and evident error in referring the species *iowensis* to the genus *Dikelocephalus*, the cranidium of which it does not resemble in any respect, I think we should assume without question that the species *iowensis* is the type of the genus *Crepicephalus*.

It is also to be noted that in the description of figure 13, plate I, by Owen, the species *wisconsensis* is referred with a query (?) to the genus *Crepicephalus*. No reference, however, is made to that species in the text.

Messrs. Hall and Whitfield, in describing Cambrian trilobites from Utah and Nevada, discussed the genus *Conocephalites* and revived *Crepicephalus* as a subgenus equivalent to *Loganellus* of Devine. They did not, however, describe the genus *Crepicephalus*, but referred a number of species to it which possess more or less distinctly marked "slipper-shaped" glabellæ. Prof. Whitfield subsequently used the genus in his description of *Crepicephalus* (*Loganellus*) *montanensis*[1] in the Paleontology of the Black Hills of Dakota.[2] But later (1882) he omitted reference to *Loganellus* in describing *Crepicephalus onustus*.[3]

Stratigraphic range.—Lower Cambrian: Upper beds: *C. augusta, C. liliana*.

Middle Cambrian: *C. convexus, C. damia, C. magnus*, from China; *C. coosensis*, from Alabama.

Upper Cambrian: *C. iowensis, C. camiro, C. comus, C. coria, C. texanus, C. texanus danace, C. texanus elongatus, C. thoosa, C. tripunctatus, C. tripunctatus magnispinus, C. tumidus, C. unca, C. unzia, C. upis, C.* undt. spp.

[1] Bull. U. S. Geol. Survey, No. 30, 1886, p. 141.

[2] Rept. Geology and Resources of the Black Hills (Jenney), 1880, pp. 341-343.

[3] Geol. Wisconsin, Vol. 4, 1882, p. 182.

Geographic distribution.—Appalachian Province: Virginia to Alabama.

Mississippian Province: Wisconsin, Texas.

Cordilleran Province: Montana, northern Wyoming, Utah.

China: Southwestern Manchuria, Shantung. Australia: Gippsland, Victoria. Identified from a pygidium.[1]

Observations.—This is a very valuable genus to the stratigraphic geologist, owing to the wide distribution of several of the species, notably *C. texanus, C. thoosa,* and *C. tripunctatus.* With more thorough and systematic collecting, it will undoubtedly furnish very important data for the subdivision of the various formations in which the species and varieties occur. The persistence of a considerable range of variation among the cranidia of *C. texanus* at the several localities where the species occurs serves to strengthen the identification of that species in Texas, Arizona, Wyoming, and Alabama.

The genus falls into the family Ceratopygidæ.[2] The relatively large pygidium with its postero-lateral spines is characteristic of other genera referred to the family.

The species now referred to *Crepicephalus* are:

Crepicephalus augusta Walcott (pl. 29, figs. 6, 6*a-b*).
Crepicephalus camiro Walcott (pl. 32, figs. 2, 2*a*).
Crepicephalus comus Walcott (pl. 31, figs. 3, 3*a*).
Crepicephalus convexus Walcott [The Cambrian Faunas of China, Walcott, Carnegie Institution of Washington, Vol. 3, Pub. No. 54, 1913, p. 140, pl. 13, figs. 16, 16*a-b*].
Crepicephalus coosensis Walcott (pl. 32, figs. 3, 3*a-f*).
Crepicephalus coria Walcott (pl. 33, figs. 3, 3*a-g*).
Crepicephalus dis Walcott (pl. 32, figs. 1, 1*a-c*).
Crepicephalus damia Walcott [The Cambrian Faunas of China, *supra,* p. 141, pl. 13, figs. 14, 14*a-b*].
Crepicephalus etheridgei Chapman [Proc. Royal Soc. Victoria, n. s., Vol. 23, p. 319, pl. 58, fig. 8. Locality, Dolodrook River, N. E. Gippsland, Victoria].
Crepicephalus iowensis (Owen) (pl. 29, figs. 1, 2, 2*a-f*).
Crepicephalus liliana Walcott (pl. 29, figs. 5, 5*a-c*).
Crepicephalus texanus (Shumard) (pl. 29, fig. 7; pl. 30, figs. 1-4, 4*a*).
Crepicephalus texanus danace Walcott (pl. 29, figs. 3, 3*a*).
Crepicephalus texanus elongatus Walcott (pl. 29, figs. 4, 4*a*).
Crepicephalus thoosa Walcott (pl. 31, figs. 1, 1*a-k*).
Crepicephalus tripunctatus (Whitfield) (pl. 33, figs. 1, 1*a*).
Crepicephalus tripunctatus magnispinus Walcott (pl. 33, figs. 2, 2*a-c*).
Crepicephalus tumidus Walcott (pl. 31, fig. 2).

[1] *Crepicephalus etheridgei* Chapman.
[2] Text-book of Palæontology, Zittel-Eastman, 1913, Vol. 1, p. 717.

Crepicephalus unca Walcott (pl. 35, figs. 1, 1*a-e*).
Crepicephalus unzia Walcott (pl. 34, figs. 7, 7*a*).
Crepicephalus upis Walcott (pl. 33, figs. 4, 4*a-d*).
Crepicephalus undt. spp. (pl. 32, figs. 4, 4*a*).

The American species previously referred to *Crepicephalus* and now referred to other genera are:

Crepicephalus centralis Whitfield = *Anomocarella oweni* (Meek and Hayden).
Crepicephalus gibbsi Whitfield = *Ptychoparia* Corda.
Crepicephalus (*?*) *miniscaensis* Owen = *Ptychaspis* Hall.
Crepicephalus onusius Whitfield = *Anomocarella* Walcott.
Crepicephalus roanensis Safford = Unpublished species Walcott.
Crepicephalus similis Safford = Unpublished species Walcott.
Crepicephalus tennesseensis Safford = Unpublished species Walcott.
Crepicephalus ? wisconsensis Owen = *Lonchocephalus* Owen.
Crepicephalus (*Bathyurus?*) *angulatus* Hall and Whitfield = *Ptychoparia* (*Emmrichella*) Walcott.
Crepicephalus (*Loganellus*) *granulosus* Hall and Whitfield = *Inouyia* Walcott.
Crepicephalus (*Loganellus*) *haguei* Hall and Whitfield = *Ptychoparia* Corda.
Crepicephalus (*Loganellus*) *maculosus* Hall and Whitfield = *Ptychoparia* Corda?
Crepicephalus (*Loganellus*) *montanensis* Whitfield = *Ptychoparia* Corda.
Crepicephalus (*Loganellus*) *nitidus* Hall and Whitfield = *Ptychoparia* Corda.
Crepicephalus (*Loganella*) *planus* Whitfield = *Ptychoparia* Corda.
Crepicephalus ? (*Loganellus*) *quadrans* Hall and Whitfield = *Ptychoparia* Corda.
Crepicephalus (*Loganellus*) *simulator* Hall and Whitfield = *Inouyia* Walcott.
Crepicephalus (*Loganellus*) *unisulcatus* Hall and Whitfield = *Ptychoparia* Corda?

CREPICEPHALUS AUGUSTA Walcott

Plate 29, figs. 6, 6*a-b*

Crepicephalus augusta Walcott, 1886, Bull. U. S. Geol. Survey, No. 30, p. 208, pl. 28, figs. 2, 2*a-b*. (Description and illustration of cranidium and pygidium.)
Crepicephalus augusta Walcott, 1891, Tenth Ann. Rep. U. S. Geol. Survey, p. 653, pl. 96, figs. 9, 9*a-b*. (Republishes illustrations of 1886.)
Crepicephalus augusta (Walcott), Grabau and Shimer, 1910, North American Index Fossils, Vol. 2, p. 283, fig. 1585. (Described and figured.)

A detailed description of the specimen representing this species was published in 1886, and nothing has been added to it since. The illustrations are given in this paper in order that the American species referrred to *Crepicephalus* may be brought together for comparative study.

Formation and locality.—Lower Cambrian: (30) Limestone 8 miles (12.8 km.) north of Bennetts Spring, on the west slope of the Highland Range; (31a) limestones of Pioche formation, just above the quartzite on east side of anticline, near Pioche, both in Lincoln County, Nevada.

CREPICEPHALUS CAMIRO, new species

Plate 32, figs. 2, 2*a*

This is the Appalachian representative of *C. iowensis.* It differs in its small glabella and broad frontal limb of the cranidium, and the associated pygidium has about six faintly defined rings and a terminal section on the axial lobe. The outline of the postero-lateral borders of the pygidium also differs materially by sloping inward, and the two spines are shorter and nearer together proportionally with regard to the size of the pygidium.

Surface of test minutely pitted or apparently punctate under strong lens, but smooth to the unaided eye.

Formation and locality.—Upper Cambrian: (120) Maryville limestone; north of Bays Mountain, on Beaver Creek, Sevier County, 18 miles (28.8 km.) east-northeast of Knoxville; and (107) Bull Run Ridge, northwest of Copper Ridge, 11 miles (17.6 km.) northwest of Knoxville, both in Tennessee.

CREPICEPHALUS COMUS, new species

Plate 31, figs. 3, 3*a*

This species is represented by cranidia and associated pygidia. The glabella is tumid as in *C. tumidus,* but the frontal limb is little more than a narrow convex extension of the convex fixed cheeks grading into the broad frontal groove which lies within the very prominent, rounded frontal border. The three pits in the frontal furrow are nearly round, and large for the size of the cranidium.

Surface finely granulated and test apparently punctate.

The largest cranidium in the collection has a length of 17 mm.

The associated pygidia (fig. 3*a*) are much like those of *C. thoosa* (figs. 1*f-k*).

Formation and locality.—Upper Cambrian: (120) Maryville limestone; north of Bays Mountain, on Beaver Creek, Sevier County, 18 miles (28.8 km.) east-northeast of Knoxville; (107) Bull Run Ridge, northwest of Copper Ridge, 11 miles (17.6 km.) northwest of Knoxville; and (119) beneath Nolichucky shale on Cub Creek, 1.5 miles (2.4 km.) southeast of Morristown, Hamblen County, all in Tennessee.

CREPICEPHALUS COOSENSIS, new species

Plate 32, figs. 3, 3*a-f*

This fine species occurs with a somewhat earlier fauna than that of *C. iowensis* and other species referred to *Crepicephalus* with the exception of *C. liliana* and *C. augusta* (pl. 29). It belongs with the *C. iowensis* group of species and differs from them by its broad frontal limb and border and strongly marked pygidium. The thorax has 12 segments and the axial lobe of the pygidium five rings and a terminal section.

The large dorsal shield has a length of 6.5 cm. exclusive of the spine of the pygidium. Fragments of the cranidium indicate that a few individuals attained a length of about 7.5 cm.

Outer surface minutely granular and apparently minutely punctate. Fine irregular venation lines radiate from in front of the glabella across the frontal limb to the edge of the border.

All the known specimens of this species occur on the exterior of, or in siliceous nodules that weather out of, a dark argillaceous shale of the Conasauga formation. The associated fauna is a large one, and includes: *Laotira cambria* Walcott, *Brooksella alternata* Walcott, *Micromitra alabamaensis* (Walcott), *Lingulella hayesi* (Walcott), *Acrothele bellula* Walcott, *Acrotreta kutorgai* Walcott, *Ptychoparia,* several species, *Anomocare,* several species, and *Olenoides curticei* Walcott.

Formation and locality.—Middle Cambrian: (90x) Conasauga formation; in and attached to the outer surface of siliceous nodules in a dark argillaceous shale of the lower part of the Conasauga formation; east of Center, near Blaine, Coosa Valley, Cherokee County, Alabama.

CREPICEPHALUS CORIA, new species

Plate 33, figs. 3, 3*a-g*

Crepicephalus texanus WALCOTT, 1908, Smithsonian Misc. Coll., Vol. 53, p. 178. (Name listed in fauna 1*b* and 1*c* of section.)

This species is much like *C. texanus* (pl. 30). It differs in having 14 instead of 12 thoracic segments and a uniformly sized and distributed granulation on the exterior surface of the test. Test probably punctate, as minute pits occur between the surface granules.

The largest cranidium has a length of 3.5 cm.

The variation in the width of the frontal border is similar to that of *C. texanus,* and the glabella is very much alike in the two forms. *Crepicephalus coria* is the representative in western Utah of *C. texanus.*

Formation and locality.—Upper Cambrian: (30n, 30 o, 14v) Weeks formation, in 1*b* and 1*c* of section (Walcott, Smithsonian Misc. Coll., Vol. 53, 1908, p. 175); (30h, 30i) Orr formation; near base and about 275 feet from 2*a* of section (*Idem,* p. 177); north side of Weeks Canyon, about 4 miles (6.4 km.) south of Marjum Pass, House Range, Millard County, Utah.

CREPICEPHALUS DIS, new species

Plate 32, figs. 1, 1*a-c*

Crepicephalus WALCOTT, 1908, Smithsonian Misc. Coll., Vol. 53, pp. 175, 176. (Name listed in geological section.)

This is the *C. iowensis* (pl. 29) representative in the Cordilleran province. It has the same form of glabella except that it is a little more conical or rounded in front; the frontal limb is narrower, and the occipital ring is narrower towards the ends when viewed from above. The associated pygidia differ in outline of the postero-lateral portions of the border, which in *C. dis* are prolonged into short spines and in *C. iowensis* into long, sharp spines.

Crepicephalus dis is associated with *C. coria,* but neither the cranidium nor the pygidium is similar to that species. The pygidium is much like that of *C. camiro* (pl. 32, fig. 2*a*) except that the axial lobe is shorter and has three instead of five or six rings.

Surface of test smooth to the unaided eye, and minutely pitted and apparently punctate as seen by a strong lens.

Formation and locality.—Upper Cambrian: (30n, 30 o, 14v) Weeks formation, in 1*b* and 1*c* of section (Walcott, Smithsonian Misc. Coll., Vol. 53, 1908, p. 175); (30j) Orr formation; 1*e* of section (*Idem,* p. 177); north side of Weeks Canyon, about 4 miles (6.4 km.) south of Marjum Pass, House Range, Millard County, Utah.

CREPICEPHALUS IOWENSIS (Owen)

Plate 29, figs. 1, 2, 2*a-f*

Dikelocephalus ? iowensis OWEN, 1852, Rept. Geol. Surv. Wis., Iowa, Minn., p. 575, pl. 1, fig. 4; pl. 1A, fig. 13. (Describes and illustrates species.)

Conocephalites iowensis (Owen) HALL, 1863, Sixteenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 162, pl. 7, figs. 29-33; pl. 8, figs. 10-12, 30. (Describes and illustrates species.)

Conocephalites iowensis (Owen) SHUMARD, 1863, Trans. Acad. Sci. St. Louis, Vol. 2, p. 102. (Refers to species and having found the head.)

Conocephalites iowensis (Owen) HALL, 1867, Trans. Albany Inst., Vol. 5, p. 149, pl. 7, figs. 29-33; pl. 3, figs. 10-12, 30. (Reprint of paper of 1863.)

Ptychoparia (*Crepicephalus*) *iowensis* (Owen) WALCOTT, 1884, Bull. U. S. Geol. Surv., No. 10, p. 36, pl. 6, figs. 2, 2a. (Refers to use of *Crepicephalus* as a subgenus and illustrates a cranidium and pygidium.)

Ptychoparia (*Crepicephalus*) *iowensis* (Owen) LESLEY, 1889, Geol. Surv. Pa., Rept. P 4, p. 832. (2 text figs. only.)

Crepicephalus iowensis (Owen) WALCOTT, 1899, Monogr. U. S. Geol. Surv., Vol. 32, Pt. 2, p. 459. (Refers to this species as type of genus *Crepicephalus*.)

To the description given by Hall [1863] we may now add that the thorax has 12 segments; and we are also enabled to illustrate the form and general character of the entire dorsal shield, which is rather closely related to that of *C. texanus* (pl. 30). There is considerable variation in the form of the pygidium. In Owen's illustration [1852, pl. IA, figs. 11, 13, 15] the postero-lateral spines diverge from the median line of the axial lobe, but this divergence decreases in other specimens until the sides of the pygidium are nearly straight, and the ends of the spines curve inward toward the median line. The degree of the divergence varies in specimens from different localities, but in the collection from Menomonie there is variation from those that are strongly divergent to those that are diverging but slightly from the median line.

The reasons for considering this species the type of the genus are given under the description of the genus (p. 199).

Crepicephalus iowensis is very abundant in the shaly and thin-bedded sandstone of Wisconsin and eastern Minnesota. Only rarely have the cephalon, thorax, and pygidium been found unbroken; there is only one example known to me in which they are united in their natural position, and this is broken so that less than one-half of the dorsal shield remains; this specimen is used as the base for the restored figure 1 on plate 29.

In all specimens known to me the test has disappeared, but from the casts in fine sandstone the outer surface appears to have been smooth.

The larger cranidium has a length of 30 mm., and the one specimen showing the length of the dorsal shield has the following dimensions:

Total length	78 mm.
Cephalon	12.5 mm.
Thorax	29.5 mm.
Pygidium	14 mm.

Crepicephalus iowensis is very abundant in the Eau Claire formation and the upper part of the Dresbach formation.

Formation and locality.—Upper Cambrian: Eau Claire formation; (84) Dresbach, opposite the mouth of Black River, Winona County, Minnesota.

