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V

No. 3.—CAMBRIAN AND OZARKIAN TRILOBITES

(With Plates 15 to 24)

BY
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INTRODUCTION

The collections of invertebrate fossils in the United States National Museum from the Cambrian and Ozarkian formations of the United States and Canada contain a large and varied series of trilobites, many of which are undescribed, while others have been given only provisional study and publication.

These collections have accumulated during the past 25 years, largely as the result of my studies of the various formations of the Cambrian and Ozarkian in western America. In the actual collecting, I have been aided by several assistants, notably Dr. Cooper Curtice, Mr. F. B. Weeks, Dr. L. D. Burling, Dr. Charles E. Resser, my two sons, Sidney and Stuart, and their mother, and during the past 10 years, Mrs. Mary Vaux Walcott has been most helpful in assisting me in gathering the faunas of the lower Ozarkian and Cambrian in the Canadian Rockies. During this period over 65,000 specimens have been deposited in the Museum from collections made in the Cordilleran area alone. Many specimens have been contributed and loaned by local collectors, and the generous cooperation of the Geological Survey of Canada has been of great service through assistance in my field-work and in loaning specimens for study. Dr. E. O. Ulrich has gathered a great quantity of material from the Lower Paleozoic formations of the Appalachians and the Mississippi Valley, in connection with his field studies as a member of the U. S. Geological Survey. From time to time he has made many intensive studies of the fragmentary trilobites but refrained from publication in order to obtain a more comprehensive knowledge of the faunas and the formations in which they occur. I pursued a somewhat different course, as it was essential that a few at least of the fossils occurring in the great Cordilleran sections should be made known to the geologist. This has led to much preliminary study and publication, since otherwise the entire work would have been delayed for many years. Now, thanks to the enthusiastic work of Dr. Charles E. Resser, aided and checked by Dr. Ulrich, the great collections are being systematically worked, studied and prepared for future publication.

At the present time Dr. Ulrich is actively engaged in preparing descriptions of the Ozarkian fossils together with a volume on the stratigraphy. It is expected that portions of both volumes will be ready for the press within a few months. Dr. Ulrich and Dr. Resser are also carrying forward their studies of the Cambrian faunas of the Mississippi Valley. Prof. B. F. Howell of Princeton University and Dr. Resser also have under way a monographic study of the

Agnostidae, from which it is hoped much data will be obtained for more exact correlation of the older beds. Several of the studies listed above will be published in parts, which together with descriptions to be published by me from time to time, will in the near future equip the worker in Cambrian stratigraphy so that more detailed and more correct stratigraphic conclusions can be reached.

The genera described and illustrated in this paper were recognized and prepared for study at various times during the past 10 years. Diagrammatic outline sketches of most of them were published in 1924,[1] and the names given many have been used in connection with description of formations and geological sections.[2] In the preparation of descriptions of genera, free use was made of Dr. Ulrich's notes on some; also the observations of Dr. Resser.

The dorsal tests of the trilobites are usually dismembered and often only a single head or tail of a species is found; then again the rock may be almost made up of various parts of many species crowded together in great disorder. The most skillful manipulation is required to work out identifiable specimens and then the interpretation of the probable relations of the various parts requires patient study and a wide acquaintance with the fauna.

Mr. J. A. Mirguet did much of the preliminary working out of the fossils from their matrix. Miss Sara Evans has assisted Dr. Resser, and Miss Frances Wieser and Miss Doris Cochran have made outline sketches and retouched the photographs where necessary.

DESCRIPTION OF GENERA AND SPECIES

Genus AMECEPHALUS Walcott

Amecephalus Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, pp. 53, 54.

Description.—The genus *Amecephalus* was established to include the forms with a wide frontal border that were formerly placed in *Ptychoparia piochensis* (Walcott) (s. l.).

The broad, flat border is characteristic of the genus. Cranidium wide with the glabella occupying only about one-half the length of the head and well defined by the dorsal furrow. There are three sets of glabellar furrows that are usually moderately impressed and which turn sharply backward as they approach the middle of the head where most of the specimens of the type species have a more or less

[1] Smithsonian Misc. Coll., Vol. 75, Nos. 1 and 2, 1924.
[2] Smithsonian Misc. Coll., Vol. 67, No 8, 1923; Vol. 75, No. 1, 1924.

pronounced longitudinal keel. Fixed cheeks wide, with strong ocular ridges crossing them. Palpebral lobes rather small and slightly upturned. The broad frontal limb and border in front of the eye-lines is marked by irregular inosculating lines. There is a tendency toward the formation of a boss immediately in front of the glabella, a feature which seems to occur in a greater or less degree in nearly all trilobites with a wide frontal limb. The present incomplete study indicates a possibility that several of the American species now referred to the European genus *Acrocephalites* may ultimately be included in *Amecephalus*.

The free cheeks are of moderate size and of the usual shape. They have a very narrow border with a tendency to turn up somewhat into a wire edge. A comparatively wide doublure is present under the cheeks and possibly maintains its width across beneath the cranidium. The facial suture is intramarginal for about one-third the distance in front of the cranidium. The broad frontal border has a very narrow rim which is usually not apparent in the flattened specimens.

The thorax in the type species has 19 segments. Those toward the rear of the body have relatively longer spines that partly envelop the small pygidium.

Pygidium small, smooth, and definitely three-lobed. The axial lobe is considerably larger than the side lobes and extends to the posterior margin; it has two or three transverse furrows that do not appear to extend out on the pleural lobes.

Derivation of name.—Αμη=shovel or spade; Κεφαλη=head.

Genotype.—*Ptychoparia piochensis* Walcott, as restricted.

Range.—Middle Cambrian of the Great Basin, Nevada, etc.

AMECEPHALUS PIOCHENSIS (Walcott)

Plate 15, figs. 8-10

Ptychoparia piochensis Walcott, 1886, U. S. Geol. Surv. Bull. 30, p. 201, pl. 26, figs. 2, 2a, b; pl. 28, figs. 1, 2-2e. (Described and illustrated.) Pack, 1906, Journ. Geol., Vol. 14, p. 297, pl. 2, figs. 4-4c. (Added notes and illustrated.) Grabau and Shimer, 1910. N. A. Index Fossils, Vol. 2, p. 276, fig. 1575. (Illustrated.)

Liostracus piochensis Lorenz, 1926, Zeits. d. d. geol. Gesell., bd. 58, heft 1, p. 61. (New generic reference with notes.)

Amecephalus piochensis Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 54, pl. 9, fig. 1.

Observations.—The original description includes the forms with an extra wide frontal border and 19 segments which here are restricted to this specific name. The specimens included under this generic and

specific name do not show intergradations relative to size of border as stated in the original description, but, as can be seen from the illustrations, large and small maintain the same relative proportions.

Formation and locality.—Middle Cambrian: (31) Chisholm formation. Chisholm mine, southwest slope of Ely Mountains, 3 miles (4.8 km.) northwest of Pioche, Lincoln County, Nev.

Genus ANORIA Walcott

Anoria Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 54.

Description.—Dorsal shield broadly oval in outline, moderately convex, with a strong axial lobe. Cephalon with a large glabella outlined by strong dorsal furrows on the sides that terminate anteriorly in slight pits: a very slight depression separates the glabella from a narrow rounded frontal rim: the sides of the glabella diverge from about midway of its length towards the front: posterior glabellar furrows slightly defined: occipital furrow well marked and occipital ring strong with a node at its center.

Fixed cheeks are narrow in front of the palpebral lobes and widening posteriorly to merge into rather short postero-lateral limbs that have a well-defined intermarginal furrow. Palpebral lobes narrow with posterior end slightly back of the transverse median line of the cranidium; ocular ridge extending across the cheek to the dorsal furrow.

Free cheeks moderately large with a furrow defining a wide border beginning near the suture at the front and curving inward to join the posterior edge of the postero-lateral limb. Genal spines long and strong. A wide doublure extends forward from the genal angle and thickens as it passes beneath the cranidium, and apparently without a median suture. The general course of the facial suture diverges from the front of the cephalon to the occipital margin; is entirely intramarginal, rounds off the corners of the glabella, passes outward around the comparatively straight palpebral lobes, and behind the eyes diverges more rapidly, cutting the posterior margin at a distance from the glabella equal to about one-third the length of it, thus leaving broadly triangular postero-lateral limbs.

Thorax in the type species with seven segments. Axis wide, each segment having a median tubercule and a faintly impressed furrow. The pleuræ are short, increasing in length relative to the width of the axis posteriorly; each pleura has a deep and wide furrow dying out rapidly near the end where the pleura begins to taper to a blunt

spine. The third segment from the posterior end of the thorax is continued laterally into a long, backward extending spine.

Pygidium semi-circular in outline. The axis is somewhat narrower than the thoracic axis and is more nearly semi-cylindrical, standing considerably higher than the side lobes. No rim is apparent except in the specimens compressed in shale when the doublure leaves an impression on the upper surface: the border flattens out and is slightly concave. Three or four axial furrows and rings are usually discernible, but they become successively fainter until indistinguishable. Those near the anterior edge have median tubercles similar to those on the thoracic segments. Several pleural furrows are very faintly visible on the lateral lobes back of the strong anterior one, the margin of which is slightly thickened.

Derivation of name.—Ανευ = without; Ορια = border.

Genotype.—*Dolichometopus tontoensis* Walcott.

Range.—Upper Cambrian.

Observations.—*Anoria* differs from *Dolichometopus,* the genus to which the type species was first referred, in several important respects. The glabella of *Dolichometopus* is definitely separated from the fixed cheeks and frontal limb by a dorsal furrow passing all the way around. The course of the facial suture is different. In *Dolichometopus* it diverges in front of the eyes as well as behind and here more rapidly than in *Anoria.* It is also not intramarginal except possibly for a short distance. The eyes of *Dolichometopus* are relatively larger and more curved than in *Anoria.*

The pygidia of the two genera are quite similar in general appearance. *Dolichometopus* always has a distinct border. The axial furrows are also distinctive in their course, which is straight across the flattened axis and not curved as in *Anoria.*

ANORIA TONTOENSIS (Walcott)

Plate 18, figs. 15-28

Dolichometopus tontoensis Walcott, 1916, Smithsonian Misc. Coll., Vol. 64, No. 5, p. 373, pl. 51, figs. 1, 1 a-h. (Description and illustration of species.)

Anoria tontoensis Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 54, pl. 9, fig. 2.

The original description with the generic description and illustrations present all that we know of the species.

Formation and locality.—Upper Cambrian: (74e) Bright Angel shale. Indian Garden Spring: (74) Nunkoweap Valley, Grand Canyon, Arizona.

Genus ARMONIA Walcott

Armonia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 54.

Description.—*Armonia* is characterized by a conical glabella with only traces of furrows. The wide frontal limb is composed of a wide rim and border and the dividing furrow turns back in the center, narrowing the border almost one-half in the genotype. The facial suture diverges moderately in front of the eyes, but rapidly back of them, thus making wide triangular postero-lateral limbs. Free cheeks small and without genal spines in the genotype.

Thorax of the type species with 14 segments which resemble those of *Chancia* and *Elrathia*.

Pygidium relatively large, with three or four axial rings and several pleuræ which continue nearly across the pleural lobes.

Observations.—*Armonia* differs from *Elrathia* in its frontal limb, absence of glabellar furrows and relatively larger pygidium.

Genotype.—*Armonia pelops* Walcott.

Range.—Upper Cambrian: Southern Appalachians.

ARMONIA PELOPS Walcott

Plate 17, figs. 28-31

Armonia pelops Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 54, pl. 10, fig. 1.

The illustrations and notes on the genus present all known features of the species.

Formation and locality.—Upper Cambrian: (95) Conasauga formation. One-half mile (0.8 km.) above Center Road Ford, Cowan Creek, Cherokee County, Alabama.

Genus BELLEFONTIA Ulrich

Bellefontia Ulrich, in Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 54.

Quotation from Dr. Ulrich's manuscript: "*Hemigyraspis* was proposed by Raymond[1] as a subgenus of *Niobe* Angelin, *Asaphus affinis* McCoy, a British Upper Tremadoc species being cited as the type. In my opinion *A. affinis,* as figured by Salter,[2] belongs to a genus quite distinct from *Niobe* which has a well-developed neck ring and a of the Asaphidae. The general aspect of *A. affinis,* on the other hand, is decidedly asaphid. In fact, so far as I can see, it differs in no

[1] Raymond, P. E. Annals Carnegie Mus., Vol. 7, No. 1, p. 41, 1910.