Also (78a) topmost bed on Mount Washington, near Eau Claire; (98, 98x) upper beds, middle beds, and lower beds near Eau Claire, Eau Claire County; (79x) near the flour mill on Beaver Creek, north of Galesville, and (100a) at Ettrick, both in Trempealeau County; (83a) Rock Falls, and (100) near Menomonie, both in Dunn County; also Dresbach formation; (83^4) lower beds just above the river, Trempealeau, Trempealeau County, all in Wisconsin.

CREPICEPHALUS LILIANA Walcott

Plate 29, figs. 5, 5*a-c*

Crepicephalus liliana Walcott, 1886, Bull. U. S. Geol. Survey, No. 30, p. 207, pl. 28, figs. 3, 3*a-c*. (Description and illustration of cranidium and pygidium.)

Crepicephalus liliana Walcott, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 653, pl. 96, figs. 7, 7*a-c*. (Republishes illustrations of 1886.)

A detailed description of the specimen representing this species was published in 1886, and nothing has been added to it since. The illustrations are given in this paper in order that the American species referred to *Crepicephalus* may be brought together for comparative study.

Formation and locality.—Lower Cambrian: (31a) Limestones of Pioche formation, just above the quartzite on east side of anticline, near Pioche; (30) limestone 8 miles (12.8 km.) north of Bennetts Spring, on the west slope of the Highland Range, both in Lincoln County, Nevada.

CREPICEPHALUS TEXANUS (Shumard)

Plate 29, fig. 7; plate 30, figs. 1-4, 4*a*

Arionellus (*Bathyurus*) *texanus* Shumard, 1861, Am. Jour. Sci. and Arts, 2d ser., Vol. 32, p. 218. (Description of species.)

Crepicephalus texanus Shumard sp. Walcott, 1899, Monogr. U. S. Geol. Survey, p. 460, pl. 65, fig. 5.

Not *Crepicephalus texanus* Walcott, 1908, Smithsonian Misc. Coll., Vol. 53, pp. 177, 178.

Crepicephalus texanus (Shumard) Grabau and Shimer, 1910, North Am. Index Fos., Vol. 2, p. 283, fig. 1586. (Reproduces Walcott's figure of 1899.)

The type specimen of this species is no longer accessible, having been destroyed by fire many years ago. Its locality was given as Clear Creek, Burnet County, Texas. The geological map of the

Burnet quadrangle, U. S. Geological Survey, shows that the head waters of Clear Creek drain an area on its western side where the Cap Mountain formation occurs, and it is from this area that the type specimen undoubtedly came. In the collections made by Dr. Cooper Curtice for the United States Geological Survey there are specimens of a similar form collected in the Clear Creek drainage area from Potatotop Hill, the upper portion of which is formed of the Cap Mountain formation; there are also specimens of the cranidium from a locality in the Cap Mountain formation 10 miles northwest of Potatotop that are identical with those from Potatotop.

Dr. Shumard's description of the cranidium and pygidium from Clear Creek corresponds so closely to the specimens from Potatotop that I do not hesitate to adopt the latter as the representative of the species, although Shumard described the flattened frontal border variety of the species, and the specimens from Potatotop have the rounded and intermediate or semi-flattened border; other specimens from 10 miles northwest, near the Colorado River, show the narrow rounded, intermediate and broad frontal border.

The cranidium has a low, broadly conical glabella marked by three pairs of short lateral furrows; fixed cheeks narrow, moderately elevated; frontal limb slightly convex, arching downward to a strong, rounded transverse furrow (parallel to the front margin) that has three elongate oval transverse pits, one of which is directly in front of the glabella and one on each side in line with the posterior lateral angle of the glabella; frontal border gently convex, nearly horizontal, and varying in width so as to be a little wider or narrower than the frontal limb; it varies in width, and may be convex or almost flat.

The palpebral lobes are not preserved, but Dr. Shumard in his description stated that "a line drawn transversely across the middle of the glabella, if extended, would pass nearly through to the center of the eyes." This corresponds to the specimens from both Texas and Alabama.

The associated pygidium is described as follows: "Pygidium short and somewhat massive, sub-elliptical, axis approaching semi-cylindrical, elevated above the lateral lobes, as wide as one lateral lobe, and occupying about two-thirds the length of the pygidium; rings four, separated by deep furrows; posterior margin gently arched in the middle and armed on either side with a long, curved, diverging spine (about eight lines long); lateral lobes gently convex, segments indistinct."[1]

[1] American Jour. Sci., 2d ser., Vol. 32, 1861, p. 219.

The pygidia from Potatotop and Bartlett Hollow correspond to the above description very closely, and also to the pygidia of the *Crepicephalus* that I have identified as *C. texanus* from the Upper Cambrian of Montana.

By comparing the specimens that are of similar size from the Cap Mountain limestone of Texas and the Conasauga shales of Coosa River, Alabama, they appear to be identical. In both, the glabella is broadly conical with frontal limb of medium width and separated from the frontal rim by a strong rounded furrow marked by three slightly transverse pits. In both, the outer surface of the glabella is nearly smooth or marked by low, scattered tubercles, while the fixed cheeks, frontal limb and rim are marked by rather strong granulations or tubercles. There is also a slight node near the center of the well-defined occipital ring; at each locality we find the long and shorter glabella, narrow rounded, intermediate and wide flattened frontal rim. As the cranidia increase in size, the frontal rim broadens so as to be proportionately wider than the frontal limb.

The following is a description based upon the Alabama specimens: General form of dorsal shield broadly oval; axial lobe convex, about half as wide as the pleural lobe. Cephalon broad, transversely semicircular, with a well-defined border that varies in width from narrow in young subjects to quite broad in the older individuals. Cranidium with strong, broadly conical glabella that is marked by three pairs of short lateral furrows; occipital ring of medium width and marked at its center by a small sharp-pointed node; occipital furrow broad, rounded, and narrowing at each end; dorsal furrow about the glabella deeply impressed. Fixed cheeks relatively narrow and generally convex; palpebral lobes rather large and nearly equal to one-third the length of the cranidium on the line of the facial suture; the narrow fixed cheeks merge into the relatively strong frontal limb, which is slightly convex and sloping downward to a well-defined transverse furrow, which is marked by three more or less strong, slightly transverse pits, the center one of which is on the line of the axis of the glabella and the lateral ones are on a line with the sides of the glabella near its posterior margin; frontal border varying from a narrow, slightly convex border in young specimens to a broad flattened border in the older and larger individuals; postero-lateral limbs long, rather narrow, and marked by a well-defined intramarginal furrow. The free cheeks terminate at the genal angles in rather strong, backward-extending spines.

Thorax with 12 segments, axial lobes convex, relatively narrow; pleural lobes broad, flattened for about one-half their width from the axis, then arching gently downward and backward to their pointed ends; pleural furrows nearly as wide as the segment for about one-third of its length, where they narrow and disappear some distance within the falcate termination of the segment.

Pygidium small, strong, convex; axial lobe broad, convex, and about three-fourths the length of the pygidium; it is divided by narrow, deep transverse furrows into three segments and a terminal section; pleural lobes rising abruptly from the margin and curving gently to the dorsal furrow about the axial lobe; pleural furrows shallow and curving backward towards the base of the lateral spine that originates on each side opposite the posterior half of the axial lobe and within the outer margin; these spines have a strong base that merges into the side of the pleural lobes in such a manner as to give the impression that they were formed by the continuation outward and backward of three of the anchylosed segments of the pygidium. The strength and curvature of the spines vary somewhat, but as a rule they are much like those of figures 1, 1*a*, plate 30.

Surface of test finely punctate with strong scattered granulations over free and fixed cheeks, frontal limb and border, and raised portions of thoracic segments and pygidium; on the glabella a few rather large, low tubercles are scattered over the surface. Some specimens have a rather fine, even granulation over the glabella and other parts of the cephalon.

Measurements.—This is one of the largest trilobites known to me from the Cambrian above the "*Olenellus*" zone and below the *Dikelocephalus* zone with the exception of *Paradoxides* of the Atlantic Coast province. Fragments of the cephalon and thorax indicate a length of 21 cm. exclusive of the long spines of the pygidium. The proportions of an entire dorsal shield are shown by figure 1, plate 30.

Observations.—I have hesitated to identify the Alabama form with that from Texas, owing to the large size the latter attains, but with specimens of the cranidium of the same size the similarity is so great that there does not appear to be sufficient reason to distinguish them as distinct species. The greater proportional broadening of the frontal border of the cranidium with increase in size of the cephalon gives an appearance to the large cephala that is of specific importance unless the broadening with growth is considered. There is also widening of the base of the glabella in the Texas forms that is seldom seen in those from Alabama, but this is not persistent; the more

elongate glabella of the Alabama specimens is similar to that of the variety *elongatus* of Wisconsin.

The identification of the species at the two localities is strengthened by the occurrence in both areas of similar variations in the form of the glabella, frontal limb, furrow, and border of the cranidium.

The stratigraphic position of the Texas and Alabama specimens is the same to the extent that both occur in the lower part of the Upper Cambrian.

In the Cordilleran region an apparently identical cranidium and pygidium occur in the Upper Cambrian (358c) Abrigo limestone of the Bisbee mining district, Cochise County, Arizona. The cranidia are typical forms with intermediate and broad frontal border. An apparently identical cranidium and pygidium occur in the (151g) Gallatin limestone of northern Wyoming (fig. 4, pl. 30). The cranidium has the wide glabella, variable frontal border, and coarsely granular surface of *C. texanus* (compare fig. 4 with figs. 2 and *2b*, pl. 30). A somewhat similar form with a wide flattened frontal border occurs in the Gallatin limestone of Meagher County, Montana, that is identified with the variety *elongatus* of the Eau Claire formation of Wisconsin (pl. 29, fig. 4).

The critical study of this species with new material results in removing the form described by Whitfield as *Arionellus tripunctatus* from *C. texanus,* to which I referred it in 1899,[1] and referring it to *Crepicephalus* as a distinct species characterized by an occipital spine and narrower glabella.

Formation and locality.—Upper Cambrian: (67a) Cap Mountain formation (upper beds); limestone on Potatotop Hill, 6 miles (9.6 km.) northwest of Burnet; also (14d) Bartlett Hollow, 2 miles (3.2 km.) southeast of mouth of Fall Creek, 17 miles (27.2 km.) northwest of Burnet, both in Burnet County, Texas.

Upper Cambrian: (358c) Abrigo limestone; north side Moore Canyon, west edge Bisbee quadrangle, Bisbee district, Arizona.

Upper Cambrian: (151b) Gallatin limestone; below saddle on ridge between Pebble Creek and Soda Butte Creek, Yellowstone National Park, Wyoming.

Upper Cambrian: (151i) Gallatin limestone; 6 miles (9.6 km.) northeast of White Sulphur Springs, Meagher County, Montana.

Upper Cambrian: (90a and 91) Conasauga formation: Cedar Bluff on Coosa River, Cherokee County, Alabama. Entire speci-

[1] Monogr. No. 32, U. S. Geol. Survey, p. 460.

mens occur in both argillaceous shale and shaly dark bluish-grey limestone.

Upper Cambrian: (16a, 89) Conasauga formation; shaly limestone interbedded in argillaceous shales, Murphrees Valley, Blount County; and (139a) near Chepultepec, Jefferson County, both in Alabama.

CREPICEPHALUS TEXANUS DANACE, new variety

Plate 29, figs. 3, 3*a*

This variety is represented by a single cranidium. It differs from *C. texanus* by having the glabella less convex, a trifle more elongate proportionally, and more transverse at the anterior end; and the frontal border is more rounded. Surface granulated as in *C. texanus*.

Formation and locality.—Upper Cambrian: (79d) Eau Claire formation; upper beds of sandstone on Mount Washington, near Eau Claire, Eau Claire County, Wisconsin.

CREPICEPHALUS TEXANUS ELONGATUS, new variety

Plate 29, figs. 4, 4*a*

Of this species the cranidium only is known. It is characterized by a proportionally longer glabella and narrower fixed cheeks, with a broad flattened frontal border. The transverse frontal furrow is also less deeply impressed than in typical specimens of *C. texanus*.

The surface of the test in both the Wisconsin and Montana specimens has coarse tubercles scattered irregularly on the glabella, fixed cheeks, and frontal limb.

Formation and locality.—Upper Cambrian: (79e) Eau Claire formation; 1 mile (1.6 km.) north of Eleva, Trempealeau County, Wisconsin.

Upper Cambrian: (151i) Gallatin limestone; north side of Smith River; 1.5 miles (2.4 km.) below mouth of Fourmile Creek, and 6 miles (9.6 km.) northeast of White Sulphur Springs, Meagher County, Montana.

CREPICEPHALUS THOOSA, new species

Plate 31, figs. 1, 1*a-k*

This species is based on cranidia and associated free cheeks and pygidia. It is of the *C. texanus* type, and differs from it in its more elongate, conical glabella, short frontal limb, and more thickly-set surface granules that occur on the cranidium, free cheeks, thoracic

segments, and pygidium. The associated pygidium is much like that of *C. tripunctatus magnispinus*.

With the exception of the great occipital spine, *C. thoosa* is closely related to *C. tripunctatus magnispinus*. The pygidium referred to the latter is proportionally narrower, but the postero-lateral spines are similar.

This species occurs in the upper part of the Conasauga shales in northeastern Alabama, the Maryville limestone of eastern Tennessee, and the Honaker limestone of western Virginia.

Formation and locality.—Upper Cambrian: (125a) Maryville limestone; north side of Big Creek below Harlans mill, 4 miles (6.4 km.) northeast of Rogersville; (125) about 50 feet below 125a; (123b) upper beds of Maryville limestone, 0.5 mile (0.8 km.) east of Rogersville railway depot on left of railway, in wagon road, Hawkins County; (107) Bull Run Ridge, northwest of Copper Ridge, 11 miles (17.6 km.) northwest of Knoxville; (126a) east side of Gap Creek section, 10 miles (16 km.) east of Knoxville, Knox County; (119) beneath Nolichucky shale on Cub Creek, 1.5 miles (2.4 km.) southeast of Morristown, Hamblen County; (120) north of Bays Mountain on Beaver Creek, Sevier County, 18 miles (28.8 km.) east-northeast of Knoxville; (118a) Bird Bridge road, 1.5 miles (2.4 km.) south, and (117c) 5 miles (8 km.) southeast of Greeneville, Greene County, all above in Maryville limestone of Tennessee.

Also (119a) Honaker (= Maryville) limestone, 3 miles (4.8 km.) east of Greendale, Washington County, Virginia.

Also (145a) Conasauga shale; upper part of shale beneath Knox dolomite; 1 mile (1.6 km.) east of Gaylesville; also (91) Cedar Bluff, both in Cherokee County; and (358e) Conasauga shale, opposite car barn, city of Birmingham, Jefferson County, all in Alabama.

And (358f) Conasauga formation; limestone in shales, west of Red Clay, Whitfield County, Georgia.

CREPICEPHALUS TRIPUNCTATUS (Whitfield)

Plate 33, figs. 1, 1*a-b*

Arionellus tripunctatus Whitfield, 1876, Rept. Reconnaissance from Carroll, Montana Terr., on the Upper Missouri, to the Yellowstone National Park (Ludlow), p. 141, pl. 1, figs. 3-5. (Original description and illustrations.)

Not *Crepicephalus texanus* (Shumard) Walcott, 1899, Monogr. No. 32, U. S. Geol. Survey, p. 460. (Refers *Arionellus tripunctatus* Whitfield to *C. texanus* (Shumard).)

The type of this species is a cranidium with the occipital spine broken off. Whitfield also had two associated free cheeks for study. In 1898 I collected from about the same horizon in the Gallatin limestone a number of fine cranidia, also fragments of an associated pygidium. This material shows a strong resemblance between the cranidia of *C. tripunctatus* and *C. texanus,* the difference being in the thickened occipital ring and occipital spine of *C. tripunctatus.* The outer surface of the latter species is also more thickly covered with smaller granulations. The test appears to be finely punctate.

The variation in the width of the frontal border of the two species is similar, the smaller species having a proportionally narrower border than the large ones.

The closely related *C. tripunctatus magnispinus* differs from this species in having slightly narrower fixed cheeks and a much stronger and larger occipital spine.

Formation and locality.—Upper Cambrian: (358d) Gallatin limestone; Moss Agate Springs near Camp Baker, which is 18 miles (28.8 km.) northwest of White Sulphur Springs, Meagher County; also (4r) Gallatin limestone on ridge between Luce and Deep Creeks, 8 miles (12.8 km.) east of Yellowstone River and 3 miles (4.8 km.) north-northeast of Mount Delano, Park County, both in Montana.

CREPICEPHALUS TRIPUNCTATUS MAGNISPINUS, new variety

Plate 33, figs. 2, 2*a-c*

This fine species is abundant at one locality in eastern Tennessee. It is the representative in the Appalachian area of *C. tripunctatus* of the Cordilleran area, and differs from that species in its narrower fixed cheeks and longer and stronger occipital spine. Both forms have the outer surface of the cranidium and free cheeks rather thickly dotted with irregularly arranged granules or small tubercles; the test appears to be finely punctate.

The associated pygidia are narrow with a long, strong, nearly straight spine projecting from the postero-lateral side of each pleural lobe. The axial lobe is broad and divided into three rings and a terminal section by strong backward-curving furrows.

Formation and locality.—Upper Cambrian: (107) Maryville limestone; Bull Run Ridge, northwest of Copper Ridge, 11 miles (17.6 km.) northwest of Knoxville, Knox County, Tennessee.

CREPICEPHALUS TUMIDUS, new species

Plate 31, fig. 2

This species is represented by cranidia. It differs from the cranidia of the most nearly related species, *C. texanus* and *C. thoosa,* by greater convexity of glabella and more strongly tuberculated surface. Test apparently punctate. The largest cranidium has a length of 25 mm.

It is unfortunate that we have only the cranidia of this fine species, but as they are closely allied to the cranidia of *C. texanus,* it is highly probable that the entire dorsal shield of the two forms was essentially similar.

Formation and locality.—Upper Cambrian: (120) Maryville limestone; north of Bays Mountain, on Beaver Creek, Sevier County, 18 miles (28.8 km.) east-northeast of Knoxville, Tennessee.

CREPICEPHALUS UNCA, new species

Plate 35, figs. 1, 1*a-e*

The pygidium of this species is not unlike that of *C. dis* (pl. 32, fig. 1) from the House Range of Utah. It differs in having the two posterior spines of the pygidium near together and in their broader base where joining the flattened border.

The associated cranidium is similar in outline to that of *C. dis,* but differs in having proportionally broader fixed cheeks.

The largest pygidium has a length of 12 mm. exclusive of the spines.

Formation and locality.—Upper Cambrian: (79e) Eau Claire formation; Willow River Falls, near Hudson; (79) Hudson, St. Croix County, Wisconsin.

CREPICEPHALUS UNZIA, new species

Plate 34, figs. 7, 7*a*

This species, like *C. unca,* is related to *C. dis* (pl. 32, fig. 1*b*) and *C. augusta* (pl. 29, fig. 6*b*) by the form of the pygidium, but the backward-extending spines are not attachments to the border, as the furrows indicating the anchylosed segments extend back onto the base of the spines as shown by figure 7*a*. The cranidium is quite unlike that of *C. dis.* It has a concave frontal rim and border that give it a very distinct appearance.

Surface slightly pitted and test apparently punctate. The largest cranidium has a length of 7.5 mm.

Formation and locality.—Upper Cambrian: (150b) Gallatin limestone; thin-bedded limestone in divide at White Creek and Indian Creek Pass, above Red Bluffs or Chinese Wall, Lewis and Clark National Forest, Montana.

CREPICEPHALUS UPIS, new species

Plate 33, figs. 4, 4*a-d*

The cranidium and pygidium of *C. upis* recall those of *C. liliana* (pl. 29, figs. 5, 5*a*), and the outer surface is granulated in both species, but not in the same manner. The surface of *C. liliana* has rather large pustules scattered over it, while those of *C. upis* are more numerous and smaller. The pygidium is not unlike that of *C. coosensis* (pl. 32, figs. 3*b*, 3*e*). The surface of the test between the granulations is slightly pitted and the test is apparently punctate.

The largest cranidium in the collection has a length of 14 mm.

Formation and locality.—Upper Cambrian: (150b) Gallatin limestone; thin-bedded limestone in divide at White Creek and Indian Creek Pass, above Red Bluffs or Chinese Wall, Lewis and Clark National Forest, Montana.

CREPICEPHALUS, species undetermined (1)

Plate 32, figs. 4, 4*a*

An undescribed species of *Crepicephalus* of the *C. iowensis* group is represented by a form of pygidium that is closely allied to that of *C. iowensis*. It differs in having the postero-lateral spines extending diagonally outward instead of directly backward, and in being proportionally wider.

A specimen from the shaly limestone of the Conasauga formation has a length of 16 mm. and a width of 3 cm. at the anterior margin. A smaller specimen is illustrated (pl. 32, fig. 4).

Formation and locality.—Upper Cambrian: (107) Maryville limestone; Bull Run Ridge, northwest of Copper Ridge, 11 miles (17.6 km.) northwest of Knoxville, Knox County; (119) beneath Nolichucky shale on Cub Creek, 1.5 miles (2.4 km.) southeast of Morristown, Hamblen County, both in Tennessee.

Also from (91) Conasauga formation; Cedar Bluff on Coosa River, Cherokee County; and (16) limestones in Conasauga (Coosa) shales, Murphrees Valley, Blount County, both in Alabama.

CREPICEPHALUS, species undetermined (2)

A second unidentified species of *Crepicephalus* is indicated by pygidia of the *C. iowensis* type from the Upper Cambrian. These

pygidia differ from those referred to *C. camiro* (pl. 32, fig. 2*a*), being more transverse in outline and having three rings in the axial lobe.

Formation and locality.—Upper Cambrian: (**124a**) Nolichucky shale; on Big Creek, 4 miles (6.4 km.) northeast of Rogers, Hawkins County, Tennessee; also (**124b**) Nolichucky shale; near Goodwins Ferry, Giles County, Virginia.

AMPHION ? MATUTINA Hall

Plate 26, fig. 8

Amphion ? matutina HALL, 1863, Sixteenth Ann. Rept. State Cab. Nat. Hist., p. 222, pl. 5A, fig. 6. (Original description and illustration.)

Amphion ? matutina HALL, 1867, Trans. Albany Inst., Vol. 5, p. 194. (A reprint of the paper of 1863.)

This species is illustrated, as the specimen in the collection shows that there was an occipital spine, also small palpebral lobes opposite the center of the glabella. The species appears to belong to an undetermined genus, but at present I do not wish to base a new genus on the broken cranidium.

Formation and locality.—Upper Cambrian: (**84**) Eau Claire formation; Dresbach, Winona County, Minnesota.

The specimen described by James Hall came from the lower beds near Trempealeau, Wisconsin, which also contains *Crepicephalus iowensis*, a form found with *A. ? matutina* at Dresbach.

Genus WANNERIA Walcott

Wanneria WALCOTT, 1910, Smithsonian Misc. Coll., Vol. 53, pp. 296-298.

WANNERIA WALCOTTANA (Wanner)

Plate 38, figs. 1, 2

Olenellus (*Holmia*) *walcottanus* WANNER, 1901, Proc. Washington Acad. Sci., Vol. 3, pp. 267-269, pl. 31, figs. 1, 2; pl. 32, figs. 1-4. (Described and discussed as a new species.)

Wanneria walcottanus WALCOTT, 1910, Smithsonian Misc. Coll., Vol. 53, pp. 302-304, pl. 30, figs. 1-12; pl. 31, figs. 12, 13. (Changes generic reference. Comments upon and illustrates species.)

Through the courtesy of Mr. Noah Getz and Dr. H. Justin Roddy I had the opportunity of photographing a cephalon of this species that has an unusually well-preserved surface. The cephalon has a length of 9.5 cm. and a width at base of 15.5 cm. The reticulated surface is essentially of the same character as that on a thoracic segment and hypostoma of this species from near York, Pennsyl-

vania.[1] It is also of the same type as the surface of *Olenellus reticulatus* Peach[2] from Scotland.

Formation and locality.—Lower Cambrian: (12x) Argillaceous shaly beds 1 mile (1.6 km.) north of Rohrerstown, Lancaster County, Pennsylvania.

Family Oryctocephalidæ Beecher

VANUXEMELLA, new genus

Dorsal shield small, subelliptical, moderately convex, and with strongly marked axial lobe. Cephalon semicircular in outline; glabella large, slightly expanding in front and slightly narrowed opposite the palpebral lobes; it terminates anteriorly on the frontal margin, and posteriorly is separated from the narrow occipital segment by a strong transverse furrow; two pairs of faint pits indicate the position of glabella furrows; fixed cheeks about one-half the width of glabella and with a narrow palpebral lobe about one-fourth to one-third the length of the cephalon and placed at about the transverse center of the cephalon. The facial sutures cut the posterior margin of the cephalon on a line with the outer margin of the palpebral lobes and bend inward slightly to the base of the palpebral lobes, about which they curve, and then curve slightly inward toward the margin near the glabella. Free cheeks of medium width with posterior margin bent forward at the intergenal angle to meet the base of the genal spine. The palpebral ridges cross the fixed cheeks to the dorsal furrows beside the glabella.

Thorax with four or five segments; pleuræ with strong longitudinal furrow and short, falcate ends.

Pygidium with strong axial lobe terminating just within the margin and crossed by five or six furrows which continue laterally on the pleural lobes and outline three or four segments that have a short, falcate end beyond the line of the border of the pygidium; on each side of the center of the posterior margin, at about the ends of the central third, a small, strong spine extends directly backward, and two very short spines occur between them, one on each side of the center of the posterior margin of the pygidium.

Surface slightly roughened and apparently minutely punctate.

Genotype.—*Vanuxemella contracta* Walcott. Second species, *Vanuxemella nortia,* new species.

Stratigraphic range.—Upper beds of Lower Cambrian.

[1] Smithsonian Misc. Coll., Vol. 53, No. 6, 1910, pl. 31, figs. 12 and 13.
[2] *Idem,* pl. 39, figs. 10, 11.

Geographic distribution.—*Vanuxemella contracta* occurs (localities **4v, 5j**) in the Lewis and Clark Forest Reserve of northern Montana, and *Vanuxemella nortia* at about the same stratigraphic horizon, judging from the associated fauna, on the south slope of Mount Bosworth (locality **35c**), British Columbia, Canada.

Observations.—This genus is represented by two species from the upper part of the Lower Cambrian. It is a simple form that has some features suggesting *Albertella*.[1] It differs in absence of glabellar furrows, shorter eye lobes, absence of prolonged third segment of thorax, and in having four instead of seven thoracic segments. The long spines of the pygidium spring from about the fifth segment, while in *Albertella* they appear to be the extension of the first or second anterior segment.

Vanuxemella also has an interesting feature in the union in the pygidium of three otherwise true thoracic segments. If these three anterior segments were free, the resemblance to *Albertella* would be much stronger. The genus may be characterized as an undeveloped form of the latter genus.

The cephalon of *Karlia stephenensis* Walcott[2] has an expanding glabella, but it also has quite a different glabella and fixed cheeks, and it has seven segments and a minute pygidium.

The generic name is given in memory of Lardner Vanuxem, the geologist who surveyed the "Third District of the State of New York."

VANUXEMELLA CONTRACTA, new species

Plate 36, figs. 4, 4*a*

The description and observations under the genus and the illustrations give all that is known of the species. There are five entire specimens and a few cranidia.

Dimensions.—A dorsal shield 12 mm. in length has the following dimensions:

Cephalon.	mm.
Length	6
Width at posterior margin	9
Width of base of glabella	8

[1] Smithsonian Misc. Coll., Vol. 53, 1908, pls. 1 and 2.

[2] Proc. U. S. Nat. Mus., 1888, Vol. 11, 1889, p. 445. See plate 36, fig. 8, of this paper.

Thorax.
Length 3.5
Width of first segment..... 8
Width of axial lobe..... 3
Pygidium.
Length 5
Width of axial lobe..... 2.5

Observations.—The associated fauna at localities 4v and 5j includes:

Micromitra (Iphidella) pannula (White).
Obolus (Westonia) ella (Hall and Whitfield).
Acrothele colleni Walcott.
Acrothele panderi Walcott.
Wimanella simplex Walcott.
Ptychoparia sp.
Olenopsis americanus Walcott.
Albertella helena Walcott.
Bathyuriscus ? sp.
Vanuxemella contracta Walcott.

This fauna is of the same type as that found with *Vanuxemella nortia* in Canada (see p. 223).

Formation and locality.—Lower Cambrian: (4v) About 200 feet (61 m.) above the unconformable base of the Cambrian and 75 feet (22.9 m.) above the top of the quartzitic sandstones, in a shale which corresponds in stratigraphic position to shale No. 6 of the Dearborn River section, Gordon Creek, 6 miles (9.6 km.) from South Fork of Flathead River, Ovando quadrangle (U. S. G. S.); and (5j) above the quartzitic sandstones, in a shale corresponding to the same position, about 6 miles (9.6 km.) west-northwest of Scapegoat Mountain, on the Continental Divide between Bar Creek and the headwaters of the south fork of North Fork of Sun River, Coopers Lake quadrangle (U. S. G. S.), both in Powell County, Montana.

VANUXEMELLA NORTIA, new species

Plate 36, fig. 5

This species differs from *Vanuxemella contracta* in having a greater expansion of the glabella towards the frontal margin; longer palpebral lobes; five instead of four thoracic segments, and smaller posterior spines on the pygidium.

The fauna associated with this species includes at locality 35c the following:

Micromitra (Paterina) wapta Walcott.
Obolus parvus Walcott.
Acrothele colleni Walcott.
Wimanella simplex Walcott.
Hyolithellus.
Hyolithes.
Albertella bosworthi Walcott.
Albertella helena Walcott.
Bathyuriscus.
Agraulos stator Walcott.
Ptychoparia.

Formation and locality.—Lower Cambrian: (35c) Drift blocks of siliceous shale supposed to have come from the Mount Whyte formation, found on the south slope of Mount Bosworth, about 500 feet (152 m.) northwest of the Canadian Pacific Railway track between Stephen and Hector, eastern British Columbia, Canada.

Genus KARLIA Walcott

Karlia Walcott, 1889, Proc. U. S. Nat. Mus., Vol. 11, p. 444. (Described as below.)

Form elongate-oval, convex. Head longitudinally semicircular, deeply marked by the dorsal furrows. Glabella clavate, broadly expanded in front, with or without faint glabellar furrows. Occipital furrow well defined. Fixed cheeks subtriangular; posterior furrow broad; eye lobe small; free cheeks narrow. Hypostoma with a thick, rounded anterior margin that is produced into the large lateral wings, the sides of which extend one-half way back on the oval, convex body; posterior marginal rim strong and separated from the body by a well-defined sulcus.

Thorax with seven segments; axis with a central spine on each segment; pleural lobes with a broad groove; anterior lateral ends of pleuræ faceted.

Pygidium short, transverse, four to five segments in the axis, lateral lobes slightly grooved.

Surface granulose.

Genotype.—*Karlia minor* Walcott.

Stratigraphic range.—Middle Cambrian.

Geographic distribution.—Eastern Newfoundland; Canadian Rocky Mountains, British Columbia, Canada.

Observations.—The compact, strong dorsal shield of *Karlia* at once recalls that of *Bathyuriscus.* It differs from the latter in its small eye lobes, and seven instead of 10 or 11 thoracic segments.

Two species only have thus far been referred to the genus.

KARLIA MINOR Walcott

Plate 36, figs. 7, 7*a-c*

Karlia minor Walcott, 1889, Proc. U. S. Nat. Mus., Vol. 11, p. 445. (Described as below.)

Form elongate-oval, convex. Average size, 7 mm. in length by 3 mm. in breadth. Head longitudinally semicircular, convex; frontal rim a narrow margin which passes into a stronger rim on the sides. Glabella clavate, expanding from the base to twice the width in front, marked by four pairs of short, faint glabellar furrows; occipital furrow deep; occipital ring strong and with a sharp, slight node at the center. The broad, deep dorsal furrows unite with the posterior furrows to separate the strongly convex subtriangular fixed cheeks; eye lobe short, narrow, and defined by a well-marked groove from the cheek; the groove extends forward to the dorsal furrow. Free cheeks narrow; marginal rim round and strong; posterior angle pointed, but not known to be extended into a spine.

Thorax with seven segments; median lobe convex and with a very short node or spine at the center of each segment; pleural lobes flat to the geniculation of the pleuræ, where the outer half of the segments is bent obliquely downward and slightly backward; pleural groove the full width of the segment to the geniculation, where it abruptly tapers to a point by the cutting in of the facet on the anterior side of the segment.

Pygidium of medium size, transversely semicircular; axis convex and crossed by three or four rings and the terminal lobe; the rings are extended out on the lateral lobes as broad, low ridges trending obliquely backward to the rounded margin.

Surface of the head granulated; thorax and pygidium apparently smooth.

All the specimens seen are small, none exceeding 10 mm. in length.

Formation and locality.—Middle Cambrian: (1) Manuels formation; Manuels Brook, Conception Bay, Newfoundland.

KARLIA STEPHENENSIS Walcott

Plate 36, fig. 8

Menocephalus salteri ? Rominger, 1857, Proc. Acad. Nat. Sci., Philadelphia, Pt. 1, p. 16, pl. 1, fig. 6. (Described and figured.)

Karlia stephenensis Walcott, 1889, Proc. U. S. Nat. Mus., Vol. 11, p. 445. (Described as below.)

Karlia stephenensis Walcott, 1908, Canadian Alpine Jour., Vol. 1, No. 2, pl. 3, fig. 4. (Specimen figured.)

This species differs from the *K. minor* in its greater size, 40 mm. in length by 30 mm. in breadth; the fixed cheeks are wider and the grooves on the pleuræ are narrower. In one of the large specimens the surface of the glabella is covered with fine, irregular elevated striæ.

Formation and locality.—Middle Cambrian: (14s) Stephen formation; about 2,300 feet (701 m.) above the Lower Cambrian, on the northwest slope of Mount Stephen, above Field, on the Canadian Pacific Railway, British Columbia, Canada.

HANBURIA, new genus

General outline of dorsal shield a broad oval; convex; axial and pleural lobes clearly defined.