[2] Salter, J. W. Monogr. Brit. Trilobites, p. 164, p. 24, figs. 13, 14, 1864.

essential feature from *Platypeltis* Galloway except that its eyes are smaller. *Hemigyraspis,* as based on McCoy's species, may be a subgenus of *Platypeltis,* or perhaps of *Symphysurus,* but not of *Niobe.* Again, *Hemigyraspis affinis* seems a close relative of *Asaphellus* with which it agrees in every generic character, except that the facial suture in the former cuts the anterior edge of the cephalon in front of the eye, whereas in the typical species of *Asaphellus* the suture remains on the dorsal side to the middle of the anterior edge. In view of these facts it is difficult to decide as to which of these suggested alliances is the closest. Personally, I doubt very much that we know enough of these trilobites to warrant any definite conclusion. For the present, therefore, I prefer to view *Hemigyraspis* as a distinct genus, and would refer to it only those species that are unquestionably congeneric with the type species.

" Thus restricted it becomes questionable whether the genus is truly represented in American deposits. Raymond refers here Matthew's *Asaphellus ? planus,*[1] but that Bretonian species is described as having an unlobed pygidium, on which account its reference to *Hemigyraspis* seems very doubtfully warranted. He describes also two new species, one of which, *H. mcconnelli,*[2] from the vicinity of Golden, British Columbia, is based on specimens too imperfect for exact determination. The other is founded on separated pieces of a trilobite collected at Bellefonte, Pa., from near the top of the Stonehenge limestone, which is the lowest of four alternating limestone and dolomite formations into which the great development of the Canadian system in central Pennsylvania has been divided. Raymond[3] applied the name *Hemigyraspis collieana* to this Bellefonte species.

" Unfortunately, the specimens on which Raymond based this species, especially that, or those of the cranidium, are so imperfect that he failed entirely to observe certain important characters that are quite at variance with those assigned to his genus *Hemigyraspis.* Thus, in *H. collieana* the glabella is clearly outlined in front—as well, indeed, as in any asaphid; and in front of it the cranidium incloses a fairly wide flat border. The facial suture does not cut the front edge of the cephalon, as in *H. affinis,* but, as shown by the anterior

[1] Matthew, G. F., 1902, Bull. New Brunswick Nat. Hist. Soc. No. 20, p. 419, pl. 18, fig. 11; Geol. Survey Canada Ann. Rept. 1903, Cambrian Rocks Cape Breton, p. 237, pl. 18, fig. 11.

[2] Raymond, P. E., 1913, Victoria Mem. Mus. Bull. No. 1, p. 40, pl. 4, fig. 4.

[3] Raymond, P. E., 1910, Annals Carnegie Mus., Vol. 7, p. 41, pl. 14, figs. 9-13.

extensions of the free cheeks remains on the dorsal surface well within the edge. Finally, the eyes are not 'nearly halfway to the front of the cephalon' but wholly behind the midlength of the cranidium. The hypostoma, when the anterior wings are entirely uncovered, is much wider than long. In most other respects also it resembles the hypostoma of *Symphysurina,* the only differences of any consequence being that the anterior wings are more quadrate in form and pointed at the outer front extremity, and the depression at the middle of the anterior edge much shallower.

"In none of the features mentioned is *H. collieana* like *H. affinis.* They cannot belong to the same genus. So far as the cephalon is concerned, the former is much nearer *Ogygia corndensis,* a British Llandeilo Flags species figured by Salter in his monograph, and for which Raymond[1] has proposed the new designation *Ogyginus.* The similarity and apparent relation to the latter extends to the hypostoma; but the neck and glabellar furrows, even though imperfectly developed, together with a strongly segmented pygidium, are essential characters of *Ogyginus* whose absence in the species *collieana* will not permit its unqualified reference to that genus. As the peculiarities of the latter species do not seem to be covered by any established genus, the new generic term *Bellefontia* is proposed for it.

"It is this *Bellefontia collieana* that is above referred to as a close ally of *Symphysurina.* It seems to me a derivative of some species of this genus, differing from its ancestors in the development of a flat border in front of the glabella. At the same time, and perhaps largely in consequence of the growth of the border, the facial suture became intramarginal. These departures approximate to conditions usually found in typical Asaphidae. But this seems a case of parallel tendencies in the development of different lines and not one of orthogenesis."

Genotype.—Hemigyraspis collieana Raymond.

Range.—Ozarkian: Mons formation. Alberta, Canada. Rocky Mountains. Canadian: Stonehenge, Bellefonte, Pennsylvania.

Observations.—This genus has many species in the Ozarkian and so far as the studies have gone only a few pass into the Canadian. The study of the group, however, is too little advanced to be altogether certain of its complete range.

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[1] Raymond, P. E., 1912, Roy. Soc. Canada, Proc. and Trans., 3d ser., Vol. 5, sec. 4, p. 117.

BELLEFONTIA COLLIEANA (Raymond) Ulrich

Plate 23, figs. 1-6

Asaphus marginalis Collie (not Hall), 1903, Bull. Geol. Soc. Amer., Vol. 14, p. 413. (Listed only.)

Hemigyraspis collieana Raymond, 1910, Annals Carnegie Mus., Vol. 7, No. 1, p. 41, pl. 14, figs. 9-13.

Bellefontia collieana (Raymond) Ulrich, in Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 54, pl. 9, fig. 3.

Raymond's description of the species is as follows:

"Cephalon short and wide, glabella smooth, not outlined, no glabellar furrows. Neck-furrow shallow, hardly visible. Eyes nearly halfway to the front of the cephalon, large, very far apart. Between the eyes is a small median tubercle. Free cheeks short, wide, with long narrow spines at the genal angles. Facial suture entirely intramarginal. There is a narrow depressed border on the front of the cranidium.

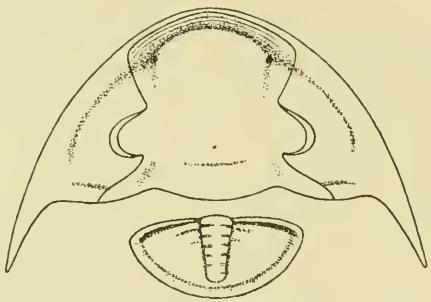

FIG. 12.—*Bellefontia collieana* (Raymond). Corrected drawing of the genotype.

"Axial lobe of thorax one-third the total width; pleura grooved. Pygidium short, wide, semi-circular in outline. Axial lobe narrow, rather prominent, showing traces of two or three rings. Pleural lobes convex, without traces of ribs. Border narrow, concave; doublure narrow, convex."

It is to be noted that Raymond places the eyes too far forward in his illustrations.

Formation and locality.—Canadian: (271r) Lower Stonehenge. Bellefonte, Pennsylvania.

BELLEFONTIA NONIUS (Walcott)

Plate 23, figs. 7-11

Niobe ? nonius Walcott, 1923, Smithsonian Misc. Coll., Vol. 67, No. 8, p. 473. (Listed under locality 65y.)

This species averages larger in size than *B. collieana*. In the cranidium the greatest difference between the two species lies in the

slightly different front. *B. nonius* has a flatter rim, but the glabella is marked off in much the same way except that it is more expanded anteriorly. The head is less convex in longitudinal cross-section and the palpebral lobes are also slightly smaller.

The free cheek (fig. 9) assigned to *B. nonius* has preserved the extension of the doublure for a considerable distance beyond the cheek. The suture is intramarginal.

The pygidia associated with *B. nonius* are not unlike those of *B. collieana,* except that the axial and pleural ribs are less well developed.

Formation and locality.—Ozarkian: Mons formation. (65y) north side of Clearwater Canyon, 2 miles (3.2 km.) from divide at head of canyon and about 21 miles (33.8 km.) in an air line north, 2° west, of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

This species occurs in 1c of the Clearwater section, 426 feet (129.8 m.) above the base of the Mons formation and 970 feet (295.7 m.) below the summit.

BOWMANIA, new genus

Description.—Only the glabella of the type species is known. Due to the meager material the following generic description must be regarded as tentative.

The glabella is cylindrical, rounded in front and a little less than half the length of the head. Two pairs of very short glabellar furrows are present. Eyes small, situated back of the middle of the glabella. Ocular ridges strong. Frontal border wide, convex, with a narrow rim, and covered with fine, irregular lines.

Facial suture unknown. The frontal rim is of an even width throughout, which proves that the suture was not intramarginal.

Genotype.—*Arethusina americana* Walcott.

Range.—Upper Cambrian.

BOWMANIA AMERICANA (Walcott)

Plate 15, figs. 15, 16

Arethusina americana Walcott, 1884, Monogr. U. S. Geol. Surv., Vol. 8, p. 62, pl. 9, fig. 27. (Described and illustrated.) Brögger, 1886, Geol. Foren. Stockholm Fornhandl., bd. 8, p. 206. (Mentioned.)

Harpides ? americanus Frech, 1897, Leth. geog., th. 1, Leth. Pal., 2, p. 44, footnote. (Generic reference changed.)

Aulacopleura americana Raymond, 1913, Ottawa Nat., Vol. 26, p. 6. (Generic reference changed.)

See original description for details.

Formation and locality.—Upper Cambrian: (66) Hamburg limestone? On first ridge north of the Dunderberg Mine, Eureka District, Nevada.

Subfamily DIKELOCEPHALINÆ Beecher

Dikelocephalinæ Beecher, 1897, Amer. Journ. Sci., 4th Ser., Vol. 3, p. 192.

In a paper on *Dikelocephalus* and other genera of the Dikelocephalinæ[1] I included in this subfamily:

Dikelocephalus Owen 1852.
Conokephalina Brögger 1886.
Calvinella Walcott 1914.
Osceolia Walcott 1914.
Saukia Walcott 1914.

To the above five genera there is now added *Briscoia* Walcott which occurs in the lower beds of the Mons formation of the Ozarkian of Alberta and British Columbia, and the Lower Ozarkian of Devils Lake and Mendota formations of Wisconsin and Hoyt limestone of New York. The non-spinose species belonging in the Upper Cambrian are also included.

BRISCOIA Walcott

Briscoia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 1, p. 37.

Briscoia is founded on the cranidium, free cheeks, fragments of thoracic segments and entire pygidia of a large trilobite that occurs in the lower portion of the Mons formation.

Observations.—*Briscoia* differs from *Dikelocephalus* in its elongate glabella, frontal limb and course of the facial sutures in front of the glabella, and in the latter the suture is intramarginal to the center while in *Briscoia* the suture appears to be intramarginal for a less distance: the most strongly marked difference, however, is the presence of the characteristic postero-lateral spine on the pygidium of *Dikelocephalus*. The thoracic segments are essentially the same.

Genotype.—*Briscoia sinclairensis* Walcott.

Stratigraphic range.—Ozarkian, lower portion of the Mons formation. Hoyt limestone of New York. Upper Cambrian of Wisconsin and Minnesota.

Geographic distribution.—Cordilleran area of Alberta and British Columbia, from Glacier Lake to Mount Sabine at the southern end of the Stanford Range; Saratoga County, New York; Devils Lake sandstone and Mendota limestone areas of Wisconsin.

[1] Smithsonian Misc. Coll., 1914, Vol. 57, No. 13.

The species now referred to the genus from the Mons formation, in the present stage of the study, are:

Briscoia glaucus Walcott.
B. onophas Walcott.
B. opimius Walcott.
B. sinclairensis Walcott.
B. splendens Walcott.
B. zebina Walcott.

There should also be included:

B. limbatus (Hall) = *Dikelocephalus ? limbatus* Hall (Walcott).[1]
B. coloradoensis Walcott = *Saukia coloradoensis* Walcott.[2]

BRISCOIA SINCLAIRENSIS Walcott

Plate 20, figs. 1-10

Briscoia sinclairensis Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 1, p. 37, fig. 9.

Description.—This is the largest species of the genus although *B. splendens* is close to it in size. The material representing the cephalon is far from satisfactory, but by combining data from several specimens a fairly satisfactory outline is obtained. Glabella with nearly parallel straight sides and broadly rounded front; rather strongly convex and marked by a distinct narrow occipital furrow that bends slightly forward towards the ends; the first furrow is narrow and distinct; it slopes forward from near the center and terminates just within the lateral margin, not entering the dorsal furrow; the second furrow is represented by a short furrow on each side corresponding to the lateral third of the second furrow; the anterior lobe of the glabella is smooth, sloping rather abruptly down to the faint dorsal furrow between it and the frontal limb; the first and second lobes are rather slightly convex and a little wider than the occipital lobe which is flattened and without a node at its central posterior margin. Dorsal furrow beside the glabella narrow and distinct; both the glabella and fixed cheeks rise abruptly from it.

Fixed cheeks narrow, expanding in front to merge into the frontal limb and posteriorly widening a little as they join the narrow posterior limbs; palpebral lobes nearly one-third the length of the cranidium, narrow and with a well-defined furrow within the outer margin; frontal limb broad, about one-fifth the length of the cranidium; it is nearly flat but rises slightly towards the slightly convex frontal rim

[1] Smithsonian Misc. Coll., 1914, Vol. 57, No. 13, pl. 65, figs. 5-8.
[2] Loc. cit., p. 376, text figs. 14-16.

which is delimited by a very gentle smooth furrow from the frontal limb. The facial sutures curve outward and forward from the base of the eye and recurve abruptly inward so as to cut across the frontal rim at a very slight angle; their course in front is unknown.

Free cheeks broad, large and terminating in a strong, long spine.

The few fragments of the thorax were found which indicate that the segments were similar in form to those of *B. splendens.*

The associated pygidium has a strong axial lobe crossed by four narrow sharp furrows that separate four strong, slightly convex segments and a terminal portion that is nearly as long as the segmented portion. The axis is a little more than one-half the length of the pygidium and merges into it at the end of a very steep slope; the lateral lobes slope rapidly from near the axis down to the broad planulate margin that extends from the anterior margin entirely around the lateral and posterior margins; the transverse furrows of the axis extend diagonally backward and fade out on the margin along with the pleural furrow of each segment represented in the pygidium.

Surface marked by very fine, raised, irregular inosculating lines.

An associated hypostoma is illustrated by figure 7, plate 20. It is not unlike that of *Dikelocephalus minnesotensis* Owen[1] but varies in details.

Dimensions.—The largest cranidium has a length of about 50 mm. and pygidium of 50 mm.

Observations.—This species differs from *D. splendens* in the character of the frontal limb and rim, and in the proportions of the glabella. The pygidia associated with the cranidiæ of the two species are much alike, but the axial lobe of *B. splendens* is more slender.

Formation and locality.—Ozarkian: (16t') Mons formation. Thin layers of limestone interbedded in gray argillaceous shale, Brisco Range, north side of Sinclair Canyon about 500 feet (152.4 m.) above creek and a little west of Radium Hot Springs.

(17n) Thin layer gray nodular limestone interbedded in argillaceous shale, at north side of Stoddart Creek Canyon near its mouth, 6 miles (9.6 km.) south of Sinclair Canyon, Stanford Range, on east side of Columbia River Valley, British Columbia, Canada.

Ozarkian. (64n) Mons formation (Lower). Near base of 1e of field section. Cliff on southeast side of Mons Glacier, above head of Glacier Lake Canyon valley about 50 miles (80.5 km.) northwest of Lake Louise Station on Canadian Pacific Railway, Alberta, Canada.

[1] Smithsonian Misc. Coll., 1914, Vol. 57, No. 13, pl. 81, fig. 3.

Fragments that may belong to this species occur in the lower part of the Mons at locality 21p: Ozarkian: Mons formation: Gray limestone interbedded in shale of 1g of section and a little below faunal horizon of 17s. West slope Sabine Mountain 500 feet (152.4 m.) above south end of Columbia Lake, 2 miles (3.2 km.) north of Kootenay River bridge and about 2 miles (3.2 km.) northeast of Canal Flats Station on Canadian Pacific Railway, British Columbia, Canada.

Genus BURNETIA Walcott

Burnetia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 54, pl. 10, fig. 2.

Description.—A single cranidium and a free cheek assigned to it are the only parts of this trilobite thus far obtained.

This form is peculiar in several respects. It is characterized by a strongly convex high glabella which arches rapidly from the occipital furrow to the anterior margin. The occipital and the posterior pair of glabellar furrows are fairly well marked, and a second pair of short anterior furrows is faintly outlined. The dorsal furrow is strongly defined all around. The wide, flaring, steeply inclined, smooth border is slightly concave in front and forms a notable character of the cranidium.

Fixed cheeks narrow: palpebral lobes and eyes moderately large, and the posterior portion of the palpebral lobe extends to a point in line with the occipital ring: ocular ridges clearly outlined. Free cheek elevated and with a wide border. The facial suture may possibly be intramarginal to the apex.

Surface of the type species granulose.

Genotype.—*Ptychoparia ? urania* Walcott.

Range.—Upper Cambrian: Texas.

BURNETIA URANIA (Walcott)

Plate 17, figs. 1-3

Ptychoparia ? urania Walcott, 1890, Proc. U. S. Nat. Mus., Vol. 13, p. 274, pl. 21, figs. 10, 11. (Original description.)

Burnetia urania Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 54, pl. 10, fig. 2.

The original description outlines what is known of the species.

Formation and locality.—Upper Cambrian: (68) Cap Mountain formation. Packsaddle Mountain, Llano County, Texas.

Genus BYNUMIA Walcott

Bynumia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 54.

Observations.—*Bynumia* is a small trilobite closely related to *Kingstonia* and several undescribed genera. In the shape and obscure definition of the glabella and in the general configuration of the posterior portion of the cranidium, it agrees almost exactly with *Kingstonia.* It differs in the following points: (1) The eyes are situated just about opposite the middle of the glabella and farther back than in *Kingstonia.* (2) The front of the cranidium is narrower and more produced in the middle varying from obtusely angular to narrowly rounded in outline. (3) The cranidium lacks a frontal rim. The last character suggests that the rim is on the free cheeks and that the suture is intramarginal.

No pygidium that can be referred with this head has been discovered in the collections containing the type cranidium, but with other species there is associated a form not very unlike the pygidium of *Kingstonia,* which may belong to this genus.

Genotype.—*Bynumia eumus* Walcott.

Range.—The type species occurs in the Upper Cambrian Lyell formation of British Columbia. Two other species are known, one from the Maryville limestone of Tennessee and a second from the Lower Ozarkian of St. Albans, Vermont.

BYNUMIA EUMUS Walcott

Plate 17, figs. 4-6

Bynumia eumus Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 54, pl. 14, fig. 3.

The illustrations exhibit the known characters of this species.

Formation and locality.—Upper Cambrian: (66m) Lyell formation. Second canyon northwest of Mt. Edith, 4.75 miles (7.6 km.), Sawback Range. (64b) Lyell formation, Head of Glacier Lake, Canyon valley, about 48 miles (77.2 km.) northwest of Lake Louise, Alberta, Canada.

Genus CEDARIA Walcott

Cedaria Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 55.

Description.—The genus *Cedaria* includes a number of species which have long been known in the collections but of which only one has been described (*Agraulos woosteri* Whitfield).

Cephalon semi-circular in outline. Glabella smooth, tapers slightly to rounded front, a little more than half the length of the cranidium. Occipital furrow present, dorsal furrow strongly impressed. Frontal limb consists of a border and a fairly wide rim. The course of the facial suture is unusual: back of the eye it turns directly outward and somewhat forward, making a postero-lateral limb that is wider at its outer extremity than immediately below the eye. In front of the eye the suture turns outward very sharply as does the posterior portion. It is intramarginal for about half the distance between the anterior corners of the cranidium and the center. A cranidium viewed with the free cheek separated exhibits the characters of a Proparian trilobite, in which the facial suture cuts the margin anterior to a rounded genal angle. When, however, this free cheek with its long genal spine is studied, its true course, which is illustrated by figure 24, plate 17, becomes clear. It is also not unlike that of the Hypoparian *Trinucleus* in the manner of rounding the genal angle. The facial suture is usually so tight in most species that the free cheeks are seldom separated.

The thorax of the genotype has seven segments.

The pygidium is nearly as large as the cephalon. It is semi-circular in outline and has a sloping border: axis convex with four or five segments that continue across the pleural lobes to merge into the border.

Surface smooth or slightly roughened by fine depressed granulations.

Genotype.—*Cedaria prolifica* Walcott.

Range.—Upper Cambrian: Appalachians, Wisconsin.

CEDARIA PROLIFICA Walcott

Plate 17, figs. 18-21

Cedaria prolifica Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 55, pl. 10, fig. 6.

The generic characterization together with the figures present the features of this species.

Formation and locality.—Upper Cambrian: (91) Conasauga formation. Cedar Bluff, Cherokee County, Alabama.

CEDARIA TENNESSEENSIS, new species

Plate 17, figs. 22-25

Observations.—This species differs from *C. prolifica* in the wider postero-lateral limbs and the wider frontal limb of the cranidium.

The facial suture diverges less both before and behind the eye, making the free cheek more triangular and less quadrangular in outline.

The pygidium has a wider border than *C. prolifica.*

Formation and locality.—Upper Cambrian. Nolichucky shale (Loc. 107a): Bull Run Ridge, 11 miles (17.6 km.) northwest of Knoxville, Tennessee.

Genus CHANCIA Walcott

Chancia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 55

Description.—*Chancia* is characterized by a wide cephalon and thorax. Fixed cheeks at the narrowest point nearly as wide as the glabella on the same line. Palpebral lobes moderately small and connected with the dorsal furrow near its front by an ocular ridge. Frontal limb wide, and marked by a strong transverse furrow that divides the wide rim from the border. Glabella tapering, marked by a rounded median ridge and apparently faint glabellar furrows, whose position and direction are similar to those of *Ptychoparia.*

Free cheeks undetermined.

Thorax with numerous segments, 20 in the genotype and 24 in *C. evax.* The pleural furrows are similar to those of *Elrathia.*

Pygidium small, trilobed and faintly segmented.

Observations.—*Chancia* resembles *Elrathia,* but differs in its wider fixed cheeks and wider rim, but most strongly in the small pygidium.

From *Amecephalus* it differs in the presence of a wide frontal rim, wider fixed cheeks and occipital furrow. The pygidium, while small and unsegmented as in *Amecephalus,* is wider and the trilobation is less pronounced, due to a lower axis. The thoracic segments of *Chancia* are blunt compared to the slender spines of the posterior portion of the thorax in *Amecephalus.*

Genotype.—*Chancia ebdome* Walcott.

Range.—Middle Cambrian: Rocky Mountains of Idaho.

CHANCIA EBDOME Walcott

Plate 17, fig. 26

Chancia ebdome Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 55, pl. 10, fig. 4.

The illustration of this species presents its characters quite clearly.

Formation and locality.—Middle Cambrian: (55c) Spence shale: Danish Flat, six miles (9.7 km.) southwest of Liberty, Bear Lake County, Idaho.

CHANCIA EVAX, new species

Plate 17, fig. 27

Observations.—*C. evax* differs from *C. ebdome* in having at least 24 thoracic segments instead of 20, the uncertainty as to number being due to the incompleteness of the posterior portion of all specimens in the collection. *C. evax* has a wider rim in proportion to the border, but is essentially the same in other respects.

Formation and locality.—Middle Cambrian: (55c) Spence shale: Danish Flat, six miles (9.7 km.) southwest of Liberty, Bear Lake County, Idaho.

Genus CORBINIA Walcott

Corbinia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 55.

Description.—*Corbinia* is founded on the cranidium and associated free cheek and pygidium. The cranidium has a strongly defined, slightly subconical, truncated glabella, strong occipital ring, very narrow fixed cheeks and a flattened frontal border that turns up somewhat as does the frontal border of *Eurekia* (fig. 13, pl. 16). The associated pygidium is small, with a very strong axial lobe marked by one furrow and the pleural lobes have about five short, broad spines on the margin.

A second species, *C. valida* Walcott (fig. 18), is represented by a single cranidium.

Corbinia differs by the form of its frontal limb and border from nearly all genera except *Eurekia*. (For comparisons see p. 89.)

Genotype.—*Corbinia horatio* Walcott.

Range.—Ozarkian: Mons formation, Clearwater Canyon, Alberta.

CORBINIA HORATIO Walcott

Plate 16, figs. 19-22

Corbinia horatio Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 55, pl. 10, fig. 5.

The illustrations and brief notes under the genus give all that we know of the species.

Formation and locality.—Ozarkian: (65x) Mons formation. North side of Clearwater Canyon, two miles (3.2 km.) from the divide at head of Canyon, about 21 miles (33.8 km.) in an air line north of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

CORBINIA VALIDA, new species

Plate 16, fig. 18

Of this species only the cranidium illustrated is known. It differs in details of the outline of the glabella, occipital ring and frontal limb and border, from *C. horatio.*

Formation and locality.—Same as that of *C. horatio.*

Genus CRUSOIA Walcott

Crusoia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 55.

Description.—This genus is characterized by the peculiar upturned front of the head, the small glabella and the extremely small pygidium.

The cranidium is wide at the base and narrowed in front. The frontal border is turned up quite sharply in the middle. Eyes are extremely small, situated at the end of an eye-line at a point opposite the anterior end of the glabella. Glabella about two-thirds as long as the entire cranidium and rounded conical in shape. A pair of posterior glabellar furrows, triangular in outline, is faintly visible on some specimens.

Free cheeks small, without genal spines. They have a definite rim and a doublure of uniform width.

Thorax with about 16 segments. The axis is convex and relatively wide; pleural segments with a narrow, nearly straight furrow within a high posterior marginal rim and a narrow depressed anterior border.

The character of the pygidium is uncertain. There are several entire individuals in the collections, but the pygidium is not clearly defined on any of them. It is certainly very small.

Genotype.—*Crusoia cebes* Walcott.

Range.—Middle Cambrian: Wolsey shale, Montana.