Cephalon transverse, semicircular when not distorted; genal angles rounded on the postero-lateral limbs; marginal border narrow and wire-like on the outer margins; posterior border broader and flatter and well defined by a narrow furrow that curves forward at the genal angles to unite with the narrow furrow within the outer border. Glabella large, increasing in width by gradual divergence of the sides to the broadly rounded transverse frontal margin; three short raised lobes, one outlined on each side by furrows or depressions that join a longitudinal depressed area extending along the median line; dorsal furrow beside the glabella indistinctly defined; occipital ring narrow, transverse, and a little raised above the slight occipital furrow; frontal limb wider than the border in advance of the glabella. Fixed cheeks broad, slightly convex, and with rounded genal angles. Free cheek, if present, narrow, elongate, narrowing to a point where it joins the border posteriorly and anteriorly in front of the antero-lateral angle of the glabella. Supposed eye lobe indistinct and it may not be present; it appears to be situated opposite the anterior fourth of the glabella, but it may be only a slight flexure of the thin test.

The facial sutures are very uncertain, and it is doubtful if they are present at all.

Thorax with seven sharply defined narrow segments. Axial lobe about two-thirds the width of the palpebral lobes and clearly outlined by the dorsal furrows; pleural lobes flattened; each pleural segment terminates in a blunt rounded end; it has a broad rounded furrow that occupies nearly all its surface for about three-fifths of its length and then narrows to a point just inside the outer end of the segment; a slightly faceted surface extends along the outer anterior edge of the segment, and the back edge is rounded.

Pygidium large; axial lobe distinct and narrowing from the front margin to within a short distance of the posterior margin; it is divided into six rings and a short terminal section by narrow transverse furrows; on the broad pleural lobes seven anchylosed pleural segments similar in appearance to those of the thorax extend from the axial lobe across to the outer rim.

Surface apparently finely and minutely granular or pustulose.

Dimensions.—The largest dorsal shield has a length of 24 mm.

Genotype.—*Hanburia gloriosa* Walcott.

Stratigraphic range.—Middle Cambrian: Burgess shale member of Stephen formation.

Geographic distribution.—Limited to fossil bed on ridge between Mounts Wapta and Field, west of the Continental Divide, British Columbia, Canada.

Observations.—The existence of free cheeks and facial sutures is problematical, owing to the compression of the thin test along the edge of the cephalon. They seem to be indicated and to form a part of the margin opposite the anterior third of the glabella. There is also a slight line that may be traced diagonally backward across the inner portion of the fixed cheek from about opposite the anterior edge of the middle lobe or tubercle of the glabella. This is suggestive of the false "eye line" of *Conocoryphe*. As I expect to work the Burgess Pass fossil quarry another season, it may be that a more perfect cephalon will be found of this species. The large pygidium and few thoracic segments suggest the order Opisthoparia and family Asaphidæ rather than the order Proparia.

HANBURIA GLORIOSA, new species

Plate 36, figs. 3, 4

The generic description includes what is known of this species. Three specimens have been found during the five seasons' collecting at the fossil quarry. These are all compressed in the fine shale, and, like *Burlingia hectori*[1] from the same general horizon on Mount Stephen, had a very delicate test.

Formation and locality.—Middle Cambrian: (**35k**) Burgess shale member of the Stephen formation, on the west slope of the ridge between Mount Field and Mount Wapta, 1 mile (1.6 km.) northeast of Burgess Pass, above Field, British Columbia, Canada.

[1] Smithsonian Misc. Coll., Vol. 53, 1908, p. 15, pl. 1, fig. 8.

Genus TSINANIA Walcott

Tsinania Walcott, 1914, Smithsonian Misc. Coll., Vol. 64, p. 43. (Genus described.)

Genotype.—*Illœnurus canens* (Walcott) [Cambrian Faunas of China, Carnegie Inst. of Washington, Pub. No. 54, 1913, p. 222, pl. 23, fig. 3].

TSINANIA CLEORA Walcott

Plate 36, figs. 9, 9*a-c*

Tsinania cleora Walcott, 1914, Smithsonian Misc. Coll., Vol. 64, p. 43. (Name mentioned in text.)

The cranidium of *T. cleora* is much like that of *T. canens*. It differs in being longer in proportion to the width. The associated free cheek (fig. 9*a*) is large, broad, and gently convex to the outer margin. An associated thoracic segment has the pleural lobe with a very faint longitudinal furrow. The associated pygidium is transverse, about twice as wide as long, and marked by a low axial lobe that becomes very inconspicuous toward the posterior margin of the pygidum. Only a slight trace of transverse furrows can be detected on the matrix of the axial lobe. The pleural lobes are about twice as broad as the axial lobe. The test is thick and apparently smooth on its outer surface.

The largest cranidium has a length of 14 mm. An associated pygidium has the same length with a width of 28 mm.

The pygidium of *T. cleora* is proportionally shorter than that of *Tsinania canens*,[1] but the general character is the same in the two species and quite unlike the pygidium of *Illœnurus quadratus*.[2]

Numerous specimens of the cranidium and pygidium are associated, and the only other trilobitic remains are those of small species of *Agraulos* and *Solenopleura*-like forms. The associated brachiopods are *Schizambon typicalis* Walcott ? and *Eoorthis desmopleura* (Meek).

This species is referred to the Upper Cambrian, but it may belong to a lower Ozarkian fauna that has not yet been well determined and probably will not be until the various faunal horizons of the lower Pogonip limestones have been studied in the field.

Formation and locality.—Upper Cambrian: (30w) Notch Peak formation; drift bowlder of limestone supposed to have come from

[1] Cambrian Faunas of China, Carnegie Inst. of Washington, Pub. No. 54, 1913, p. 222, pl. 23, fig. 3.

[2] 16th Ann. Rept. New York State Cab. Nat. Hist., 1863, pl. 7, fig. 56.

the beds forming 1*a* of the Notch Peak limestone on Notch Peak, found 2 miles (3.2 km.) south of Marjum Pass, House Range, Millard County, Utah.

TSINANIA ELONGATA, new species

Plate 36, figs. 10, 10*a*

This species is founded on a small pygidium that is longer in proportion to its width than described species. It has a length of 4 mm. and a width of 2.5 mm. in front of the small palpebral lobes. The postero-lateral limbs are relatively large and a posterior occipital ring is very faintly defined. The longitudinal outline of the cranidium is nearly flat from its posterior margin to the anterior line of the palpebral lobes, where its gentle curve increases so as to bring the anterior margin far below the level of the palpebral lobes.

This is a small species allied to *Tsinania canens*[1] from eastern China. It is associated with *Dikelocephalus ? dalyi* Walcott,[2] and is supposed to be of Upper Cambrian age. Several undescribed species that occur in Upper Cambrian formations of the Appalachian region of southeastern North America are closely related to this species.

The only associated species is *Dikelocephalus dalyi* Walcott.[3]

Formation and locality.—Upper Cambrian: (346e) Limestone nodules in calcareous shales in rock cut on Canadian Pacific Railway, 54.5 miles (87.2 km.) west of Field, and 2 miles (3.2 km.) west of Donald Station, British Columbia, Canada. (R. A. Daly, 1912.)

Type specimen in Victoria Memorial Museum, Ottawa, Canada.

CONASAUGA FORMATION

In the Coosa Valley and adjoining areas the shales and interbedded limestones referred to the Conasauga formation include both Upper and Middle Cambrian species. It is quite probable that a detailed study of the formation will result in the separation of the dark shales with the so-called "cobble" beds, and containing a Middle Cambrian fauna, from the lighter colored shales and interbedded limestones. When this is done the term Conasauga will be restricted to the Upper Cambrian, and the Middle Cambrian beds will be given a formation name.

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[1] Research in China, Carnegie Inst. of Washington, Vol. 3, Pub. No. 54, 1913, p. 222, pl. 23, fig. 3.

[2] Smithsonian Misc. Coll., Vol. 57, 1914, p. 367, pl. 64, figs. 1, 1*a*, 2, 3, 4, 4*a*, 5.

[3] Idem, p. 366.

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Acrocephalites stenometopus (Angelin) 181

FIGS. 1, 1*a*. (×3.) Reproduction of photograph of the type specimen of the cranidium.

1*b*. (×3.) Matrix of free cheek assigned to the cranidium.

The specimens illustrated are from the (309n) *Agnostus lævigatus* zone of the Middle Cambrian limestone at Gudhem, Skaraborg (Vestergötland), Sweden. Type in Geol. Min. Inst., Lund, Sweden. Plastotype, U. S. National Museum, Catalogue Nos. 61555 and 61556.

Acrocephalites americanus Walcott 177

FIG. 2. (×2.5.) Dorsal view of a nearly entire cranidium, with the outline of the missing parts restored from other specimens. U. S. National Museum, Catalogue No. 61557.

2*a*. (×3.) A cranidium varying in details from fig. 2. U. S. National Museum, Catalogue No. 61558.

2*b*. (×8.) Surface of the cranidium of fig. 2 on left side of fixed cheek in front of ocular ridge.

3. (×1.5.) An imperfect dorsal shield with 29 thoracic segments. This is the only specimen known to me that indicates the appearance of the thorax. (Locality 90x.) U. S. National Museum, Catalogue No. 61559.

3*a*. (×4.) Cranidium and portion of thorax of a specimen from the shale in which the siliceous nodule specimens represented by figs. 2, 2*a-c*, and 3 were embedded. (Locality 112.) U. S. National Museum, Catalogue No. 61560.

3*b*. (×5.) Side view of a free cheek associated with this species. (Locality 16d.) U. S. National Museum, Catalogue No. 61561.

The specimens represented by figs. 2, 2*a-b* are from the siliceous nodules of locality 89x. These occur in the Conasauga shales of the Middle Cambrian, Coosa Valley, Livingston, Floyd County, Georgia.

Figs. 3, 3*a-b* are of specimens from the shale in which the nodules occur, (90x, 112, and 16d) Coosa Valley, Cherokee County, Alabama.

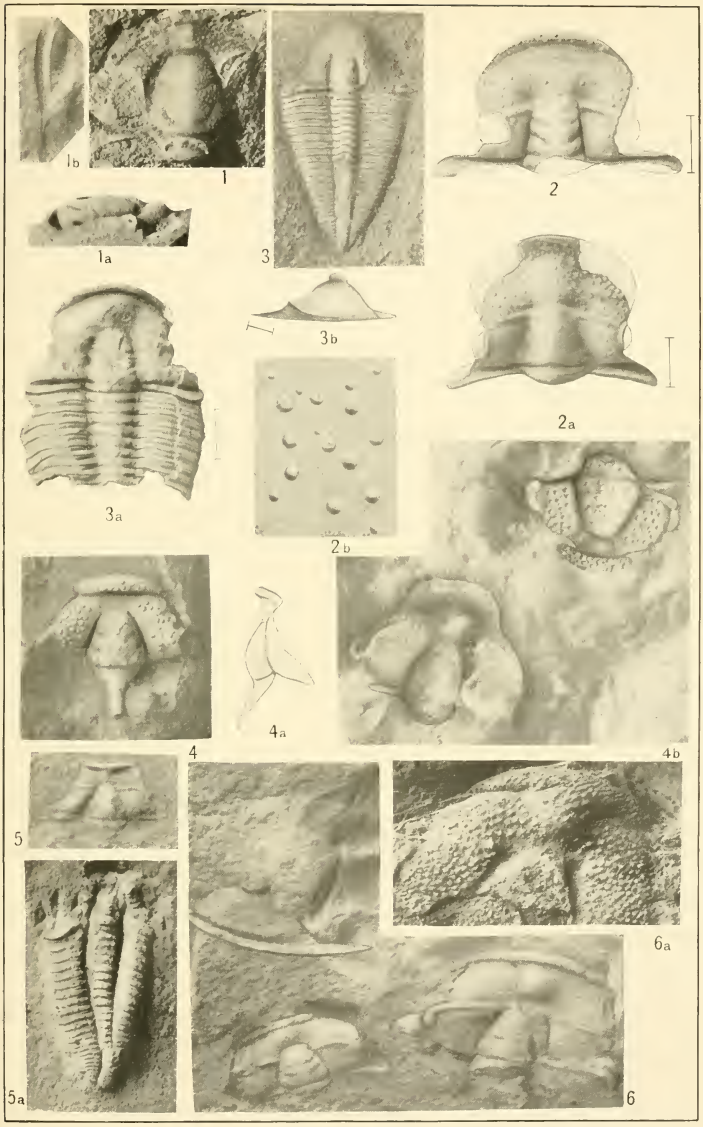
Acrocephalites haynesi Walcott 179

FIGS. 4, 4*a*. (×3.) Dorsal view and side outline of a small cranidium on which the tubercle in front of the glabella is only slightly developed.

4*b*. (×3.) Dorsal view of two cranidia illustrating variation in frontal tubercle.

The specimens illustrated by figs. 4, 4*a*, and 4*b* are from the Upper Cambrian, Meagher limestone on Pole Creek, Montana. The type specimen is at the Museum of Comparative Zoölogy, Cambridge, Massachusetts.

Plastotypes, U. S. National Museum, Catalogue No. 61562, 61563.



ACROCEPHALITES

DESCRIPTION OF PLATE 25

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Acrocephalites insignis Walcott 179

FIG. 1. (×4.) Cranidium with strong palpebral lobes, and ridges crossing fixed cheeks. U. S. National Museum, Catalogue No. 61568.

1*a*. (×4.) Nearly entire dorsal shield crushed in the shale. U. S. National Museum, Catalogue No. 61569.

1*b*. (×4.) A cranidium and part of thorax. Free cheek and outline of eye preserved. U. S. National Museum, Catalogue No. 61570.

The specimens represented by figs. 1, 1*a-b* are from locality 112, Middle Cambrian: Conasauga shale; east of Center, Cherokee County, Alabama.

Alokistocare subcoronatum (Hall and Whitfield) 187

FIG. 2. (×4.) Cranidium of the type specimen of the species. U. S. National Museum, Catalogue No. 15442.

The type specimen and cotypes are from a limestone of Lower Cambrian age, (31c, 54 0) Ute Peak, Wasatch Range, Cache County, Utah.

Alokistocare althea Walcott 184

FIG. 3. (×3.) Cast of cranidium in fine-grained sandstone. U. S. National Museum, Catalogue No. 61571.

3*a*. (×2.) Matrix of a cranidium in fine-grained sandstone. U. S. National Museum, Catalogue No. 61572.

The specimens illustrated are from locality 74, Middle Cambrian: Tapeats sandstone; at head of Nunkoweap Valley, Grand Canyon of the Colorado River, Arizona.

4. (×2.) Cephalon and portion of thorax. U. S. National Museum, Catalogue No. 61573.

4*a*. (×2.) Entire dorsal shield with exception of free cheeks. Both 4 and 4*a* are compressed in fine arenaceous shale. U. S. National Museum, Catalogue No. 61574.

The specimens represented by figs. 4 and 4*a* are from the Upper Cambrian: (74e) Bright Angel shale; Cameron trail, Grand Canyon of the Colorado River, Arizona.

Alokistocare ? labrosum Walcott 184

FIGS. 5, 5′. (×3.) Dorsal view of the cast of the interior surface of a cranidium and outline of profile. U. S. National Museum, Catalogue No. 61575.

5*a*. (×3.) A small cranidium from which the test has been exfoliated. U. S. National Museum, Catalogue No. 61576.

The specimens illustrated by figs. 5 and 5*a* are from the Middle Cambrian: (5f) limestone in Wolsey shale, 11 miles (17.6 km.) south of Neihart, Cascade County, Montana.


1


2

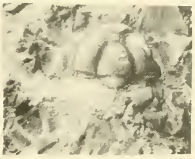

3


1a

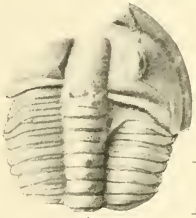

4


4a


5


5a


5′ 5a′


1b


7


8


6


7a

CAMBRIAN TRILOBITES

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Alokistocare pomona Walcott..... 186

FIG. 6. (×3.) Entire dorsal shield. The type specimen of the species compressed in fine shale. U. S. National Museum, Catalogue No. 61577.

From Middle Cambrian: (159f) Wolsey shale; Sixteen-mile Canyon, Meagher County, Montana.

Alokistocare linnarssoni (Walcott)..... 185

FIG. 7. (×2.) Type specimen of species. Cranidium. U. S. National Museum, Catalogue No. 24611.

7*a*. (×2.) Two cranidia showing variation in width of fixed cheek as compared with fig. 7, also free cheek. U. S. National Museum, Catalogue No. 24611.

The specimens represented by figs. 7 and 7*a* are from the Middle Cambrian: (58) Shaly limestone in Secret Canyon shale; New York and Secret Canyons, Eureka district, Nevada.

Alokistocare ? prospectense (Walcott) 186

FIG. 8. (×4.) Dorsal view of a somewhat flattened cranidium which is the type specimen of the species as it occurs in a shaly limestone. U. S. National Museum, Catalogue No. 15441.

The type specimen is from the Middle Cambrian: (52a) Prospect Mountain formation; Prospect Mountain, Eureka mining district, Nevada.

DESCRIPTION OF PLATE 26

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Acrocephalites ? majus Walcott 180

FIG. 1. (Natural size.) Large cranidium doubtfully referred to this genus. U. S. National Museum, Catalogue No. 61578.

The specimen illustrated is from the Middle Cambrian: (4g) Wolsey shale: 1 mile (1.6 km.) north of forks of East and West Gallatin Rivers, Gallatin County, Montana.

Acrocephalites ? vulcanus (Billings) 182

FIG. 2. (×3.) Cranidium from the type locality of the species. U. S. National Museum, Catalogue No. 15437.

From Lower Cambrian: (25) Shaly sandstone just above Parkers Quarry, Georgia, Franklin County, Vermont.