CRUSOIA CEBES Walcott

Plate 15, figs. 5-7

Crusoia cebes Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 55, pl. 10, fig. 7.

This species is fairly abundant at the type locality.

The generic description together with the illustrations clearly defines the characters of the species.

Formation and locality.—Middle Cambrian: (4g) Wolsey shale. Five miles (8 km.) northeast of Logan, Montana.

DESMETIA, new genus

There is barely sufficient material to allow a description of the genus, but because it is unusual in several respects, it is included in this preliminary work.

The glabella is rounded with minute recurved glabellar furrows. Fixed cheeks and frontal limb wide and convex. Eyes small and far forward.

Observations.—At first sight it seems as if *Desmetia and Raymondina* Clark[1] are synonymous, and the insufficiency of material will not now allow a solving of this question. Clark's figure, according to imperfect casts, is incorrect in the unusual rearward extension of the postero-lateral limbs. The forward turning of the occipital furrow on the fixed cheeks argues strongly for the Proparian nature of *Raymondina* and the straight course of the same suture in *Desmetia* would seem to indicate a difference. *Desmetia* also seems to lack a frontal border.

Genotype.—*Ptychoparia ? annectans* Walcott.

Range.—Ozarkian: Nevada.

DESMETIA ANNECTANS (Walcott)

Plate 15, figs. 24, 25

Ptychoparia ? annectans Walcott, 1884, Monogr. U. S. Geol. Surv., Vol. 8, p. 94, pl. 12, fig. 18. (Described and illustrated.)

See original description.

Formation and locality.—? Ozarkian: (201) Goodwin formation. East slope of the ridge east of Hamburg ridge, Eureka District, Nevada.

Genus DOKIMOCEPHALUS Walcott

Dokimocephalus Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 55.

Observations.—This genus is characterized by the great extension of the frontal border and large convex glabella. It may be compared with *Burnetia* (pl. 17, figs. 1-3) and *Elkia* (pl. 18, figs. 1-3).

Proampyx Frech, based on *Anomocare acuminatus* Angelin, and to which the genotype had been referred, is too uncertain to be used. It has a nasute extension of the frontal border but differs in glabella, occipital ring, and frontal limb.

Two species have been referred to the new genus, *D. pernasutus* (Walcott) and *D. gregori,* new species. Free cheeks similar to the one assigned to *D. pernasutus* are present in collections from several

[1] Clark, Bull. American Pal., Ithaca, N. Y., 1924, Vol. 10, No. 41, p. 35, pl. 4, fig. 8.

localities in which no cranidia have yet been noted. It is also hoped that further study, particularly of the collections from Loc. 11e, will permit the assignment of a pygidium to this head.

Genotype.—*Ptychoparia pernasuta* Walcott.

Range.—Upper Cambrian, Nevada.

DOKIMOCEPHALUS GREGORI, new species

Plate 16, figs. 32, 33

Observations.—This species differs from *D. pernasutus* in details of the cranidium, the only part available for comparison. A comparison of figures 29, 30 and 32, 33 of plate 16 shows the stronger occipital ring, broader glabella and shorter frontal limb of *D. gregori.*

Formation and locality.—Upper Cambrian: (11e): Southwest of Potosi, Missouri.

DOKIMOCEPHALUS PERNASUTUS (Walcott)

Plate 16, figs. 29-31

Ptychoparia ? pernasutus Walcott, 1884, Monogr. U. S. Geol. Surv., Vol. 8, p. 49, pl. 10, figs. 8, 8a, b. (Description and illustration of species.)

Proampyx ? pernasutus Walcott, 1913, Research in China, Vol. 3, Cambrian Faunas of China, p. 145. (Generic reference.)

Dokimocephalus pernasutus Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 55, pl. 11, fig. 1.

The original description and new figures include what is known of this species. It is a rare form in the Cordilleran area and only one allied species, *D. gregori,* is known from elsewhere.

Formation and locality.—Upper Cambrian: (61) Secret Canyon shale. A little north of Hamburg Mine, Eureka District, Nevada.

Genus DUNDERBERGIA Walcott

Dunderbergia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 56.

Observations.—*Dunderbergia* was proposed to include a group of species numbering perhaps 20 or more, all formerly assigned to *Ptychoparia* or closely related genera. The original description of the genotype and the figures of the cranidium and associated pygidium give all that is known of this genus.

Dunderbergia differs from *Modocia* in its narrower fixed cheeks, and in the direction of the facial sutures across the frontal border being intramarginal to the center.

Genotype.—*Crepicephalus* (*Loganellus*) *nitidus* Hall and Whitfield.

Range.—Upper Cambrian; Secret Canyon shale, Cordilleran area; Eureka District, Nevada.

DUNDERBERGIA NITIDA (Hall and Whitfield)

Plate 16, figs. 4-7

Crepicephalus (*Loganellus*) *nitidus* Hall and Whitfield, 1877, U. S. Geol. Expl. 40th Paral., Vol. 4, p. 212, pl. 2, figs. 8-10. (Original description and illustrations.)

Ptychoparia nitidus Walcott, 1884, Monogr. U. S. Geol. Surv., Vol. 8, p. 57.

Dunderbergia nitida Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 56, pl. 11, fig. 2.

There is nothing to be added to the original description.

Formation and locality.—Upper Cambrian: Secret Canyon shale: (61) Adams Hill. South of Hamburg Mine, Eureka District, Nevada.

Genus ELKIA Walcott

Elkia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 56.

Description.—The outstanding characters of *Elkia* are the very narrow, fixed cheeks together with the extended frontal limb. Glabella large, convex, outlined all around and slightly tapering: occipital furrow narrow and deeply impressed. There is one pair of glabellar furrows which bend backward but very slightly and do not unite across the middle; by turning some specimens carefully in the light additional faintly defined anterior pairs may be seen.

The eyes are beneath a large and apparently flattened palpebral lobe. None of the specimens is well preserved in this area due to the fact that the fixed cheeks stand nearly vertical and are quite easily broken away. The shape and size of the postero-lateral limbs are also unknown.

The facial sutures diverge in passing forward and then converge to the median line of the head, thus outlining an unusual triangular frontal limb, separated by a very slight, transverse furrow from a narrow frontal limb. Remaining parts unknown.

Genotype.—*Dicellocephalus nasutus* Walcott.

Range.—Upper Cambrian: Eureka District, Nevada.

ELKIA NASUTA (Walcott)

Plate 18, figs. 1-3

Dicellocephalus nasutus Walcott, 1884, Monogr. U. S. Geol. Surv., Vol. 8, p. 40, pl. 10, fig. 15. (Original description and illustration.) Matthew, 1893, Trans. Roy. Soc. Canada, Vol. 10, sec. 4, p. 11, footnote.

Proampyx nasutus Walcott, 1914, Smithsonian Misc. Coll., Vol. 57, No. 13, p. 352. (Refers species to *Proampyx*.)

Elkia nasuta Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 56, pl. 10, fig. 8.

The original description includes what is known of the species, no new material being available.

Formation and locality.—Upper Cambrian: (60, 64, 54) Secret Canyon shale ?, Richmond Mine, Adams Hill, and New York Canyon, Eureka District, Nevada.

Genus ELRATHIA Walcott

Elrathia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 56.

Observations.—The genus *Elrathia,* based on *Ptychoparia kingii* Meek, will include many of the forms hitherto assigned to *Ptychoparia,* which genus was used as a sort of dumping ground for a large series of species that had the general characters formerly assigned to that genus. It is not an easy task to separate them into distinct genera, even though several quite independent groups can be readily determined. *Ptychoparia* (restricted), so far as the present study has gone, is possibly absent from American Cambrian beds, and may be confined to the Bohemian Basin. It has much wider fixed cheeks and the sutures diverge much more in front of the eyes than in *Elrathia.* They also cut the frontal rim in a different manner. In *Elrathia* the suture is intramarginal to the center. This results in a widening of the frontal rim anteriorly. In *Ptychoparia,* on the other hand, the suture is marginal. Both genera have ocular ridges but that of *Ptychoparia* is much the stronger.

Ptychoparia has a very pronounced striation of the forward parts of the head, beginning at the eyes and ocular ridges. *Elrathia* also possesses a striation, but less pronounced and not beginning so definitely at the ocular ridges, and in some species, it is absent.

The thoracic segments of the two genera are quite distinct. In *Ptychoparia* the pleural furrows maintain an even width from their origin at the axis out nearly to the end of the pleura, dividing each segment into an anterior and posterior ridge. In *Elrathia* the pleural furrow divides the segment into two unequal parts; the anterior one is narrow next to the axis and widens out toward the outer end; the posterior one is wide next to the axis and narrows outward, but less rapidly than the anterior one and unites with the latter in forming the blunt terminal spine.

The pygidium of *Ptychoparia* shows the same peculiarity as the thorax in that the edges of two segments are fused to form the ridges that appear, on first sight, to be the pleural segments and not as they are—made of the anterior ridge of one, and the posterior ridge of the next. The separating depressions are not between segments, therefore, but pleural furrows. The pygidium of *Elrathia* has under-

gone much less fusion and the individual segments can readily be distinguished. A more definite rim is also present.

Dimensions.—Average length of large specimens, four cm.

Genotype.—*Conocoryphe* (*Conocephalites*) *kingii* Meek.

Stratigraphic Range.—Middle Cambrian, mainly.

Geographic Distribution.—Cordilleran area and possibly elsewhere.

Many species of the genus will be described and illustrated as the study of the trilobites of this type progresses. One of them is the *Crepicephalus* (*C.*) *haguei* Hall and Whitfield, from the Secret Canyon shale of the Eureka District, Nevada. The types come from the White Pine District. (Geol. Expl. 40th Paral., Vol. 4, p. 210, pl. 2, figs. 14, 15, 1877.)

ELRATHIA KINGII (Meek)

Plate 15, figs. 1-4

Conocoryphe (*Conocephalites*) kingii Meek, 1870, Proc. Acad. Sci. Philadelphia, p. 63. (Description of species.)

Conocoryphe (*Ptychoparia*) *kingii* Meek, 1873, 6th Ann. Rept. U. S. Geol. Surv. Terr., p. 487. Referred U. S. Geol. Expl. 40th Paral., 1877, Vol. 4, p. 20, pl. 1, fig. 4. White, 1877, Rept. U. S. Geogr. Surv., West 100th Merid., Vol. 4, p. 40, pl. 2, figs. 2a-c. (Described and illustrated.)

Liostracus kingii Brögger, 1886, Geol. Foren. Stockholm Forhandl., bd. 8, p. 205. (Generic reference changed.)

Ptychoparia kingii Walcott, 1886, U. S. Geol. Surv. Bull. 30, p. 193, pl. 27, figs. 4, 4a. (Described and illustrated.) Research in China, 1913, Carnegie Inst., Vol. 3, pl. 12, fig. 6. (Illustrated.) Beecher, 1895, Amer. Geol., Vol. 16, p. 171, pl. 8, figs. 5-7. (Noted and illustrated.) Grabau and Shimer, 1910, N. A. Index Fossils, Vol. 2, p. 275, fig. 1573. (Illustrated.)

Elrathia kingii Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 56, pl. 11, fig. 4.

Meek's very elaborate description gives the essential characters of the species, even though he included more than one form.

Formation and locality.—Middle Cambrian: (3w, 10y, 10z, 30g) Marjum formation. 1c of section. In cliff two miles (3.2 km.) southeast of Marjum Pass, House Range, Utah.

(3y) Marjum formation. Shaly limestones forming 1d of section, 2.5 miles (4 km.) east of Antelope Springs, in ridge east of Wheeler Amphitheater, House Range, Utah.

(4) Wheeler formation. Drift below cliffs near Antelope Springs, House Range, Utah.

(15b) Wheeler formation. Near Swazey Spring, House Range, Utah.

Genus ELVINIA Walcott

Elvinia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 56.

Description.—A large number of closely related species belonging to this genus is present in the National Museum collections. Some are definitely in the Upper Cambrian while others are Ozarkian. The specific assignment of the various body parts seems fairly correct.

The principal character that distinguishes the genus is the first pair of glabellar furrows, which is strongly impressed, the lateral parts sloping backward and united by a straight horizontal furrow. Another very short and faint pair can sometimes be distinguished farther forward. An occipital furrow is present but often so shallow as to be distinguished with difficulty. Dorsal furrow strong and definite.

Fixed cheeks fairly wide. Ocular lines present, usually in the form of an escarpment-like edge of the more elevated portion of the fixed cheek lying back of this line. Eyes of moderate size and situated opposite the forward half of the glabella.

The facial suture diverges slightly in front of the eyes and is intramarginal for about half way. Back of the eyes it passes rapidly outward in a gentle curve, thus giving a wide base to the cranidium. Free cheeks wide, with a well-defined rim. Genal spines usually long.