This is the original of fig. 4, pl. 26, Bull. U. S. Geol. Survey, No. 30, 1886.

Acrocephalites aoris Walcott 178

FIG. 3. (×2.) Dorsal view and side outline of cranidium. U. S. National Museum, Catalogue No. 61579.

3*a*. (Natural size.) The same cranidium as that represented by fig. 3.

3*b*. (×1.5.) A broken cranidium showing occipital ring. U. S. National Museum, Catalogue No. 61580.

The specimens illustrated are from locality 107d, Middle Cambrian: Conococheague ? limestone; 1 mile (1.6 km.) north of Henrietta, Blair County, Pennsylvania.

Menomonia calymenoides (Whitfield) 162

FIGS. 4, 4′. (×2.) Dorsal view and side outline of an entire cranidium. U. S. National Museum, Catalogue No. 61581.

4*a*, 4*a*′. (×2.) Dorsal view and side outline of a broken cranidium. U. S. National Museum, Catalogue No. 61582.

4*b*. (Natural size.) A nearly entire specimen of the thorax, pygidium, and base of cephalon with 42 thoracic segments. U. S. National Museum, Catalogue No. 61583.

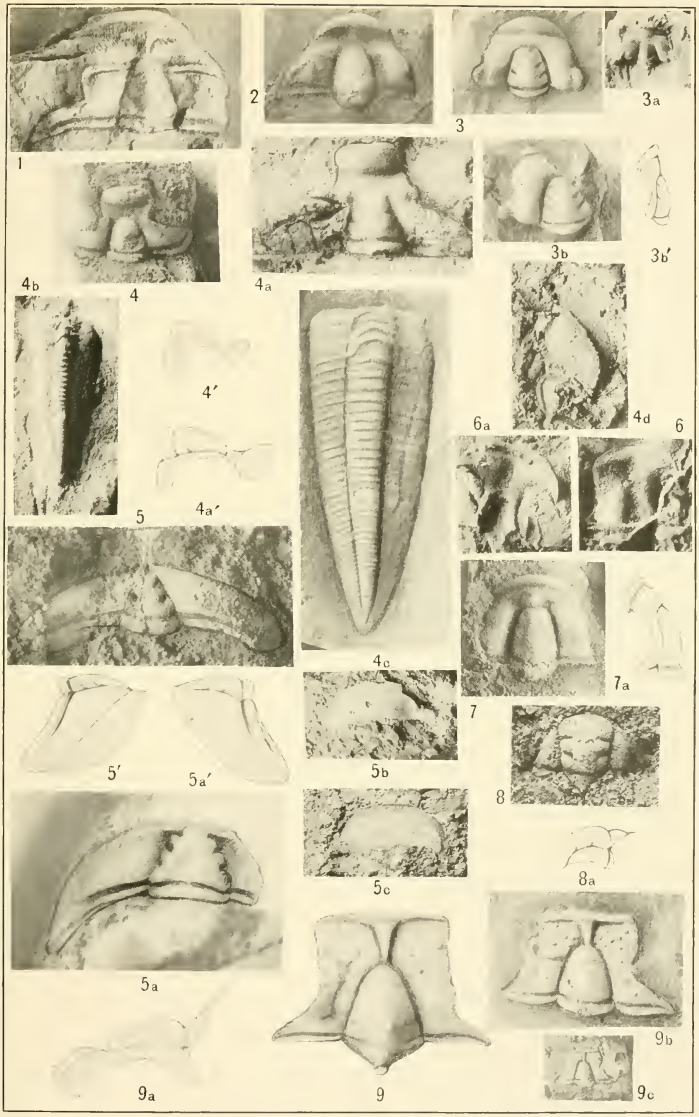
4*c*. (×2.) Same as fig. 4*b* with photograph retouched to bring out thoracic segments.

4*d*. (×2.) Free cheek associated with the specimen represented by fig. 4*a*. U. S. National Museum, Catalogue No. 61584.

The specimens illustrated by figs. 4, 4*a-d* are all from the Eau Claire formation of the Upper Cambrian. Fig. 4, from locality 100, near Menomonie, and figs. 4*a* and 4*d* from locality 83a, Rock Falls, both in Dunn County, Wisconsin. Figs. 4*b-c* are from locality 98, near Eau Claire, Eau Claire County, Wisconsin.

Dresbachia amata Walcott 167

FIGS. 5, 5′. (×4.) Dorsal view and side outline of a cranidium, preserving the projecting frontal rim with its deep median furrow. U. S. National Museum, Catalogue No. 61585.



CAMBRIAN TRILOBITES

Dresbachia amata Walcott—Continued. PAGE

5*a*, 5*a'*. (×4.) Dorsal view and side outline of a broken cranidium. U. S. National Museum, Catalogue No. 61586.

5*b*. (×2.) Free cheek associated with cranidia of this species. U. S. National Museum, Catalogue No. 61587.

5*c*. (×2.) A narrow form of free cheek associated with cranidia of this species. U. S. National Museum, Catalogue No. 61588.

The specimens represented by figs. 5 and 5*a* are from locality **79x**, north of Galesville, Trempealeau County, Wisconsin. The specimen represented by fig. 5*b* is from locality **84**, Dresbach, Winona County Minnesota, and 5*c*, from **98x**, Eau Claire, Eau Claire County, Wisconsin. All are from the Upper Cambrian, Eau Claire formation of Wisconsin and Minnesota.

Alokistocare ticida Walcott..... 187

FIG. 6. (Natural size.) A broken, weather-worn cranidium. U. S. National Museum, Catalogue No. 61589.

6*a*. (Natural size.) Interior surface of a broken cranidium. U. S. National Museum, Catalogue No. 61590.

The specimens represented by figs. 6 and 6*a* are from locality **55s**, Middle Cambrian: Bloomington formation, Blacksmith Fork Canyon, Cache County, Utah.

Acrocephalites ? glomeratus Walcott..... 179

FIGS. 7, 7*a*. (Natural size.) Top view and side outline of the type cranidium. U. S. National Museum, Catalogue No. 61591.

From locality **340c**, Upper Cambrian: Rawlins, Carbon County, Wyoming.

Amphion ? matutina Hall..... 219

FIGS. 8, 8*a*. (×4.) Dorsal view and side outline of a cranidium. U. S. National Museum, Catalogue No. 61592.

The specimen illustrated is from locality **84**, Upper Cambrian: Eau Claire formation; Dresbach, Winona County, Minnesota.

Acrocephalites ? aster Walcott..... 178

FIGS. 9, 9*a*. (×3.) Top view and side outline. The side outline from the occipital segment is traced from a second specimen. U. S. National Museum, Catalogue No. 61593.

From locality **107c**, Upper Cambrian: Maryville limestone; 11 miles northwest of Knoxville, Tennessee.

9*b*. (×3.) Cranidium compressed in shale. It shows tubercles more strongly than the specimen represented by fig. 9, which occurs in limestone. U. S. National Museum, Catalogue No. 61594.

9*c*. (Natural size.) This is the same specimen as that represented by fig. 9*b*.

The specimen represented by figs. 9*b* and 9*c* is from locality **358e**, Upper Cambrian: Conasauga formation; Birmingham City, Alabama.

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Norwoodia saffordi Walcott..... 171

FIG. 1. (×4.) Portion of cranidium showing glabellar furrows. U. S. National Museum, Catalogue No. 61595.

1*a*. (×4.) Broken and compressed cranidium. U. S. National Museum, Catalogue No. 61596.

1*b*. (×3.) Free cheek. U. S. National Museum, Catalogue No. 61597.

1*c*. (×4.) A small, almost entire cranidium. U. S. National Museum, Catalogue No. 61598.

1*d*. (×4.) A nearly entire dorsal shield with eight thoracic segments. U. S. National Museum, Catalogue No. 61599.

1*e*. (×4.) Pygidium associated with this species. U. S. National Museum, Catalogue No. 61600.

1*f*. Diagrammatic side outline of cranidium.

All of the specimens illustrated are from the Middle Cambrian: (103, 103a) Rome formation, south of Rogersville, Hawkins County, Tennessee.

Norwoodia gracilis Walcott..... 169

FIG. 2. (×4.) Entire dorsal shield as photographed and drawn from an imperfect specimen with damaged portions restored from associated specimens. U. S. National Museum, Catalogue No. 61601.

2*a* (×3) and 2*b* (×5). Cranidia illustrating form. Fig. 2*b* is a younger stage of growth. U. S. National Museum, Catalogue Nos. 61602 and 61603.

2*c*. (×4.) Ventral side of a distorted cephalon. U. S. National Museum, Catalogue No. 61604.

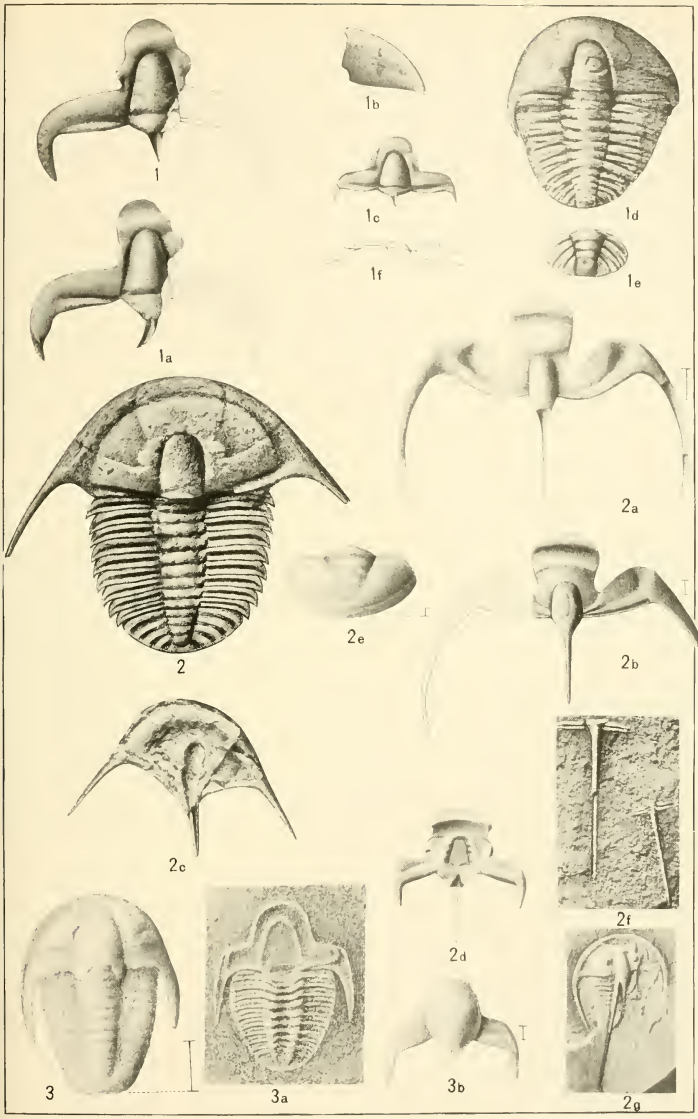
2*d*. (×4.) Ventral side of a small cranidium. U. S. National Museum, Catalogue No. 61605.

2*e*. (×8.) A small pygidium associated with specimens represented by figs. 2*a-b*. U. S. National Museum, Catalogue No. 61606.

2*f*. (×2.) Thoracic median spines. U. S. National Museum, Catalogue No. 61607.

2*g*. (×3.) Cranidium and a long thoracic median spine. U. S. National Museum, Catalogue No. 61608.

All the specimens illustrated are compressed in the Upper Cambrian fine Conasauga shale as they occur at (90a) Cedar Bluff and (92x) Yanceys Bend, on the Coosa River, Cherokee County, Alabama.



NORWOODIA

FIG. 3. (×4.) An entire, slightly weathered specimen of the dorsal shield. U. S. National Museum, Catalogue No. 61609.

3a. (×6.) Interior of a compressed dorsal shield. U. S. National Museum, Catalogue No. 61610.

3b. (×6.) An imperfect, small cranidium preserving something of its original convexity. U. S. National Museum, Catalogue No. 61611.

All the specimens illustrated are from localities 90a and 91, Upper Cambrian: Conasauga shale; at Cedar Bluff, Coosa River, Cherokee County, Alabama.

DESCRIPTION OF PLATE 28

PAGE

Norwoodia ponderosa Walcott 171

FIG. 1. (×6.) Matrix of a cranidium compressed in fine shale. The occipital spine is restored. U. S. National Museum, Catalogue No. 61612.

1*a*. (×5.) Cranidium varying in form from fig. 1. U. S. National Museum, Catalogue No. 61613.

1*b*. (×6.) Minute pygidium associated with this species. U. S. National Museum, Catalogue No. 61614.

The specimens illustrated by figs. 1, 1*a-b* are from the Upper Cambrian: (90a) Conasauga shale; Cedar Bluff on Coosa River, Cherokee County, Alabama.

Norwoodia tenera Walcott 172

FIG. 2. (×6.) Small cranidium. U. S. National Museum, Catalogue No. 61615.

2*a*. (×6.) Dorsal view of a small dorsal shield with seven thoracic segments. U. S. National Museum, Catalogue No. 61616.

2*b*. (×6.) Dorsal shield with eight thoracic segments. U. S. National Museum, Catalogue No. 61617.

2*c*. (×8.) Minute cranidium. U. S. National Museum, Catalogue No. 61618.

2*d*. (×6.) A detached median thoracic spine. U. S. National Museum, Catalogue No. 61619.

2*e*. (×4.) A broken dorsal shield on which there is a thoracic segment with a median spine attached. U. S. National Museum, Catalogue No. 61620.

2*f*. (×4.) A very minute cranidium beside a larger form. U. S. National Museum, Catalogue No. 61621.

2*g*. (×4.) Side outline of larger cranidium represented by fig. 2*f*.

The specimens illustrated are from locality 30n, Upper Cambrian: Weeks formation, Weeks Canyon, House Range, Millard County, Utah.

Millardia semele Walcott 166

FIG. 3. (×4.) Small cranidium showing tuberculated frontal rim. U. S. National Museum, Catalogue No. 61622.

3*a*. (×4.) Ventral surface of a cephalon. U. S. National Museum, Catalogue No. 61623.

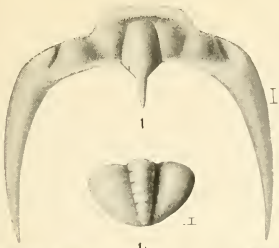
3*b*. (×4.) Dorsal shield with 23 thoracic segments. U. S. National Museum, Catalogue No. 61624.

3*b'*. (Natural size.) The same specimen as that represented by fig. 3*b*.

3*c*. (×4.) Compressed dorsal shield on surface of shaly limestone. U. S. National Museum, Catalogue No. 61625.

3*c'*. (Natural size.) The same specimen as that represented by fig. 3*c*.

The specimens illustrated are from locality 30 0, as given above under figs. 2, 2*a-g*.


1


1a

1b


2


2a


2b

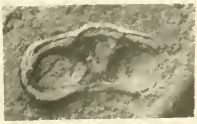

2c


2d


2e


2f


3


3a


4c

4d


2g


4e


4f


3b'

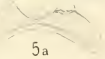

3b


3c


5

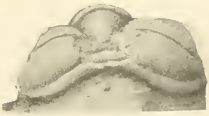
5b


3c'


5a


5c


4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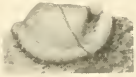
4a

CAMBRIAN TRILOBITES

PAGE

Millardia optata (Hall) 165

FIGS. 4, 4*a*, 4*b*. (×4.) Top, side, and front view of a small entire cranidium. U. S. National Museum, Catalogue No. 61626.

4*c*. (×2.) Free cheek associated with the specimen represented by fig. 4. U. S. National Museum, Catalogue No. 61627.

4*d*, 4*e*, 4*f*. (×4.) Top, side, and front views of a small entire cranidium. U. S. National Museum, Catalogue No. 61628.

The specimens represented by figs. 4, 4*a-f* are from locality 79c, Eau Claire formation, near Hudson, St. Croix County, Wisconsin.

Millardia avitas Walcott 165

FIGS. 5, 5*a*, 5*b*. (×4.) Top view of type specimen of cranidium, with outline of front and side views. U. S. National Museum, Catalogue No. 61629.

5*c*. (Natural size.) This is the same specimen as that represented by fig. 5.

The specimen represented by figs. 5, 5*a-c* is from locality 107k, Upper Cambrian: Buffalo Run limestone, 2 miles north of Benore Post Office, Center County, Pennsylvania.

DESCRIPTION OF PLATE 29

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Crepicephalus iowensis (Owen)..... 207

FIG. 1. (Natural size.) Restored figures of entire dorsal shield based on left half of a nearly entire specimen, and associated cranidium and pygidium. U. S. National Museum, Catalogue No. 61630.

2. (Natural size.) Fragment of a thorax preserving 11 segments with prolonged pleura. U. S. National Museum, Catalogue No. 61631.

2a, 2a'. (Natural size.) Broken cranidium with profile. U. S. National Museum, Catalogue No. 61632.

2b. (Natural size.) Pygidium with the outer border exfoliated. U. S. National Museum, Catalogue No. 61633.

Figures *2a* and *2b* are of material collected by Owen.

2c. (Natural size.) Free cheek with long genal spines. U. S. National Museum, Catalogue No. 61634.

2d. (Natural size.) Small, nearly entire pygidium. U. S. National Museum, Catalogue No. 61635.