The pygidium of *Elvinia* is characterized by its clearly defined rings on the axis and the broad, but more shallow, pleural furrows. The axis is convex, cylindrical to sub-cylindrical in form, and it usually extends nearly to the posterior margin. The pygidia of many species have a wire-like raised edge which widens and thickens toward the anterior angles and joins the larger segment, usually the first.

Genotype.—Dikelocephalus roemeri Shumard.

Range.—Upper Cambrian—Ozarkian: New York and Pennsylvania, and numerous localities west of the Mississippi River.

ELVINIA ROEMERI (Shumard)

Plate 17, figs. 9-13

Dikelocephalus roemeri Shumard, 1861, Amer. Journ. Sci., 2nd ser., Vol. 32, p. 220. (Original description.)

Ptychoparia roemeri Walcott, 1914, Smithsonian Misc. Coll., Vol. 57, No. 13, p. 352. (Generic reference.)

Elvinia roemeri Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 56, pl. 11, fig. 3.

Observations.—The cephalon here illustrated has been chosen as most nearly representing Shumard's description of the species. It

is necessary to make several species from among the numerous specimens from Texas. It will be noted that a different pygidium has here been assigned to this than that given by Shumard. It is true that the pygidium apparently referred to in Shumard's description occurs with the heads of *Elvinia,* but at other localities, some far removed from Texas, only the type of pygidium here illustrated is associated with these heads wherever they occur.

Formation and locality.—Upper Cambrian: (68) Cap Mountain formation. Packsaddle Mountain, Llano County.

(70) Baldy Mountain, Morgans Creek, eight miles (12.9 km.) northwest of Burnet, Burnet County, Texas.

Genus EUREKIA Walcott

Eurekia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, pp. 56, 57.

Description.—*Eurekia* is represented by numerous specimens of the cranidium, free cheeks and associated pygidium. The strongly convex glabella with its deep dorsal furrows, the narrow upturned frontal border, narrow fixed cheeks and palpebral lobes, combine to give the cranidium a very distinctive character as does the associated pygidium (pl. 16, fig. 17). As at present constituted the genus includes species both with and without glabellar furrows. It may be that as the study of this group advances beyond its present incomplete stage, the species without glabellar furrows will adhere to *Corbinia* rather than to *Eurekia,* but the structure of the frontal rim and of the pygidium seems to prevent this. The eyes of *Corbinia* are also smaller than in *Eurekia.*

There are several described species that appear to belong to the genus.

Dicellocephalus ? angustifrons Walcott, 1884, Monogr. Geol. Surv., Vol. 8, p. 42, pl. 10, figs. 1, 1a, 1b.

Ptychoparia (Euloma) dissimilis Walcott, 1884, Monogr. U. S. Geol. Surv., Vol. 8, p. 51, pl. 9, fig. 28.

Conocephalites eos Hall, 1863, 16th Ann. Rept. State Cabinet Nat. Hist., p. 151, pl. 7, fig. 24, pl. 8, figs. 8, 9.

Conocephalites binodosus Hall, 1863, 16th Ann. Rept. State Cabinet Nat. Hist., p. 160, pl. 7, fig. 47. Hall did not associate any head with this species but later collections have furnished numerous examples. It has recently been described by Clark[1] as *Bayfieldia finkelnburgi.*

Genotype.—*Eurekia granulosa* Walcott.

Range.—Upper Cambrian: Great Basin, Rocky Mountains and Mississippi Valley (north and south).

[1] Clark, 1924, Bull. American Pal., Vol. 10, No. 41, p. 32, pl. 4, fig. 7.

EUREKIA DISSIMILIS (Walcott)

Pl. 16, fig. 12.

Ptychoparia (Euloma ?) dissimilis Walcott, 1884, Monogr. U. S. Geol. Surv., 8, p. 51, pl. 9, fig. 28.

Eurekia dissimilis Walcott, 1916, Smithsonian Misc. Coll., Vol. 64, p. 409. (Generic reference.)

The original description of this imperfect cranidium suffices to indicate the species, although the structure of the frontal limb is better shown in specimens obtained more recently.

Observations.—*E. dissimilis* differs from *E. granulosa* in the longer and less quadrate glabella, the more posterior position of the occipital furrow and ring and the less granulose surface. The frontal limb is insufficiently preserved to allow a knowledge of its details.

Formation and locality.—Upper Cambrian: (54) Secret Canyon shale, New York Canyon, Eureka District, Nevada.

EUREKIA GRANULOSA Walcott

Plate 16, figs. 13-17

Eurekia granulosa Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 57, pl. 12, fig. 1.

All that is known of this species is shown by the illustrations. It apparently has a wide geographic distribution and may be one of the Mississippi Valley forms that occurs in the Cordilleran area of Nevada.

Formation and locality.—Upper Cambrian, Hamburg ? formation: (88) West side of Highland Range, 17 miles (27.4 km.) southwest of Pioche, Lincoln County, Nevada. Apparently also present in the Mississippi Valley, but further study is required to be certain that these forms are conspecific.

Genus HARDYIA Walcott

Hardyia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 57.

Description.—The glabella is rectangular in outline extending to the front of the head. Two sets of very short glabellar furrows are faintly indicated. The neck furrow and ring are rather large for so small a trilobite.

Fixed cheeks wide, particularly back of the eyes. Eyes small, situated well forward. A narrow straight rim immediately in front of the glabella.

Other portions of this trilobite unknown, and the material available for study of the cranidium is not very satisfactory.

Genotype.—*Hardyia metion* Walcott.

Range.—Ozarkian; Canadian Rockies.

HARDYIA METION Walcott

Plate 18, fig. 9

Hardyia metion Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 57, pl. 12, fig. 5.

The illustration and generic description include the known specific characters.

Formation and locality.—Ozarkian: (66k) Mons formation. Ranger Canyon, Sawback Range, Alberta.

Genus HOLTERIA Walcott

Holteria Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 57.

Description.—The genus is based primarily on the pygidium. It is fairly certain that the head and tail assigned to the genotype belong together, but the cranidia of *Holteria problematica* and of *Neolenus inflatus*[1] Walcott are indistinguishable generically while the pygidia assigned to the two species are quite unlike.

The cranidium is characterized by the large prominent glabella, which expands toward the front. There is no frontal limb, thus causing the glabella to occupy the full length of the cranidium, which has three sets of very faint glabellar furrows; the posterior pair being broad and somewhat interrupted by small elevations within them.

Fixed cheeks narrow in front, widening out rapidly posteriorly, due to the contracting glabella and the diverging suture. Eyes a little less than medium size, situated about opposite the middle of the glabella. The facial suture diverges somewhat in passing forward from the eye leaving a flat area at the front corners; it may possibly be intramarginal, a point that cannot be determined in the absence of a rim and since the free cheeks are unknown. At the point where the margin of the glabella turns toward the front, there are pit-like depressions, a character very prominent in some of the related genera. Back of the eye the facial suture turns suddenly outward outlining rather long and broad postero-lateral limbs.

The pygidium is very distinctive. It is broad and flat with a well-defined axis extending more than three-fourths of the distance to the posterior margin. The axis is relatively narrow and tapers to a slight broadening at the end. The five axial furrows are not deep and the posterior ones are barely discernible.

[1] See *Neolenus*, 1908, Smithsonian Misc. Coll. Vol. 53, No. 2, pls. 4-6.

The lateral portions of the pygidium are flat, tapering off to terminate in two long spines on each side. These spines appear to be the extension of two very broad and furrowed pleuræ, fused together by the flat areas between.

Observations.—A preliminary review has recently been made in connection with the erection of the genus *Holteria,* of the related genera. It was ascertained that all of the species previously referred to *Olenoides* (Bull. U. S. Geol. Surv. No. 30, 1886, pp. 180-190) are not congeneric with the genotype, of which only the single specimen originally described has ever been found. This fragment is made distinct by the course of the pleural furrows. It might well be that additional material, if it could ever be found, would prove this specimen to be erratic and not typical. The species of *Olenoides* all fall quite readily into *Neolenus* and *Kootenia.* The cranidia of

FIG. 13.—*Holteria problematica* (Walcott).
Side outline of the cranidium illustrated in figure 17, plate 15.

the 40 or more species of *Kootenia* and the dozen or more species assigned to *Neolenus,* together with those assigned to *Holteria,* form an almost unbroken series from the one extreme to the other and in the absence of the distinctive pygidia could well be retained in one genus. The pygidia, however, are quite distinct in plan. *Holteria* has a well-fused pygidium with two spines arising from a flat border on either side. *Neolenus* lacks the flat border, has the individual pleuræ separate enough to be readily distinguishable and from three to nine spines on either side. *Kootenia* is distinguished by the fusion of the pleuræ to the extent that the boundary between them is only rarely discernible, and then with great difficulty. The pleural furrows, as in the foregoing genera, are quite deep. *Kootenia* has usually four or five spines to a side, but they may vary in length from mere scallops to long, heavy spines equal to the length of the pygidium.

Genotype.—*Ogygia ? problematica* Walcott.

Range.—Upper Cambrian: Great Basin, Nevada.

HOLTERIA PROBLEMATICA (Walcott)

Plate 15, figs. 17-21

Ogygia ? problematica Walcott, 1884, Monogr. U. S. Geol. Surv., Vol. 8, p. 63, pl. 10, figs. 2a, b, 4. (Original description and illustration.)

Holteria problematica Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 57, pl. 13, fig. 7.

See original description of the species.

Formation and locality.—Upper Cambrian: (58) Secret Canyon shale. East side of New York and Secret Canyons, Eureka District, Nevada.

Genus HOUSIA Walcott

Ceratopyge Walcott, 1912, Smithsonian Misc. Coll., Vol. 57, No. 7, p. 233.

Housia Walcott, 1916, Smithsonian Misc. Coll., Vol. 64, No. 5, p. 374. (Subgenus of *Dolichometopus:* type *D.* (*Housia*) *varro* Walcott.)

Sodalitia Walcott, 1923, Smithsonian Misc. Coll., Vol. 67, No. 8, p. 471. (In lists.)

Housia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 57.

Description.—The type species when first described was made a subgenus of *Dolichometopus,* the cranidium being incorrectly drawn because a portion of the specimen was obscured in the matrix. The generic name *Sodalitia* was proposed in lists [1] for forms now known to belong to this genus.

Cranidium long and narrow. Glabella not separated from fixed cheeks. Eyes rather small situated opposite the middle and narrowest part of the cephalon. Postero-lateral limbs long and narrow with a shallow intermarginal furrow. The cranidium slopes down rapidly a short distance in front of the eyes and flattens out again, somewhat, into the frontal rim and border, which is moderately wide. Facial suture intramarginal. A central keel-like line is faintly visible on most specimens of the glabella and some have a tubercle directly between the eyes and another in the occipital region. Glabellar furrows none or very faint on upper surface. Three sets visible on some casts of the interior. The front set consists merely of two dots and is situated in front of the eyes. The other two sets increase in size, until the third one, beginning at a point opposite the hindermost edge of eyes and extending obliquely backward, attains considerable length.

Free cheeks with a wide border, with or without a genal spine. Those without a spine become quite circular in outline. A doublure of even width passes entirely around the cephalon and is apparently of one piece.

[1] See Synonymy.

Thorax contains 10 segments in all species of which entire specimens are known, all with a narrow median pleural furrow and ending abruptly in a blunt spine.

Pygidium consists of two parts, the posterior one being a welded shield somewhat like the tail of *Asaphiscus* and the anterior one a pleura-like segment extending into long spines, but attached firmly to the more solid shield. In some species two or more rings are visible on the axis and several lateral furrows at the front edge of this shield. Border or pygidium quite broad in some species. Apparently a doublure as wide as the border, occurs under it.

Derivation of name.—House Range, Utah.

Genotype.—*Dolichometopus* (*Housia*) *varro* Walcott.

Range.—Upper Cambrian, Cordilleran area of Canada and the United States.

Observations.—*Housia* differs from *Ceratopyge forficula* Sars, the type of the latter genus, in many important respects. In *Ceratopyge* the glabella is distinctly separated by a strong dorsal furrow, passing all the way around. There is also no wide frontal border and rim. There is a very narrow rim, almost wire-like, in which the suture could not have been intramarginal in the same manner as in *Housia*. The suture also diverges a little more in *Ceratopyge*. The glabellar furrows are definite, extending straight across and not oblique to the glabella.

The pygidia of the two genera are quite different. That of *Ceratopyge* is completely fused. There is no wide rim but simply a wire-like one. Axis relatively high and annulated. The two lateral spines of the *Ceratopyge* tail are not the definite segments as in *Housia*, but arise from the second or third segment and are fused with the rim.

In addition to the two described species of *Housia* there are two from the Goodsir formation that will be published in a future paper.