2e. (Natural size.) Hypostoma. U. S. National Museum, Catalogue No. 61637.

2f. (Natural size.) Cranidium of the characteristic form as it occurs in the Eau Claire sandstones. U. S. National Museum, Catalogue No. 61636.

The specimens represented by figs. 1, *2d*, and *2f* are from (78a) the Eau Claire formation, Eau Claire, Wisconsin.

Those represented by 2, *2a-c*, and *2e* are from the Eau Claire formation at Dresbach, Minnesota, opposite the mouth of Black River.

Crepicephalus texanus danace Walcott..... 214

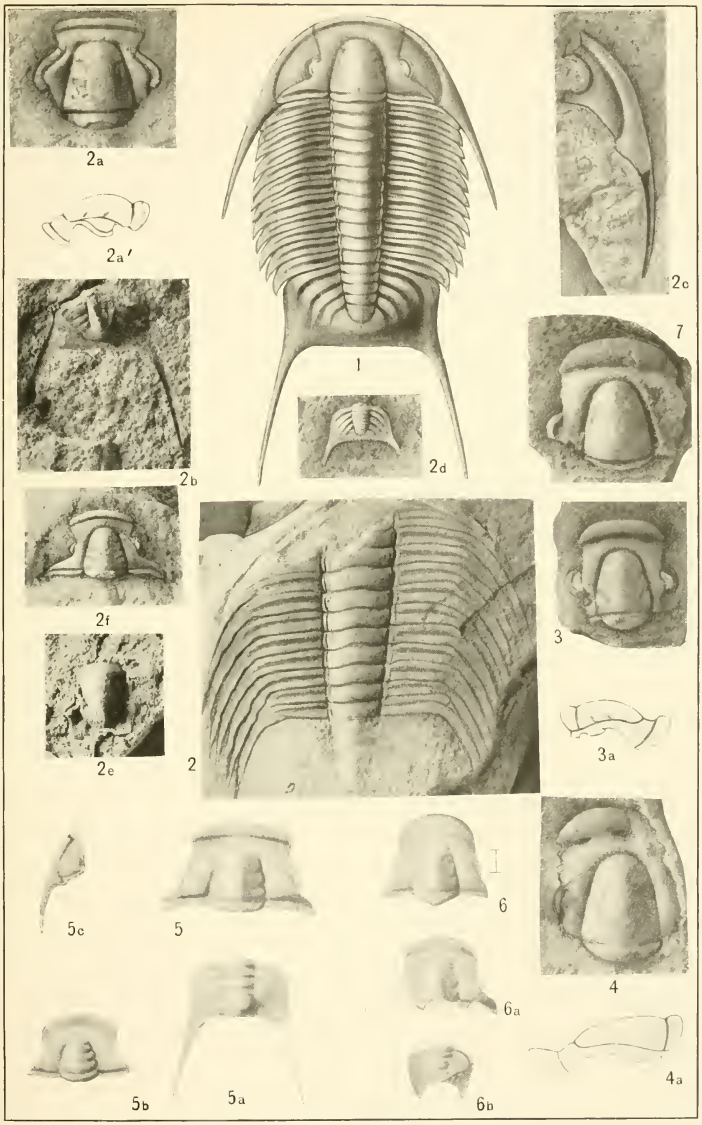
FIGS. 3, *3a*. (Natural size.) Broken cranidium and longitudinal profile of the only specimen in the collections. U. S. National Museum, Catalogue No. 61638.

From locality 79d, Eau Claire formation, near Eau Claire, Wisconsin.

Crepicephalus texanus elongatus Walcott..... 214

FIGS 4, *4a*. (Natural size.) Dorsal view and longitudinal profile of a fragmentary cranidium. U. S. National Museum, Catalogue No. 61639.

From locality 79e, Eau Claire formation, 1 mile (1.6 km.) north of Eleva, Wisconsin.



CREPICEPHALUS

PAGE

Crepicephalus liliana Walcott..... 209

FIG. 5. (Natural size.) Cranidium with granulose surface. U. S. National Museum, Catalogue No. 15428.

5*a*. (Natural size.) Pygidium associated with the specimen represented by fig. 5 in the same fragment of rock. U. S. National Museum, Catalogue No. 15428.

5*b*. (Natural size.) Cranidium from another locality. U. S. National Museum, Catalogue No. 61640.

5*c*. (Natural size.) Free cheek associated with the cranidium of 5*b*. U. S. National Museum, Catalogue No. 61641.

The specimens represented by figs. 5 and 5*a* are from 31a, Lower Cambrian: Pioche formation, near Pioche, Nevada.

The specimens represented by figs. 5*b* and 5*c* are from (30) Lower Cambrian: limestone on west slope of Highland Range, 8 miles (12.8 km.) north of Bennetts Spring, Nevada.

These figures are illustrated in the Tenth Annual Report, U. S. Geol. Survey, 1890, plate 96, figs. 7, 7*a-c*.

Crepicephalus augusta Walcott..... 204

FIG. 6. (× 4.) A small cranidium, showing variation of form from that represented by fig. 6*a*. U. S. National Museum, Catalogue No. 61642.

6*a*. (Natural size.) Broken cranidium showing form of frontal border. U. S. National Museum, Catalogue No. 61643.

6*b*. (Natural size.) Pygidium with right side partly restored. U. S. National Museum, Catalogue No. 15430.

The two cranidia represented by figs. 6 and 6*a* are from (30) Lower Cambrian: limestone on west slope of Highland Range, 8 miles (12.8 km.) north of Bennetts Spring, Nevada.

The specimen represented by fig. 6*b* is from (31a) Lower Cambrian: Pioche formation, near Pioche, Nevada.

Specimens of the pygidium also occur in locality 30.

These figures are illustrated in the Tenth Annual Report, U. S. Geol. Survey, 1890, plate 96, figs. 9, 9*a-b*.

Crepicephalus texanus (Shumard). (See pl. 30)..... 209

FIG. 7. (Natural size.) Cranidium with occipital ring restored, and associated specimen. U. S. National Museum, Catalogue No. 61644.

From locality 151 i, Gallatin limestone; northeast of White Sulphur Springs, Meagher County, Montana.

DESCRIPTION OF PLATE 30

PAGE

Crepicephalus texanus (Shumard). (See pl. 29, fig. 7)..... 209

FIG. 1. (Natural size.) Partly restored figure. Entire specimens with the genal and pygidium spines occur in large numbers. This figure is illustrated in Monograph 32, U. S. Geological Survey, 1892, Part 2, plate 65, fig. 5. U. S. National Museum, Catalogue No. 35232.

1*a*. (Natural size.) Inner side of a pygidium, showing the manner in which the two spines are attached to the pygidium. U. S. National Museum, Catalogue No. 61645.

1*b*. (Natural size.) Small cranidium with broad glabella. U. S. National Museum, Catalogue No. 61646.

All of the specimens used in the restoration of fig. 1 and in figs. 1*a* and 1*b* are from Upper Cambrian, (90a, 91) the Conasauga shales at Cedar Bluff, Alabama.

2, 2′. (× 1.5.) Top view and side outline of a broken cranidium, the broken portions of which have been restored in the outline. U. S. National Museum, Catalogue No. 61647.

2*a*. (Natural size.) Front portion of cranidium, showing frontal limb and narrow, nearly flat frontal border. U. S. National Museum, Catalogue No. 61648.

2*b*. (Natural size.) Fragment of a cranidium with the outline of broken portions restored. U. S. National Museum, Catalogue No. 61649.

2*c*. (Natural size.) Matrix and spine of a broken pygidium. U. S. National Museum, Catalogue No. 61650.

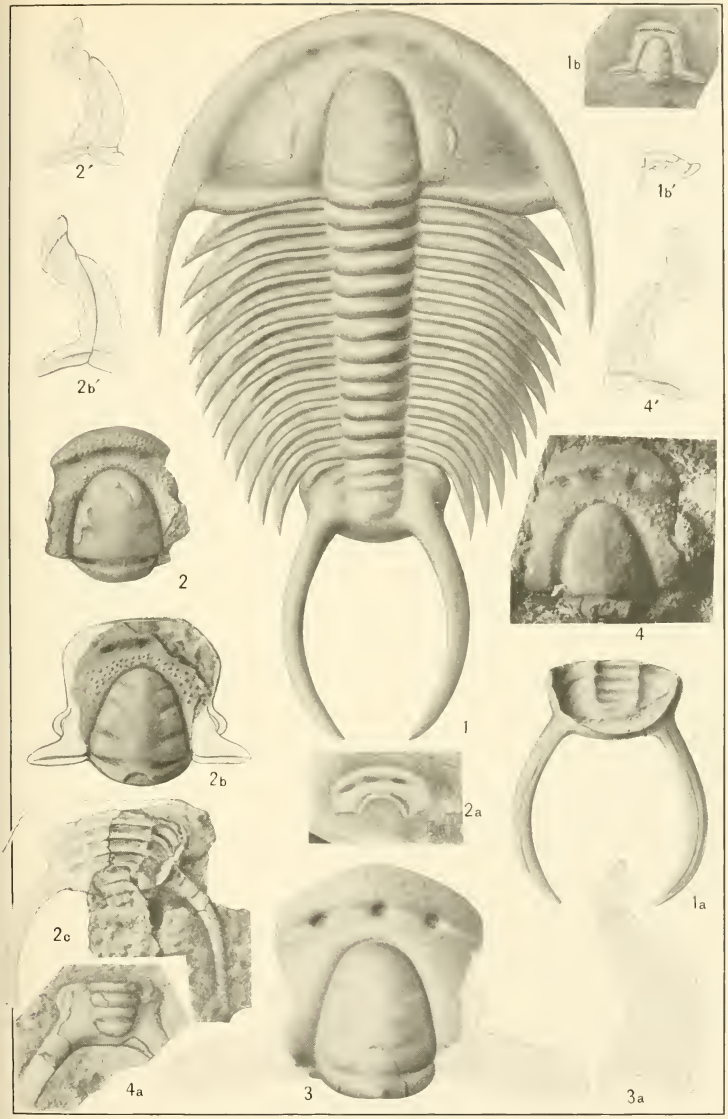
The three specimens illustrated by figs. 2, 2*a-c* are from (67a) the Cap Mountain limestone, at the head of Clear Creek on Potato-top, Burnet County, Texas.

3, 3*a*. (Natural size.) Top view and side outline of a large cranidium from limestone interbedded in the Conasauga shale, (89) Murphrees Valley, Blount County, Alabama. U. S. National Museum, Catalogue No. 61651.

4, 4′. (× 1.5.) Dorsal view and profile outline of nearly entire cranidium. U. S. National Museum, Catalogue No. 61652.

4*a*. (× 1.5.) Narrow form of pygidium tentatively referred to this species. U. S. National Museum, Catalogue No. 61653.

The specimens represented by figs. 4 and 4*a* are from locality 151b, Gallatin limestone, between Pebble Creek and Soda Butte Creek, Yellowstone National Park, Wyoming.



CREPICEPHALUS TEXANUS (Shumard)

DESCRIPTION OF PLATE 31

PAGE

Crepicephalus thoosa Walcott..... 214

FIG. 1. (Natural size.) Dorsal and side view of type specimen of the cranidium. U. S. National Museum, Catalogue No. 61654.

From (125a) Maryville limestone, Big Creek, northeast of Rogersville, Hawkins County, Tennessee.

1*a*, 1*a'*. (Natural size.) Top view and profile of a large broken cranidium. The broken parts restored in outline. U. S. National Museum, Catalogue No. 61655. (Locality 119.)

1*b*. (×2.) Free cheek associated with the cranidia of this species. U. S. National Museum, Catalogue No. 61656. (Locality 107.)

1*c*. (×3.) Small cranidium enlarged to illustrate pustulose surface and form. Broken portions restored in outline from fig. 1. U. S. National Museum, Catalogue No. 61657.

From (119a) Honaker (= Maryville) limestone, east of Greendale, Washington County, Virginia.

1*d*. (×2.) Hypostoma associated with this species at locality 119. U. S. National Museum, Catalogue No. 61658.

The specimens represented by figs. 1*a* and 1*d* are from Upper Cambrian, (119) Maryville limestone; beneath Nolichucky shale, Cub Creek, southeast of Morristown, Hamblen County, Tennessee.

1*e*. (×2.) Hypostoma associated with this species at locality 107. U. S. National Museum, Catalogue No. 61659.

1*f*. (Natural size.) Dorsal view of pygidium and side outline associated with cranidia of this species at locality 107. U. S. National Museum, Catalogue No. 61660.

The specimens represented by figs. 1*b*, 1*e*, and 1*f* are from Maryville limestone, (107) Bull Run Ridge, northwest of Knoxville, Knox County, Tennessee.

1*g*. (×2.) Pygidium associated with this species at locality 145a. U. S. National Museum, Catalogue No. 61661.

1*h*. (×6.) Enlargement of surface to illustrate granulation.

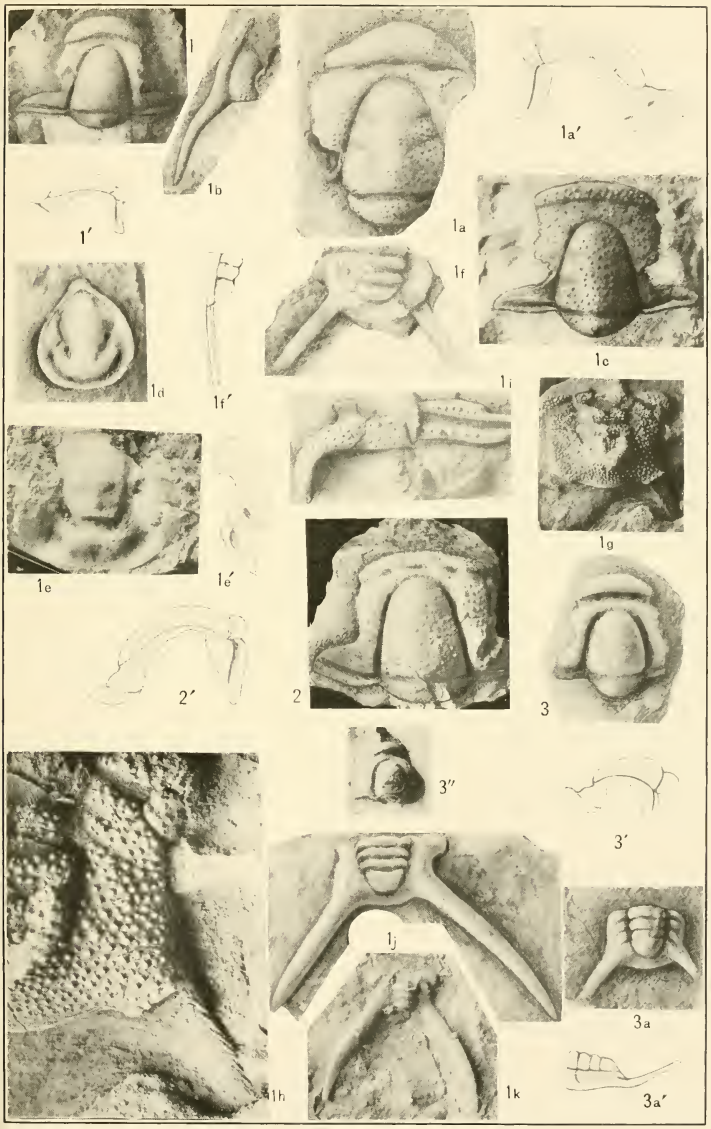
1*i*. (×3.) Broken thoracic segment, to illustrate granulation. U. S. National Museum, Catalogue No. 61662.

The specimens represented by figs. 1*g* and 1*i* are from Upper Cambrian, (145a) Conasauga shale; upper part of shale beneath Knox dolomite; east of Gaylesville, Cherokee County, Alabama.

1*j*. (×2.) Small pygidium weathered out on limestone. U. S. National Museum, Catalogue No. 61663.

1*k*. (Natural size.) Large pygidium associated with specimen represented by fig. 1*j*. U. S. National Museum, Catalogue No. 61664.

The specimens represented by figs. 1*j* and 1*k* are from locality 91, Upper Cambrian: Conasauga formation; Cedar Bluff, Cherokee County, Alabama.



CREPICEPHALUS

The specimens represented by figs. 2 and 3 are from locality 120, Upper Cambrian: Maryville limestone; north of Bays Mountain, on Beaver Creek, Sevier County, 18 miles east-northeast of Knoxville, Knox County, Tennessee.

Fig. 3*a* is from locality 107, Upper Cambrian: Maryville limestone, Bull Run Ridge, northwest of Knoxville, Knox County, Tennessee.

DESCRIPTION OF PLATE 32

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Crepicephalus dis Walcott..... 207

FIG. 1. (×1.5.) Dorsal view of cranidium. U. S. National Museum, Catalogue No. 61668.

1a. (Natural size.) Associated free cheek. U. S. National Museum, Catalogue No. 61669.

1b, 1b'. (×2.) Dorsal and side views of a slightly distorted cranidium. U. S. National Museum, Catalogue No. 61670.

1c. (Natural size.) Pygidium associated with specimen represented by figs. 1, *1a-b*. U. S. National Museum, Catalogue No. 61671.

The specimens represented by figs. 1, *1a-c* are from localities 14v, 30n, and 30o, Upper Cambrian: Weeks formation; House Range, Utah.

Crepicephalus camiro Walcott..... 205

FIGS. 2, 2'. (×2.) Dorsal view and side outline of type specimen of cranidium. U. S. National Museum, Catalogue No. 61672.

2". (Natural size.) This is the same specimen as fig. 2.

2a, 2a'. (×2.) Dorsal view and side outline of a pygidium associated with this species. U. S. National Museum, Catalogue No. 61673.

The specimens represented by figs. 2 and *2a* are from locality 120, Upper Cambrian: Maryville limestone; 18 miles east-northeast of Knoxville, Tennessee.

Crepicephalus coosensis Walcott..... 206

FIG. 3. (Natural size.) Restored figure of dorsal shield based on a large specimen preserving the cranidium, thorax, and pygidium in an imperfect condition. U. S. National Museum, Catalogue No. 61674.

3a, 3a'. (Natural size.) Dorsal view and side outline of a large cranidium. U. S. National Museum, Catalogue No. 61675.

3b. (Natural size.) Dorsal view of large pygidium. U. S. National Museum, Catalogue No. 61676.

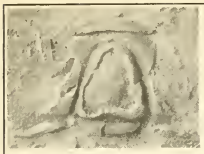
3c, 3c'. (Natural size.) Dorsal view and side outline of a medium-sized cranidium. The broken parts are restored in outline. U. S. National Museum, Catalogue No. 61677.

3d, 3d'. (Natural size.) Dorsal view and side outline of a cranidium, showing palpebral lobe and occipital ring. U. S. National Museum, Catalogue No. 61678.

3e. (Natural size.) Interior view of a pygidium showing portions of the doublure. U. S. National Museum, Catalogue No. 61679.

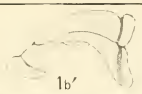
3f. (×2.) Cranidium and left free cheek. U. S. National Museum, Catalogue No. 61680.

The specimens represented by figs. 3, *3a-c* are from locality 90x, Middle Cambrian: lower part of Conasauga formation; east of Center, Cherokee County, Alabama.


1

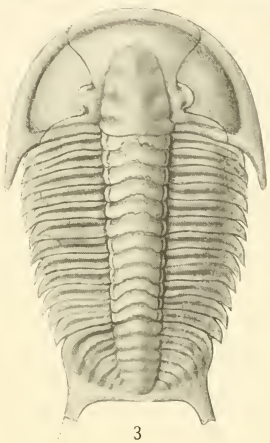

1a


1b


1b′

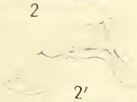

1c

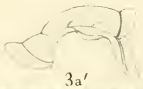

2″


3


2


3a

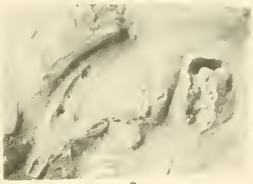

2′


3a′


2a


3b

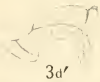

2a′


3f


3c


3d


3c′


3d′


4a


3e


4

CREPICEPHALUS

PAGE

Crepicephalus sp. undt (1) 218

FIG. 4. (Natural size.) Dorsal view of a pygidium. U. S. National Museum, Catalogue No. 61681.

From Upper Cambrian: (107) Maryville limestone; 11 miles (17.6 km.) northwest of Knoxville, Tennessee.

4*a*. (Natural size.) Interior of a large pygidium. U. S. National Museum, Catalogue No. 61682.

From Upper Cambrian: (16) thin, slabby limestone of Conasauga formation; Murphrees Valley, Blount County, Alabama.

DESCRIPTION OF PLATE 33

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Crepicephalus tripunctatus (Whitfield) 215

FIGS. 1, 1*a*. (×1.5.) Dorsal and side views of a cranidium which is the type of the species. U. S. National Museum, Catalogue No. 26934.

1*b*. (×1.5.) Free cheek associated with fig. 1. U. S. National Museum, Catalogue No. 26934.

The specimens represented by figs. 1, 1*a-b* are from the Upper Cambrian: (358d) Gallatin limestone; Meagher County, Montana.

Crepicephalus tripunctatus magnispinus Walcott 216

FIGS. 2, 2*a*. (×1.5.) Dorsal and side views of a typical cranidium. U. S. National Museum, Catalogue No. 61684.

2*b*. (Natural size.) Side view of a broken cranidium having a very large occipital spine. U. S. National Museum, Catalogue No. 61685.

2*c*. (Natural size.) Dorsal and side views of a pygidium referred to this species. U. S. National Museum, Catalogue No. 61686.

The specimens represented by figs. 2, 2*a-c* are from locality 107, Maryville limestone; 11 miles northwest of Knoxville, Tennessee.

Crepicephalus coria Walcott 206

FIG. 3. (Natural size.) Interior of a fragmentary specimen, showing 14 segments in the thorax. U. S. National Museum, Catalogue No. 61687.

3*a*, 3*a'*. (Natural size.) Dorsal and side views of a small, slightly crushed cranidium. U. S. National Museum, Catalogue No. 61688.

3*b*. (×2.) Dorsal view of a small convex cranidium. U. S. National Museum, Catalogue No. 61689.

3*c*. (Natural size.) A large cranidium illustrating slight change in form with increase in size. U. S. National Museum, Catalogue No. 61690.

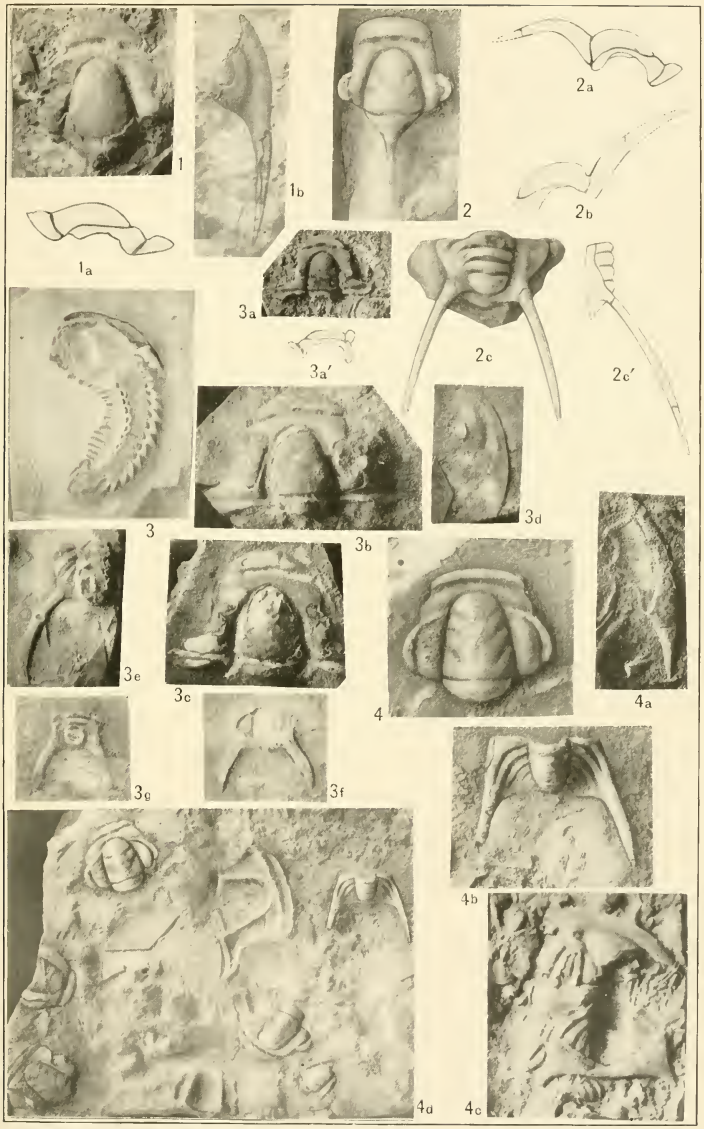
3*d*. (Natural size.) Associated free cheek. U. S. National Museum, Catalogue No. 61691.

3*e*. (Natural size.) Dorsal view of a broken pygidium. U. S. National Museum, Catalogue No. 61692.

3*f*. (Natural size.) Interior of a pygidium. U. S. National Museum, Catalogue No. 61693.

3*g*. (×2.) Dorsal view of a small pygidium. U. S. National Museum, Catalogue No. 61694.

The specimens represented by figs. 3, 3*a-g* are from locality 30n, Upper Cambrian: Weeks formation; House Range, Utah.



CREPICEPHALUS

PAGE

Crepicephalus upis Walcott..... 218

FIG. 4. (×2.) Cranidium with broken front border restored from associated specimens. U. S. National Museum, Catalogue No. 61695.

4*a*. (×2.) Under side of associated free cheek. U. S. National Museum, Catalogue No. 61696.

4*b*. (×2.) Pygidium associated with fig. 1. U. S. National Museum, Catalogue No. 61697.

4*c*. (×2.) Under side of an associated pygidium. U. S. National Museum, Catalogue No. 61698.

4*d*. (Natural size.) Fragment of weathered shaly limestone on which several cranidia occur and the pygidium represented by fig. 4*b*.

The specimens represented by figs. 4, 4*a-d* are from locality 150b, Upper Cambrian: Gallatin limestone; at head of White Creek, Lewis and Clark National Forest, Montana.

DESCRIPTION OF PLATE 34

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Lonchocephalus pholus Walcott 194

FIG. 1. (×4.) Interior of cranidium. U. S. National Museum, Catalogue No. 61699.

1*a*, 1*a'*. (×4.) Exterior of cranidium and side outline. U. S. National Museum, Catalogue No. 61700.

1*b*. (×4.) Cranidium preserving relief of glabella and strong occipital spine. There is also a cranidium of *Norwoodia tenera* on the same piece of limestone. U. S. National Museum, Catalogue No. 61701.

Lonchocephalus plena Walcott 194

FIG. 2. (×6.) Dorsal view and side outline of a broken cephalon. U. S. National Museum, Catalogue No. 61702.

2*a*. (×6.) A cranidium preserving the glabella and fixed cheek. U. S. National Museum, Catalogue No. 61703.

The specimens represented by figs. 1, 1*a-b*, 2, and 2*a* are from a shaly limestone, (30n) Upper Cambrian: Weeks formation, House Range, Utah.

Lonchocephalus chippewaensis Owen. (See pl. 37) 190

FIG. 3. (×2.) Surface of sandstone with cranidia and pygidia. A cranidium of *Pagodia thea* Walcott and fragments of *Hyolithes primordialis* Hall occur in the sandstone. (See plate 37.)

3*a*. (×6.) A nearly entire dorsal shield with the weathered surface restored from other specimens. U. S. National Museum, Catalogue No. 61704.

The specimen represented by fig. 3 is from locality 98, Upper Cambrian: Eau Claire formation; near Eau Claire, Eau Claire County (collected by Dr. Samuel Weidman, and now in collection of Geological Survey of Wisconsin at Madison); that represented by fig. 3*a* is from locality 82, St. Croix Falls, Polk County; both in Wisconsin.

Lonchocephalus minutus (Bradley) 193

FIGS. 4, 4*a*. (×3.) Dorsal and side views of a convex cranidium. U. S. National Museum, Catalogue No. 58566.

4*b*. (×3.) Associated free cheek. U. S. National Museum, Catalogue No. 58567.

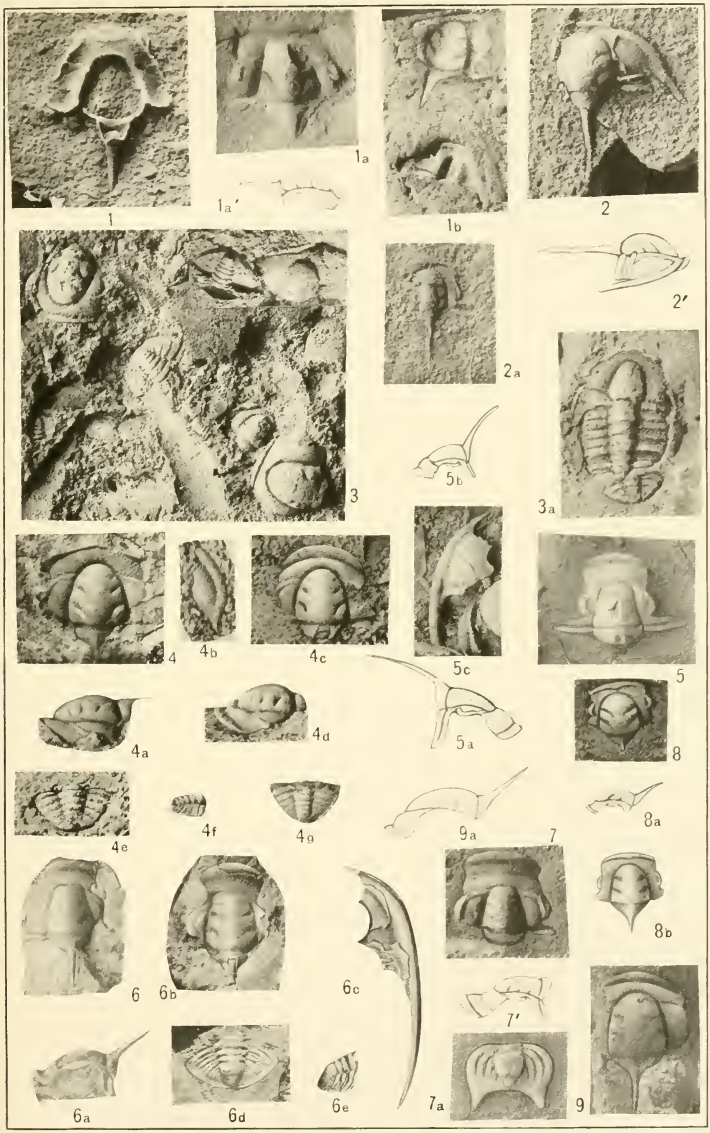
4*c*, 4*d*. (×3.) Dorsal and side views of a cranidium preserving the anterior rim and border. U. S. National Museum, Catalogue No. 58568.

4*e*, 4*f*. (×3.) Dorsal and side views of a pygidium from which the test has been exfoliated. U. S. National Museum, Catalogue No. 58569.

4*g*. (×3.) Dorsal view of a pygidium preserving the test. U. S. National Museum, Catalogue No. 58570.

The specimens represented by figs. 4, 4*a-g* are from locality 77, Upper Cambrian: Potsdam horizon; sandstone near the water below the falls at the high bridge, and also at several horizons in the section, the highest point being 70-75 feet (21.3-22.9 m.) above the water in Ausable Chasm, Essex County, New York.

The above illustrations are taken from Smithsonian Miscellaneous Collections, Vol. 57, 1914, pl. 43, figs. 21-24.



CAMBRIAN TRILOBITES

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Saratogia wisconsensis (Owen) 198

FIG. 5. (Natural size.) Cranidium with occipital spine broken off.

5*a*. (Natural size.) Side outline of fig. 5.

5*b*. (×2.) Side view of a small cranidium.

5*c*. (Natural size.) Free cheek.

The specimens represented by figs. 5, 5*a-c*, are from locality 151e, Upper Cambrian: Gallatin limestone; Yellowstone National Park, Wyoming.

These specimens are associated on a slab of limestone (U. S. National Museum, Catalogue No. 35225) and are the same that are illustrated by woodcut prints on plate 64, figs. 1, 1*a*, Monogr. 32, U. S. Geol. Survey. By error, in making up that plate, a figure of *Saratogia hamulus* (Owen), fig. 1*b*, and of the pygidium of *Ptychoparia diademata* (Hall), fig. 1*c*, was included under this species.

Saratogia calcifera (Walcott) 197

FIGS. 6, 6*a*. (Natural size.) Dorsal and side views of an imperfect cranidium. U. S. National Museum, Catalogue No. 58554.

6*b*. (Natural size.) Dorsal view of a cranidium, showing the characters of the glabella. U. S. National Museum, Catalogue No. 58555.

6*c*. (Natural size.) Free cheek. U. S. National Museum, Catalogue No. 58556.

6*d*, 6*e*. (×2.) Dorsal view and side outline of pygidium associated with this species. U. S. National Museum, Catalogue No. 58557.

The specimens represented by figs. 6, 6*a-e* are from locality 76, Upper Cambrian: Hoyt limestone; Hoyts quarry, 4 miles (6.4 km) west of Saratoga Springs, Saratoga County, New York.

The above illustrations are taken from Smithsonian Miscellaneous Collections, Vol. 57, 1914, pl. 43, figs. 7, 7*a*-10*a*.

Crepicephalus unzia Walcott 217

FIG. 7, 7'. (×2.) Dorsal view and side profile of a cranidium. U. S. National Museum, Catalogue No. 61705.

7*a*. (×3.) A small pygidium with front outline restored. U. S. National Museum, Catalogue No. 61706.

The specimens represented by figs. 7 and 7*a* are from locality 150b, Upper Cambrian: Gallatin limestone; head of White Creek, Lewis and Clark National Forest, Montana.

Lonchocephalus minor (Shumard) 192

FIGS. 8, 8*a*. (×4.) Dorsal view and side outline of a typical cranidium. U. S. National Museum, Catalogue No. 61707.

8*b*. (×4.) Pencil drawing of specimen represented by photograph in fig. 8.

From locality 84, Upper Cambrian: Eau Claire formation; Dresbach, Minnesota.

Lonchocephalus bunus Walcott 190

FIGS. 9, 9*a*. (×3.) Dorsal and side views of typical cranidium. U. S. National Museum, Catalogue No. 61708.

The specimen represented by fig. 9 is from locality 99, Upper Cambrian: Franconia formation; near Winona, Minnesota. Collected by Mr. W. A. Finkelnburg, of Winona.