HOUSIA CANADENSIS (Walcott)

Plate 22, figs. 10, 11

Ceratopyge canadensis Walcott, 1912, Smithsonian Misc. Coll., Vol. 57, No. 7, p. 233, pl. 35, figs. 17, 20, 21 (not figs. 13-16, 18, 19, 22).

Observations.—The figures of *Housia canadensis* published in 1912 are all of more or less distorted specimens which have now been referred to three species. Entire individuals are available for most of the species and so the reference of the various cheeks and pygidia to the cranidia is much more certain than where entire specimens are lacking.

Housia canadensis is one of the species with a genal spine. The illustration of the head in figure 11, plate 22, is the cast of the under side of the test. The striations shown on the frontal rim, which is here less distinct than on the dorsal side, are possibly not impressed on the upper surface.

In several of the pygidia the border is broken away exposing the striated doublure. The test of this trilobite apparently was smooth, except possibly radiating irregular lines on the free cheek, a feature found in another better preserved species.

H. canadensis differs from *H. varro* in the presence of the genal spine, which results in a less circular outline for the free cheeks. The facial suture diverges a little more. The pygidium of *H. canadensis* has more clearly marked axial and pleural furrows. The rim is also relatively wider.

Formation and locality.—Upper Cambrian, Goodsir formation. Ice River Valley about six to eight miles (9.7 to 12.9 km.) southeast of Leanchoil Station; Moose Creek; and Mount Goodsir, British Columbia.

HOUSIA VARRO (Walcott)

Plate 18, figs. 4-8

Dolichometopus (*Housia*) *varro* Walcott, 1916, Smithsonian Misc. Coll., Vol. 64, No. 5, p. 374, pl. 65, figs. 1, 1a-e.

Housia varro Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 57, pl. 12, fig. 4.

The original description, together with the generic diagnosis, gives the character of this species.

Formation and locality.—Upper Cambrian: (30y) Orr formation. Orr Ridge, south of Marjum Pass, House Range, Utah.

Genus IDAHOIA Walcott

Idahoia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 58.

Description.—The genus *Idahoia* is characterized by the unusual development of the frontal limb. The glabella occupies only about half the length of the cranidium and has no glabellar nor occipital furrow. The broad occipital segment bears a strong occipital spine that is nearly as long as the glabella. Dorsal furrow well-marked and transverse in front of the glabella, which tapers slightly. The facial sutures delimit long and narrow postero-lateral limbs and diverge rapidly in front of the eyes and are entirely intramarginal. The frontal limb is composed of three wide parts. On the cranidium

there is the border and rim and in front of this the free cheeks add a narrow part that merges into the front of the border.

Free cheeks wide, with long strong genal spines: they appear somewhat unusual because of the extra furrow necessitated in order to fit on the front of the head.

Associated pygidium large with the high, strong axis occupying about half its length: border concave and considerably upturned in some species. Three axial rings and three to four pleuræ are outlined that merge into the broad border.

Genotype.—Idahoia serapio Walcott.

Range.—Upper Cambrian: Rocky Mountains of Idaho.

Observations.—Idahoia, during its study, was first regarded as a relative of *Saratogia,* but the absence of glabellar and occipital furrows, the wider fixed cheeks, the intramarginal suture and the frontal limb give the genus very distinctive characters.

IDAHOIA MALADENSIS, new species

Plate 19, figs. 13, 14

Observations.—This species is represented by considerably less material than *I. serapio.* It differs from the latter in the greater convexity of the border and rim. The glabella is also lower, with a hint of two pairs of short glabellar furrows.

The associated pygidium assigned to this species differs from that assigned to *I. serapio* in its somewhat broader, even more concave, border and fewer pleural segments.

Formation and locality.—Same as for *Idahoia serapio.*

IDAHOIA SERAPIO Walcott

Plate 19, figs. 1-12

Idahoia serapio Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 58, pl. 14, fig. 1.

Observations.—The generic description, together with figures, present most of the characters of the species. None of the free cheeks is sufficiently well preserved to give a complete representation of the anterior portion. The width of the doublure is indicated in figure 4, where the upper shell is broken away.

Formation and locality.—Upper Cambrian: (54w) Ovid formation. On the north side of Two Mile Canyon, two miles (3.2 km.) southeast of Malad, Oneida County, Idaho.

Genus IDDINGSIA Walcott

Iddingsia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 58.

Description.—*Iddingsia* is based on the cranidium and includes a small group of species present in the Great Basin and eastward.

The cranidium of *Iddingsia* is distinguished by its nearly flat, sloping, equally divided frontal border, strongly developed glabella and narrow fixed cheeks. It differs from *Dunderbergia* and *Modocia*, with which it is associated, in the equal width of its border and rim. The ocular ridges are also quite prominent.

The other parts are unknown.

Genotype.—*Ptychoparia similis* Walcott.

Range.—Upper Cambrian, Eureka District, Nevada.

The generic name is in memory of Dr. Joseph P. Iddings, geologist, who was my associate in the survey of the Eureka District in 1880.

IDDINGSIA ROBUSTA (Walcott)

Plate 16, figs. 10, 11

Ptychoparia similis robustus Walcott, 1884, Monogr. U. S. Geol. Surv., Vol. 8, p. 53, pl. 1, figs. 9, 9a. (Original description and illustrations.)

This species varies slightly from *I. similis* in the relative proportions of the parts of the cranidium, sufficiently to warrant regarding it as a full species rather than a variety.

Formation and locality.—Same as for *I. similis*.

IDDINGSIA SIMILIS (Walcott)

Plate 16, figs. 8, 9

Ptychoparia similis Walcott, 1884, Monogr. U. S. Geol. Surv., Vol. 8, p. 52, pl. 10, fig. 10. (Original description and illustration.)

Iddingsia similis Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 58, pl. 12, fig. 6.

The original description and figures 8 and 9 give all that is known of this species.

Formation and locality.—Upper Cambrian: (60) Secret Canyon shale, near Richmond Mine. (61) Near Hamburg Mine, Eureka District, Nevada.

Genus IRVINGELLA Ulrich and Resser

Irvingella Ulrich and Resser in Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 58.

Description.—Glabella large, the dorsal and occipital furrows very strong and usually rather wide; the posterior pair of glabellar fur-

rows is always present and is usually united across the glabella; a second pair is usually short, but sometimes deep and extending entirely across the glabella. Fixed cheeks wide, with very large palpebral lobes in most of the species. In the type species they are more than three-fourths as long as the glabella. Most of the species of *Irvingella* have a narrow transverse frontal border but no rim.

Free cheeks very narrow, in most species being little more than a band passing around the eyes and filling in the notch anterior to them and meeting the very short, and usually blunt, postero-lateral limbs. So far as known the free cheeks have long genal spines.

Thorax unknown except for isolated segments, in which the elevation of the axis usually agrees with that of the transverse section of the head.

The pygidium has a high, wide and long axis and flat sides. Several rings are usually present in the axis. The sides may or may not have pleuræ indicated. Border often turned up into a wire-like rim.

Derivation of name.—Proposed in honor of the late Professor J. D. Irving.

Genotype.—*Irvingella major* Ulrich and Resser.

Range.—Upper Cambrian and Ozarkian: Appalachians and Mississippi Valley, Rocky Mountains, and Nova Zemlya.

Observations.—*Irvingella* resembles *Chariocephalus* very closely; in fact the two genera approach so nearly that it is almost necessary to draw an arbitrary line separating them. *Irvingella* is distinguished by its larger eyes, usual presence of glabellar furrows—sometimes, however, not any more visible than in *Chariocephalus*—larger fixed and smaller free cheeks and the better definition of the axis of the pygidia.

More than 25 species have been determined in about one-half of the collections in the National Museum from the Upper Cambrian and Ozarkian, in which the genus is widely distributed.

IRVINGELLA MAJOR Ulrich and Resser

Plate 15, figs. 26-29

Irvingella major Ulrich and Resser in Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 58, pl. 10, fig. 3.

The illustrations, particularly figure 26 which has been carefully restored, show the characters of this species. All the specimens, about 20 in number, both complete cranidia and fragments, are contained in a single hand specimen.

Formation and locality.—Upper Cambrian: (8on) Micaceous shale member of the Franconia formation, Ableman, Wisconsin.

ISOTELOIDES

Isoteloides Raymond, 1910, Ann. Carnegie Mus., 7, No. 1, pp. 36, 67; 1910, 7th Rep. Vermont State Geol., p. 223; 1912, Trans. and Proc. Roy. Soc. Canada, 5, 3d ser., sec. 4, p. 115.

Observations.—This genus appears to be characteristic of the Beekmantown and Ordovician, occurring over a wide area in the northern Rocky Mountains, in the Garden City limestone and beds of similar age. Its presence in the upper Mons suggests the possibility of the uppermost beds here and there being referable to the Beekmantown, but like *Bellefontia* it may occur in greater numbers in the Ozarkian.

ISOTELOIDES LAUTUS, new species

Plate 24, fig. 25

Observations.—This cranidium and free cheek which may belong together are referred to *Isoteloides* with reservation since the head is quite narrow and has very narrow fixed cheeks.

Formation and locality.—Ozarkian: (66v) Mons formation. Upper Johnson Creek Canyon about one mile (1.6 km.) below divide on east side of canyon, Sawback Range, 21 miles (33.8 km.) northwest of Banff, Alberta, Canada.

ISOTELOIDES ? MALADENSIS, new species

Plate 24, fig. 27

Observations.—With better preserved specimens this species may be transferred to *Xenostegium*. The cranidium resembles that of *X. kirki* and does not seem to be an *Isoteloides* because of its expanded front. The pygidium appears to belong to the latter genus, but it is broken away posteriorly so that the presence or absence of a spine is uncertain.

Formation and locality.—Upper Ozarkian ?: Near Malad, Idaho.

ISOTELOIDES OCCIDENTALIS, new species

Plate 24, fig. 26

Observations.—The cranidium and pygidium associated on a fragment of rock appear to have the essential characters of *Isoteloides*. The species differs from *I. whitfieldi* Raymond mainly in its wider cranidium, and the pygidium, so far as its characters are ascertainable, is very little different from the one assigned to that species.

Formation and locality.—Ozarkian ?, Mons formation (67h) North fork Saskatchewan River, 3 miles (4.8 km.) south of Wilcox Pass, Alberta, Canada.

ISOTELOIDES ? sp. undt.

Plate 24, fig. 24

This small fragmentary cranidium is presented here in order to illustrate a group of trilobites that occurs occasionally, but of which the material thus far is so poor that the characters cannot yet be determined. The fragment bears a superficial resemblance to this genus and on that account may be tentatively referred to it.

Formation and locality.—Ozarkian: (67h) Mons formation. Head north fork Saskatchewan River, three miles (4.8 km.) south of Wilcox Pass, Alberta, Canada.

KAINELLA, new genus

Hungaia Walcott, 1913, Smithsonian Misc. Coll., Vol. 57, No. 12, p. 336 (listed); idem, 1924, Vol. 75, No. 1, p. 37.

Kainella Walcott, 1925, Smithsonian Misc. Coll., Vol. 77, No. 2, p. 14. (New name proposed.)

This genus is clearly defined by the unusual direction of the facial suture, together with the peculiarities of the associated pygidium. No entire specimens have yet been found of any species belonging to it.

Glabella rectangular in outline, slightly rounded in front, relatively flat in cross-section. Two sets of glabellar furrows are present in front of the occipital furrow. The anterior set consists of two oblique depressions, while the posterior ones are similar, though longer, and are connected across the glabella by a very shallow furrow.

Eyes large and situated about the midlength of the glabella.

Fixed cheeks very narrow.

Facial suture outlining long narrow postero-lateral limbs, passes around the eyes and a short distance beyond, turns outward almost at right angles to the glabella. The distance from this angle to the frontal rim equals two-thirds or more of the length of the glabella. The suture is intramarginal to the center.

Frontal rim and border wide. Border between the glabella and rim marked by rather pronounced, peculiar ridges, slightly irregular in course and size. In the different species, these radiate from the front of the glabella in groups of varying numbers. The stronger ones usually start from two points of origin near the front inner corners of the glabella and extend to and merge into the rim. The weaker ones, originating in front and back and along the sides of the glabella almost to the eyes, for the most part fail to reach the

rim. A row of deep pits, somewhat irregularly spaced, occur in the frontal furrow immediately back of the frontal rim.

Free cheeks large, extending into a strong and long genal spine. Their shape is somewhat peculiar due to the unusual direction taken by the facial suture. A wide doublure extends from the genal angles forward, maintaining practically an even width from a point anterior to the occipital furrow to the center of the head. Thus far none of the specimens has permitted the determination as to whether this doublure is continuous and uninterrupted across the front of the cephalon, or whether there is a median suture, or finally whether there is an epistoma. As now known, specimens suggest a continuous doublure. The pleuræ near the front of the thorax are long, to accord with the wide cranidium. They have a rather deep, narrow pleural furrow, that has a slightly oblique direction, but yet approximately bisecting the pleuræ and extending out to about the point where the pleura begins to bend backward. The pleuræ near the posterior end are shorter in a transverse direction, with wider furrows, which bend backward with the pleura. The pleuræ here are as long as those in the anterior portion of the thorax, but bend backward much sooner and are extended into a long slender spine. The posterior pleuræ must have enveloped the pygidium.

Pygidium large and flat, with a definite, large, high axis. The axis consists of from four or five to seven or more rings. The axial furrows do not pass straight across but are as illustrated in figure 4. The axis proper terminates some distance from the posterior edge, dropping steeply off to the flat border, but with a median ridge extending to the posterior edge, such as would be made by pinching the axis with the fingers if it were made of some plastic material. There are two definite pleuræ in the tail outside of the flat areas, which lie on either side of the axis and which vary in relative size in the different species and in some, one or more additional pleuræ, differentiated by additional shallow furrows, may be distinguished. The outer pleuræ always extend beyond the border into sharp spines. They are unfurrowed and the interpleural furrows are characterized by their wavy course.

Derivation of name.—Named in honor of Conrad Kain, Swiss guide and explorer of the Canadian Rockies.

Genotype.—*Hungaia billingsi* Walcott.

Range.—Ozarkian: Cordilleran area of Canada and the United States, Province of Quebec at Point Levis and possibly Vermont in Champlain Valley.

KAINELLA BILLINGSI (Walcott)

Plate 22, figs. 1-7

Hungaia billingsi Walcott, 1913, Smithsonian Misc. Coll., Vol. 57, No. 12, p. 336 (listed only); idem, 1924, Vol. 75, No. 1, p. 37, fig. 7.

Observations.—This species, known only from the dissociated parts, is the largest of six species determined from the locality. The presence of so large a number of species makes it impossible to be altogether certain that the pleuræ, pygidium, and free cheeks here assigned to this cranidium actually belong together. Most species of this genus have been founded on the pygidium, one of which (*H. flagricaudus*) was long ago described by White, as these parts are more readily distinguishable one from the other than the cranidia. All that can be said with respect to the grouping of the parts here assigned to *K. billingsi* is that it seems most natural after a study of the available material.

The illustrations, together with the generic diagnosis, give the characters of the species.

Specific name is given in honor of Elkana Billings, a pioneer paleontologist of the Geological Survey of Canada.

This is a widely distributed genus in the Cordilleran area of western Canada and the United States. Thus far it has been found only in dismembered fragments of the dorsal shield, but usually in great quantities of one or two species. Altogether 20 species have thus far been differentiated.

The Kainella zone is a well-marked horizon in the lower part of the upper third of the Mons formation and thus far it has been found to be a serviceable unit in comparing stratigraphic sections. It has a known vertical range from a few feet up to 130 feet (39.6 m.).

The described species referred to the genus are:

Dicellocephalus ? flagricaudus White, 1874. See U. S. Geol. Surv. Bull. 30, 1886, p. 185, pl. 25, fig. 4.

Dicellocephalus inexpectans (Walcott), 1884. Monogr. U. S. Geol. Surv., Vol. 9, p. 90, pl. 1, fig. 10.

Formation and locality.—Ozarkian: (61q) Chushina formation. Gray limestone in beds of varying thickness, one or two layers quite ferruginous. In Billings Butte (Extinguisher) at end of west spur of Mount Lynx, above Hunga Glacier and east of Robson Peak, Robson Park, northwest of Yellowhead Pass, in eastern British Columbia, Canada.

Genus KINGSTONIA Walcott

Kingstonia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 58.

Description.—Cephalon semi-circular in outline, without genal spines; nearly uniformly convex, all furrows weak or quite invisible externally, but the dorsal and occipital furrows more or less plainly indicated on inner surface of test; a very thin rim usually striated, around middle half of head. Glabella subquadrate, rounded in front, not extending to the frontal groove, but leaving a wide invariably undefined brim between it and the rim. Fixed cheeks rather wide, eyes very small, situated nearly opposite but always behind the anterior extremity of the glabella. Suture extending almost directly forward from the eyes and cutting the rim abruptly. Behind the eyes it runs diagonally backward and outward, ending just within the genal angles. Free cheeks small, narrow.

Pygidium relatively large, externally unsegmented without border, varying in outline from subtriangular to transversely suboblong, with convex, steeply descending and often thick edge. Axis rather narrow, long, usually clearly, though never deeply, outlined on sides and behind. Where the shell is removed traces of segments usually observable on both the axis and pleural lobes.

Genotype.—*Kingstonia apion* Walcott.

Range.—Small trilobites belonging to *Kingstonia, Ucebia,* and five or six related genera have been noted in the older collections for many years, but more recently many species and hundreds of individuals have come to light. *Kingstonia* occurs in the upper Cambrian formations of the southern Appalachians, central Pennsylvania, and throughout the Rocky Mountains. A single species occurs in the Ozarkian in northern Vermont. *Kingstonia* appears in faunas of Atlantic and Arctic waters.

KINGSTONIA APION Walcott

Plate 16, figs. 27-28a

Kingstonia apion Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 58, pl. 14, fig. 2.

This trilobite was considered at first to be a small species of *Illaenurus,* but comparison with specimens of the latter led to its being taken as the type of a new genus. The generic description and figures present its more prominent characters.

Formation and locality.—Upper Cambrian: (127) Maryville formation. Five miles (8 km.) west of Cleveland, Tennessee.

Genus LEIOSTEGIUM Raymond

Leiostegium Raymond, 1913, Bull. No. 1, Victoria Memorial Museum, p. 68.

Observations.—The genus *Leiostegium* founded by Raymond on Billings' *Bathyurus quadratus* hitherto has had a few species referred to it. At the present time in the study of the Ozarkian faunas 22 additional species have been determined or referred to the genus. Furthermore, three new genera have been erected to include the many forms grouping themselves about characters not belonging to *Leiostegium*. The name *Ptychostegium* appeared in certain published faunal lists, but further study proved that the characters used in the preliminary determinations were not of sufficient importance to be of generic rank.

LEIOSTEGIUM MANITOUENSIS, new species

Plate 23, figs. 12-19

Observations.—This species is characterized by its quadrate glabella with the two pits at each side in front, together with the size and position of the eyes and the small frontal border. Free cheeks fairly wide, all with a long genal spine. Facial suture intramarginal for a short distance. The doublure of the free cheeks is a continuous piece of even width across the front of the head.

The associated pygidium is not very unlike that of *Bellefontia* (see figs. 10, 11, pl. 23), but it can be distinguished by its more definite border, definite rings on the axis and by its more subtriangular outline.

Formation and locality.—Ozarkian: (187) Basal Manitou limestone, two miles (3.2 km.) below Manitou Park Hotel, Colorado: Chushina formation, Mt. Extinguisher near Mt. Robson, British Columbia (61q).

Genus MALADIA Walcott

Maladia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 59.

The cranidium of *Maladia* is somewhat quadrate in shape. The glabella is outlined by the dorsal furrow and a wide, deep occipital furrow. Eyes large. Free cheeks rounded and without genal spines. Pygidium with spinose border, with a very high axis. Pleuræ are well fused.

This genus with its strongly defined cranidium and associated pygidium (same at several localities) is related by the course of its facial sutures, free cheeks, and pygidium with *Eurekia*, and to a much less extent with *Corbinia*, but is clearly not congeneric with either.

Genotype.—*Maladia americana* Walcott.

Range.—Upper Cambrian: Ovid formation, Idaho. Grand Canyon, Arizona.

MALADIA AMERICANA Walcott

Plate 16, figs. 23-26

Maladia americana Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 59, pl. 12, fig. 2.

The illustrations present practically all that is known of this species.

Formation and locality.—Upper Cambrian: (54x) Ovid formation. Sixty feet (18.3 m.) from top of bed 4, north side of Two Mile Canyon near its mouth, two miles (3.2 km.) southeast of Malad, Idaho.

Genus MODOCIA Walcott

Modocia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 59.

The genus *Modocia* is based on the cranidia of a species known for more than 60 years that has been referred to six different genera by authors. It does not fall strictly within any described genus and to avoid further confusion a new name is proposed for it.

The cranidium of *Modocia* is characterized by its strong, subconical glabella without definite glabellar furrows; occipital furrow clearly defined and extending across the fixed cheeks within their posterior margin; occipital segment rather narrow: fixed cheeks broad and merging into strong postero-lateral limbs and the frontal limb which is of medium width: frontal border rounded, narrow at the ends and broadening very gradually to the center owing to the course of the facial outline which cuts the border on a line with the eyes and then curves sharply and continues obliquely across the border nearly to the center and possibly the two branches meet at the center, but the material in hand does not prove this: palpebral lobes small and located just back of the line of the longitudinal center of the cranidium. The fixed cheeks must have been of medium size. An associated pygidium was illustrated by Walcott.[1]

Genotype.—*Arionellus* (*Crepicephalus*) *oweni* Meek and Hayden.

Range.—Upper Cambrian: Black Hills, South Dakota, Big Horn Mountains, Wyoming, and probably in the Cordilleran area of western North America.

Observations.—The cranidium of *Modocia* suggests that of species which have been referred to *Crepicephalus, Blountia, Bathyuriscus, Asaphiscus,* etc. The cranidium, however, differs in the direction of the facial sutures through the frontal border and the very broad fixed cheeks.

[1] Monogr. U. S. Geol. Surv., 1884, Vol. 8, pl. 10, fig. 3a.

MODOCIA OWENI (Meek and Hayden)

Plate 16, figs. 1-3

Arionellus (*Crepicephalus*) *oweni* Meek and Hayden, 1861, Proc. Acad. Nat. Sci. Philadelphia, p. 436. (Original description of species.)

Arionellus ? oweni Meek and Hayden, 1862, Amer. Journ. Sci. Arts, ser. 2, Vol. 33, p. 74, fig. 4. (Description and illustration.)

Agraulos oweni Meek and Hayden, 1865, Pal. Upper Missouri, Smithsonian Contr. Knowl., Vol. 14, No. 172, p. 9, figs. a-c. (Change of generic reference.)

Crepicephalus (*Loganellus*) *centralis* Whitfield, 1877, Prelim. Rept. Pal. Black Hills, U. S. Geol. Surv., p. 10. (Description.)

Crepicephalus centralis Whitfield, 1880, Rept. Geol. Res. Black Hills, U. S. Geogr. and Geol. Surv., p. 341, pl. 2, figs. 21-24. (Description and illustration.)

Ptychoparia oweni Walcott, 1884, Monogr. U. S. Geol. Surv., Vol. 8, p. 55, pl. 10, figs. 3, 3a. (Change of generic reference.) Grabau and Shimer, 1910, N. A. Index Fossils, Vol. 2, p. 277. (Mentioned.)

Crepicephalus oweni Miller, 1889, North Amer. Geol. Pal., p. 540. (Generic reference.)

Anomocarella oweni Walcott, 1916, Smithsonian Misc. Coll., Vol. 64, No. 3, p. 204. (Generic reference.)

Modocia oweni Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 59, pl. 12, fig. 7.

The generic description and the illustrations give all we know of this species.

Formation and locality.—Upper Cambrian: Deadwood formation. Castle Creek and Deadwood, Black Hills, South Dakota. Powder River, Big Horn Mountains, Wyoming.

Genus MOOSIA Walcott

Moosia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 59.

Observations.—The genus *Moosia* is very much like *Olenus* in many respects. The glabellar and dorsal furrows are very similar in position, size and amount of depression. The eyes are also in very nearly the same position and of the same relative size. The three characters of *Moosia* which exclude it from *Olenus* are, first, the slight tapering of the glabella; second, the slightly greater divergence of the facial suture anterior to the eyes; and third, the eye-lines which here slope back whereas in *Olenus* they always run straight out from the glabella or even forward.

The pygidium associated with *Moosia* agrees in general appearance with that of *Olenus,* but differs in the greater width of the axis and character of furrows.

Genotype.—*Moosia grandis* Walcott.

Range.—Upper Cambrian: at present known only from the Rocky Mountains of southeastern British Columbia.

MOOSIA GRANDIS Walcott

Plate 23, figs. 20, 21

Moosia grandis Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 59, pl. 14, fig. 9.

This species is founded on a few cranidia and one associated pygidium. Free cheeks unknown.

The illustrations and the generic description present the essential characters of the species.

Formation and locality.—Upper Cambrian: Goodsir formation. Moose Creek, British Columbia.

Genus MOXOMIA Walcott

Moxomia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 59.

Glabella quadrate, two sets of glabellar furrows present, not joined across the glabella. Dorsal furrow deep and glabella clearly marked off all around.