DESCRIPTION OF PLATE 35

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Crepicephalus unca Walcott 217

FIG. 1. (×1.5.) Cranidium and side outline. U. S. National Museum, Catalogue No. 61709.

1*a*. (Natural size.) The same cranidium as fig. 1.

1*b*. (×2.) Slightly distorted free cheek with outline restored from an associated specimen. U. S. National Museum, Catalogue No. 61710.

1*c*. (×1.5.) Fragment of a cranidium to illustrate palpebral lobe and postero-lateral limb. U. S. National Museum, Catalogue No. 61711.

1*d*. (×1.5.) Dorsal and side views of pygidium associated in same layer of sandstone with fig. 1. U. S. National Museum, Catalogue No. 61712.

1*e*. (×2.) A smaller pygidium, showing doublure and a slightly different outline from that of fig. 1*d*. U. S. National Museum, Catalogue No. 61713.

The specimens represented by figs. 1, 1*a-e* are from locality 79c, Upper Cambrian: Eau Claire formation; Willow River, near Hudson, Wisconsin. (Collected by Mr. W. A. Finkelnburg, of Winona, Minnesota.)

Saratogia volux Walcott 198

FIGS. 2, 2*a*. (×3.) Cranidium and side outline. U. S. National Museum, Catalogue No. 61714.

From locality 78a, Upper Cambrian: Eau Claire formation; near Eau Claire, Wisconsin.

Saratogia hera Walcott 197

FIGS. 3, 3*a*. (×1.5.) Dorsal and side views of cranidium. U. S. National Museum, Catalogue No. 61715.

3*b*. (Natural size.) Spine bearing thoracic segment associated with this species. U. S. National Museum, Catalogue No. 61716.

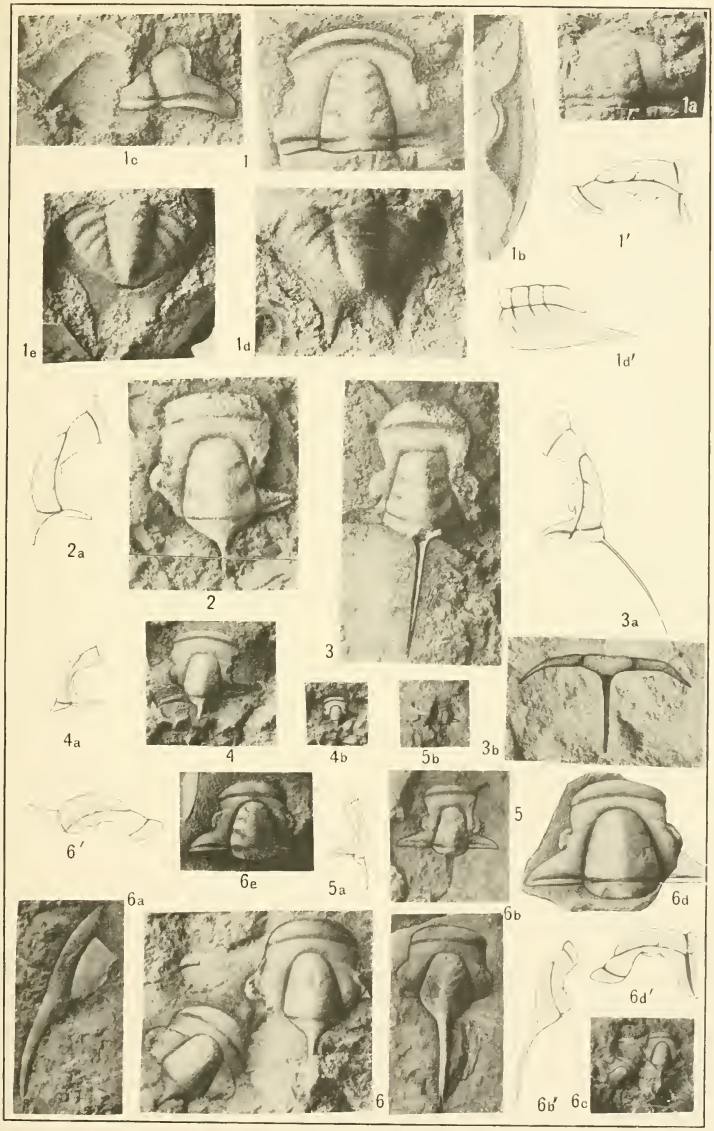
The specimens represented by figs. 3, 3*a-b* are from locality 98a, Upper Cambrian: Franconia formation, Marine Mills, Minnesota.

Saratogia arses Walcott 196

FIGS. 4, 4*a*. (×3.) Cranidium and side outline of type specimen. U. S. National Museum, Catalogue No. 61717.

4*b*. (Natural size.) The same cranidium as that represented by fig. 4.

The specimen represented by figs. 4, 4*a-b* is from locality 173, Upper Cambrian: Nolichucky shale; Maryville, Blount County, Tennessee.



CAMBRIAN TRILOBITES

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Saratogia aruno Walcott..... 196

FIGS. 5, 5*a*. (×4.) Cranidium with cast of occipital spine. U. S. National Museum, Catalogue No. 61718.

5*b*. (Natural size.) The same cranidium as that represented by fig. 5.

The specimen represented by figs. 5, 5*a-b* is from locality **128,** Upper Cambrian: Conasauga formation; 1.5 miles southwest of Cleveland, Bradley County, Tennessee.

Lonchocephalus appalachia Walcott..... 190

FIGS. 6, 6′. (×3.) Two cranidia with side outline (6′) of specimen on left side. U. S. National Museum, Catalogue No. 61719.

6*a*. (Natural size.) Free cheek associated in same layer with the specimen represented by fig. 6. U. S. National Museum, Catalogue No. 61720.

6*b*, 6*b*′. (Natural size.) Cranidium and side outline of a specimen with a long occipital spine. U. S. National Museum, Catalogue No. 61721.

6*c*. (Natural size.) The same specimen as that represented by fig. 6.

6*d*, 6*d*′. (×1.5.) Cranidium and side profile of a specimen with the occipital spine broken off. U. S. National Museum, Catalogue No. 61722.

6*e*. (Natural size.) The same specimen as that represented by fig. 6*d*.

The specimen represented by fig. 6*b* is from locality **139a,** Upper Cambrian: Conasauga formation; bluish limestones in shales on road near Wades Gap, near Chepultepec, Jefferson County, Alabama.

The specimens represented by figs. 6, 6*a*, 6*c-e*, are from locality **123a,** Upper Cambrian: Maryville limestone; Big Creek, 4 miles northeast of Rogersville, Hawkins County, Tennessee.

DESCRIPTION OF PLATE 36

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Lonchocephalus sospita Walcott 195

FIG. 1. (×3.) Fragment of sandstone with several cranidia in it. U. S. National Museum, Catalogue No. 61723.

1*a*. (×3.) Side outline of cranidium.

The specimens represented by figs. 1 and 1*a* are from locality 339k, Upper Cambrian: Eau Claire formation, near Winona, Minnesota. (Collected by W. A. Finkelnburg, of Winona.)

Hanburia gloriosa Walcott 226

FIG. 2. (×3.) Entire dorsal shield flattened in shale. U. S. National Museum, Catalogue No. 61724.

3. (×3.) Entire dorsal shield flattened in shale. U. S. National Museum, Catalogue No. 61725.

The specimens represented by figs. 2 and 3 are from locality 35k, Middle Cambrian: Burgess shale member of the Stephen formation, on the west slope of the ridge between Mount Field and Wapta Peak, 1 mile northeast of Burgess Pass, above Field, British Columbia.

Vanuxemella contractor Walcott 221

FIG. 4. (×2.5.) A crushed dorsal shield, showing the principal characters of the species. U. S. National Museum, Catalogue No. 61726.

4*a*. (×2.5.) A crushed dorsal shield varying slightly from that represented by fig. 4. U. S. National Museum, Catalogue No. 61727.

The specimens represented by figs. 4 and 4*a* are from locality 5j, Lower Cambrian: about 6 miles west-northwest of Scapegoat Mountain, Powell County, Montana.

Vanuxemella nortia Walcott 222

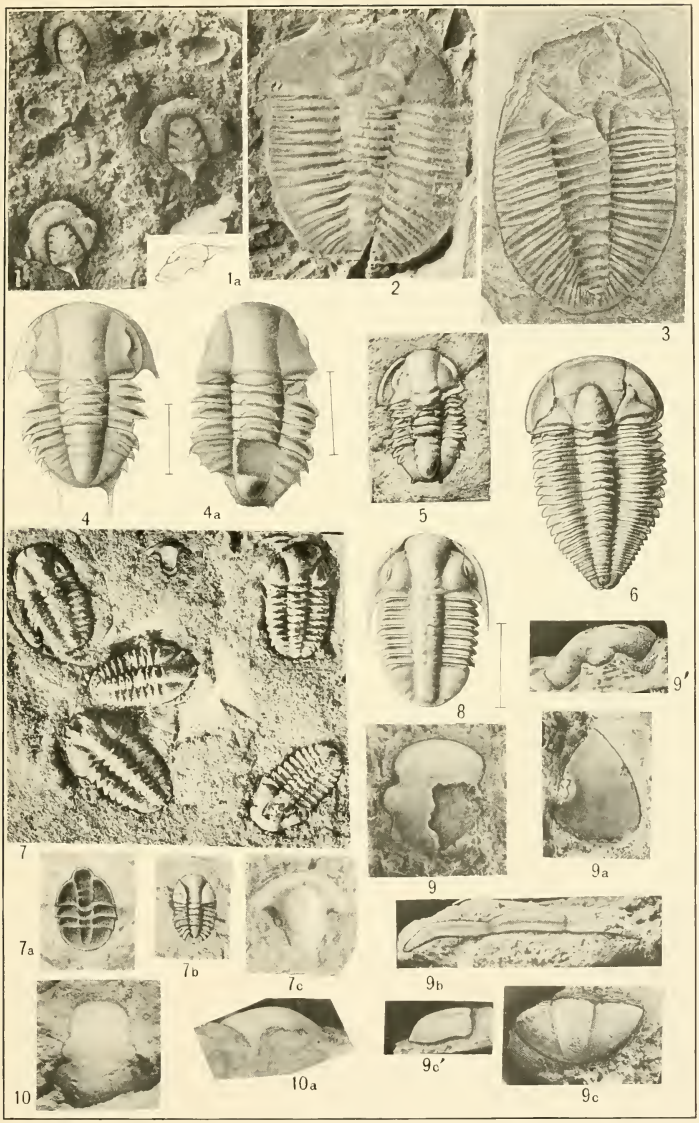
FIG. 5. (×2.) A nearly entire dorsal shield somewhat crushed in the shale. U. S. National Museum, Catalogue No. 61728.

From locality 35c, Lower Cambrian: Mount White formation; in drift bowlder on the south slope of Mount Bosworth, British Columbia, Canada.

Agraulos stator Walcott 173

FIG. 6. (Natural size.) A nearly perfect dorsal shield that well illustrates the characters of the species. U. S. National Museum, Catalogue No. 61729.

From locality 35c, Lower Cambrian: Mount White formation; in drift bowlder on the south slope of Mount Bosworth, British Columbia, Canada.



CAMBRIAN TRILOBITES

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Karlia minor Walcott..... 224

FIG. 7. (×4.) Group of specimens on a fragment of shale, and showing characteristics of the species. U. S. National Museum, Catalogue No. 26703.

7a. (×10.) A young individual with two segments. U. S. National Museum, Catalogue No. 26703.

7b. (×6.) Dorsal shield with three segments. U. S. National Museum, Catalogue No. 61730.

7c. (×6.) Hypostoma. A smaller hypostoma is shown on fig. 7. U. S. National Museum, Catalogue No. 26703.

The specimens represented by figs. 7, *7a-c* are from locality 1, Middle Cambrian: Manuels River, above Conception Bay, near Topsail Head, Newfoundland.

Karlia stephenensis Walcott..... 224

FIG. 8. (×2.) Nearly entire dorsal shield with the free cheeks restored from other specimens. U. S. National Museum, Catalogue No. 61731.

From locality 14s, Middle Cambrian: Stephen formation; Mount Stephen, British Columbia, Canada.

Tsinania cleora Walcott..... 227

FIGS. 9, 9′. (×3.) Top and side view of cranidium. U. S. National Museum, Catalogue No. 61732.

9a. (×2.) Associated free cheek. U. S. National Museum, Catalogue No. 61733.

9b. (×2.) Associated thoracic segment. U. S. National Museum, Catalogue No. 61734.

9c, 9c′. (×2.) Top and side view of an associated pygidium. U. S. National Museum, Catalogue No. 61735.

The specimens represented by figs. 9, *9a-c* are from locality 30w, Upper Cambrian: Notch Peak limestone; House Range, Utah.

Tsinania elongata Walcott..... 228

FIGS. 10, *10a.* (×4.) Top and side view of a cranidium. U. S. National Museum, Catalogue No. 61736.

The specimen represented by figs. 10 and *10a* is from locality 346e, Upper Cambrian: 2 miles west of Donald Station, on the Canadian Pacific Railway, British Columbia, Canada.

DESCRIPTION OF PLATE 37

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Block of sandstone with *Lonchocephalus chippewaensis* and several other species characteristic of the Eau Claire formation of Wisconsin..... 190

A. *Hyolithes primordialis* Hall.
B. *Anomocarella onusta* (Whitfield).
C. *Pagodia thea* Walcott.
D. *Lonchocephalus chippewanesis* Owen (p. 190, and see pl. 34).
E. *Menomonia calymenoides* (Whitfield) (p. 162).
F. *Crepicephalus iowensis* (Owen) (p. 207).
G. *Dicellomus politus* Hall.
H. *Obolus matinalis* Hall.

U. S. National Museum, Catalogue No. 61737.

From locality 83a, Upper Cambrian: Eau Claire formation; Rock Falls, Dunn County, Wisconsin.

LONCHOCEPHALUS CHIPPEWAENSIS Owen (D) AND OTHER SPECIES

DESCRIPTION OF PLATE 38

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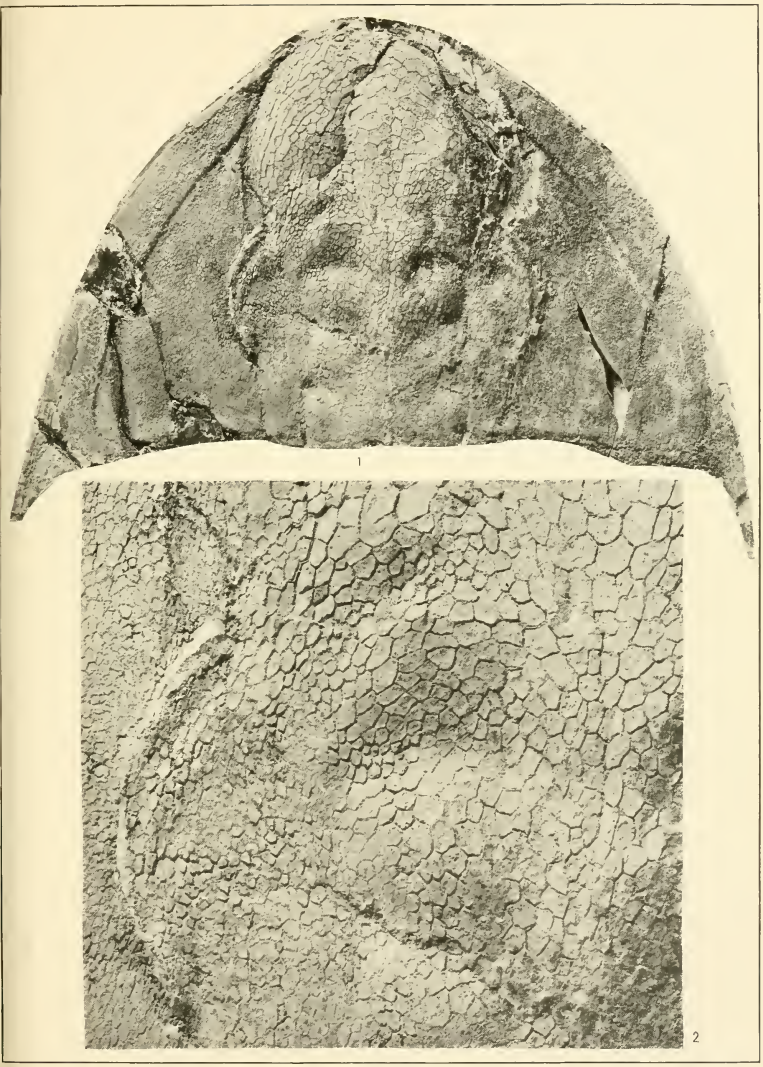
Wanneria walcottana (Wanner) 219

FIG. 1. (Reduced to three-fourths natural size.) Cranidium crushed nearly flat in argillaceous shaly rock.

2. (×2.5.) Portion of the surface of the specimen represented by fig. 1, enlarged so as to bring out the reticulate structure.

The specimen represented by figs. 1 and 2 is from (12x) Lower Cambrian: 1 mile (1.6 km.) north of Rohrerstown, Lancaster County, Pennsylvania. It was loaned to me by Dr. H. Justin Roddy.



WANNERIA WALCOTTANUS (Wanner)

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The references in **heavy-faced** type refer to the locality numbers and the pages upon which the genera and species are described and figured.