Eyes small, situated well forward. Palpebral lobes not elevated as high as the glabella. Fixed cheeks about one-quarter the width of the glabella. A steep frontal border with a narrow rim present. Just inside of rim a row of pits. Rim ornamented by a series of fine, irregular lines running in a transverse direction. Facial suture diverges only slightly in front of the eye and apparently intersects the margin near the point where it joins the rim: *i. e.*, intramarginal for a short distance. Occipital furrow present.

Genotype.—*Crepicephalus* (*Bathyurus?*) *angulatus* Hall and Whitfield.

Range.—Ozarkian: Eureka District, Nevada; Robson Peak District, British Columbia.

MOXOMIA ANGULATA (Hall and Whitfield)

Plate 22, figs. 8, 9

Crepicephalus (*Bathyurus* ?) *angulatus* Hall and Whitfield, 1877, U. S. Geol. Expl. 40th Paral., Vol. 4, p. 220, pl. 2, fig. 28.

Ptychoparia ? *angulatus* Walcott, 1884, Monogr. U. S. Geol. Surv., 8, p. 269 (Generic Reference).

Ptychoparia (*Emmrichella*) *angulatus* Walcott, 1916, Smithsonian Misc. Coll., Vol. 64, p. 204 (Generic Reference).

Moxomia hecuba Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 59, pl. 12, fig. 3.

The generic description indicates all the known characters of this species.

Formation and locality.—Ozarkian: (61q) Chushina formation. Gray limestone in beds of varying thickness one or two layers quite ferruginous. In Billings Butte (Extinguisher), at end of west spur of Mt. Lynx, above Hunga Glacier and east of Robson Peak, Robson Park, northwest of Yellowhead Pass, in eastern British Columbia, Canada.

SYMPHYSURINA Ulrich

Symphysurina Ulrich in Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 1, p. 37.

Quotation from Dr. Ulrich's manuscript:

Description.—"Cephalon strongly convex, a quarter-sphere in form. Cranidium subquadrate, usually longer than wide, excepting the more or less produced post-lateral extremities, bordered in front with a narrow striated rim. Palpebral lobes situated either midway between the anterior and posterior angles or somewhat behind the midlength of the cranidium, the length of the lobes equaling one-sixth to one-fourth the length of the cranidium, and between one-fourth and one-third the distance between their bases. Eyes moderate in size and prominence, facetted as in the Asaphidae. Median tubercle small but constantly present, situated between the eyes, hence far from the posterior edge. Glabella large, unfurrowed, convex, not defined in front of the eyes and usually but faintly outlined behind them; fixed cheeks narrow. Neck furrows and neck ring practically indistinguishable. Sutures nearly straight and commonly diverging slightly anteriorly from the eyes, reaching the edge of the cephalon which they follow in passing around the front of the cranidium. Free cheeks large, rounded triangular to subquadrate in outline, the posterior edge curving forward to the genal angle which is broadly obtuse, sharply pointed, or drawn out into a spine. Surface of cheeks with or without a wide, undefined, depressed border, and more generally a striated raised rim that increases in prominence as it approaches the anterior angle of the cranidium. This rim is the dorsal edge of the doublure which continues its course beneath the front edge of the cranidium until it meets the similar extension from the opposite cheek.

"The associated hypostoma is broadly alate anteriorly, with a deep pit at the middle of the anterior edge making this part appear bilobed, median portion strongly swollen; posterior margin rounded, with two concentric, partly interrupted ridges. The marginal ridge dies out forward on the posterior part of the anterior wings.

"Thorax known only from fragments of the segments; the axis approximately one-third the width. An imperfect specimen suggests

that the segments were nine in number, rather wide, and grooved as in *Asaphus.*

"Associated pygidia referred to the genus semi-elliptical to triangular, always much wider than long, with a fairly distinct axis that may or may not reach the margin, and in others prolonged posteriorly into a spine. Segmentation imperfect, usually obsolete except for one or two ribs at the anterior edge, or with as many as four segments on the axis but never more than two on the pleura, that latter being for the greater part smooth. Surface gently convex to the edge or with an obscurely defined, wide, marginal depression. Doublure rather wide, about as in *Asaphus.*"

Dimensions.—The known species range in length from less than one inch to perhaps three inches (2.54 to 7.62 cm.).

Genotype.—*Symphysurina woosteri* Ulrich.

Stratigraphic range.—Lower or Middle to Upper Ozarkian.

Geographic distribution.—Quebec, upper Mississippi Valley, Nevada, Alberta and British Columbia.

Observations.—"As defined *Symphysurina* is remarkable in that it includes species with and others without genal spines; also species in which the axis of the pygidium fails to reach the posterior margin, and others in which it is prolonged posteriorly in a long spine. In some the pygidium has a flattened or concave border and in others the slope of the pleural lobes continues convex to the edge. Such differences are often regarded as of generic significance, but in *Symphysurina* the cranidial characters are so constant that they do not appear to be of more than specific importance. Besides, the associated pygidia of the various species exhibit among them every gradation from the condition obtaining in *S. illaenoides,* in which the end of the axis is blunt and one-fourth its length from the margin, to the long-spined condition observed in *S. spicata* and *S. goniura.* The progressive chain formed by the pygidia of *S. illaenoides, S. billingsi, S. striatifrons, S. eurekensis, S. obtusa, S. woosteri, S. spicata* and *S. goniura,* while probably not altogether genetic, is yet too gradual in the differentiation of its limits to encourage one in drawing even a subgeneric boundary between any two of them. And it is much the same with respect to the genal spines and the submarginal grooves. Apparently *Symphysurina* affords here merely another illustration of the unstability of the Ozarkian trilobites in characters that were developed more regularly in the preceding Cambrian and succeeding Canadian and later periods.

"Two species of this new genus have been referred to *Symphysurus* by Brögger and Raymond, the former having done this

for *S. eurekensis* (Walcott) and the latter for *S. illaenoides* (Billings). Indeed, the cranidium in the new genus is considerably like that of such typical species of *Symphysurus* as *S. angustatus* and *S. palpebrosus*. Carefully compared, however, certain differences appear: the eyes are larger and situated nearer the front in *Symphysurus;* the dorsal furrows are deeper and in front of the eyes follow the suture, there being in this part no fixed cheek. In *Symphysurina,* on the contrary, there is always—even though the dorsal furrow is shallow—some space left on the antero-lateral parts of the cranidium that may be called a fixed cheek. As for the posterior fixed cheeks, these are relatively larger in *Symphysurus,* while the opposite is true of the free cheeks. The free cheeks show another, probably more important, difference in the extension of the doublure beneath the front of the cranidium. As described by Brögger and others these extensions from the opposite cheeks unite in the middle of the head of typical species of *Symphysurus* and *Nileus* without leaving a suture where they join. The two cheeks thus are united into a single piece. In *Symphysurina,* however, this never occurs, the two cheeks being separated by a suture precisely like that found in all of the true Asaphidae.

"On the other hand, as already indicated, the cephalon of *Symphysurina* is not greatly different from that of *Nileus* and *Symphysurus*. However, only the latter requires close comparison because *Nileus* is distinguished readily enough by its evenly convex, unlobed and unsegmented pygidium, very wide thoracic axis, and larger eyes.

"Regarding *Symphysurus* so far as shown by the collections in the U. S. National Museum, this genus is not represented in American deposits. Raymond [1] has on two occasions referred American species to it. They do not appear to belong to *Symphysurus* but to Walcott's *Tsinania*. The name of the New Jersey species, therefore, becomes *Tsinania columbiensis* (Weller), while that from the Valley of New York becomes *T. convexus* (Cleland), providing Whitfield's *Illaenurus convexus* is not congeneric.

"The reference of *Illaenurus eurekensis* Walcott [2] to *Symphysurus* by Raymond [3] had been anticipated by Brögger's [4] suggestion. Raymond in the same paper refers also *Asaphus illaenoides* Billings to

[1] Annals Carnegie Mus., Vol. 7, 1910, pp. 42-44. Roy. Soc. Canada, Proc. and Trans., 3d ser., Vol. 5, 1912, sec. 4, p. 117.

[2] Paleontology of the Eureka District: Monogr. U. S. Geol. Surv., Vol. 8, 1884, p. 97, pl. 12, figs. 4, 4a.

[3] Annals Carnegie Mus., Vol. 7, 1910, p. 144.

[4] Ueber die Verbreit. der Euloma-Niobe Fauna: Nyt. Mag. for Naturvidensk., Vol. 36, 1898, pp. 189, 228, Christiania.

the same genus. But neither of these species has the essential characters of *Symphysurus*. Both fall definitely into the new genus *Symphysurina*.

"Taking into account both the hypostoma and the dorsal surface of the trilobite, the relationship of *Symphysurina* to *Platypeltis* Calloway [1] is perhaps as close as to any other established genus. The differences lie in the cephalia of the two genera, especially in the course of the facial sutures and consequent distinctions in the forms of the cranidia, free cheeks, and eyes. Judging from the form of the cranidium and the general shape and construction of the cephalon, *Platypeltis* represents a younger stage in the evolution of the asaphid trilobites than is represented by *Symphysurina*.

"One other British genus may be mentioned as probably related to *Symphysurina*, namely, *Psilocephalus* Salter, based on a Lower Tremadoc species. Critically compared, the latter proves to have a relatively much larger cranidium, with broader fixed cheeks, this difference being particularly notable in the posterior limbs. The course of the facial suture in *Psilocephalus* also is quite different, the curves both in front and behind the eyes, as shown by the outlines of the cranidium, being decidedly convex instead of nearly straight to distinctly concave.

"Of American genera, *Platycolpus*, proposed a few years ago by Raymond [2] for species of the type of *Bathyurus capax* Billings, agrees in certain respects closely with *Symphysurina*, but the margin of the palpebral lobes in *Platycolpus* is less convex, especially in the anterior half, and is provided with a raised rim. Another constant difference is to be noted at the anterior edge of the cranidium. This is bordered by a simply thickened, generally finely striated rim in *Symphysurina*, whereas in *Platycolpus* the rim expands into an oblique or vertical flattened coarsely striated area.

"As a rule the dorsal furrows are more distinct and the glabella correspondingly better outlined in *Platycolpus* than in *Symphysurina*. But a more striking difference is noted in comparing the posterior parts of the cranidia. In *Platycolpus*, namely, the neck furrow and neck ring are usually more or less clearly developed, which is never the case in *Symphysurina*. The postero-lateral limbs also are much nearer the genal angles than in *Symphysurina*. Another important difference is in the location of the small median tubercle which is found on the glabella between the eyes in *Symphysurina* and on the neck ring in *Platycolpus*.

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[1] Quart. Journ. Geol. Soc., Vol. 33, 1887, p. 664, pl. 25, figs. 2, 2a.

[2] Victoria Mem. Mus. Bull. No. 1, 1913, p. 63.

"Comparison of the thoracic segments brings out another difference. Thus, while these segments in *Symphysurina* are broadly furrowed lengthwise, those of *Platycolpus* are more deeply and narrowly furrowed. In other words, the thoracic segments in the former genus are essentially like those in *Megalaspis*. In the latter genus, on the contrary, they are marked much the same as in the Dikelocephalinae.

"Despite certain similarities the two genera appear to be widely distinct genetically, *Platycolpus* being derived from a Cambrian genus allied to *Dikelocephalus,* while *Symphysurina* descended from an *Illaenurus*-like type.

"Finally, it remains to compare the new genus with the older *Illaenurus* Hall, and the younger American species of *Hemigyraspis* Raymond, to both of which it seems to be closely allied. In fact these three genera represent stages in a single genetic line. The cranidium of *Illaenurus* is scarcely distinguishable from that of *Symphysurina,* except that in the latter a tendency to develop genal spines is commonly manifested that has not been observed in the Upper Cambrian species of *Illaenurus*. The real differences between the two types are found in the thorax and pygidium. In *Illaenurus,* namely, the thoracic axis is much broader and less distinctly separated from the pleura, while the pygidium is relatively smaller and shorter, evenly convex, and without a sign of an axis."

Among the species now referred to *Symphysurina* are:

S. ? entella Walcott.
S. eugenia Walcott.
S. eurekensis (Walcott).
S. illaenoides (Billings).
S. spicata Ulrich.
S. woosteri Ulrich.

In addition there are also at least 20 species in process of illustration and description.

SYMPHYSURINA ? ENTELLA, new species

Plate 21, figs. 19-24, 30

Observations.—This species should perhaps be referred to *Symphysurina* with reservation since it departs considerably from the other species referred to the genus. Compared with *S. woosteri* Ulrich, the facial suture of *S. entella* diverges considerably more and takes a much more convex course anterior to the eyes. It is intramarginal almost to the center. The eyes themselves are a bit smaller. The median tubercle is also situated farther back. No dorsal furrows are apparent, their position being indicated by depressions where the

postero-lateral limbs join the glabella, and connecting them is a shallow furrow which causes a slight up-turning of the occipital edge. The free cheeks of *S. entella* are larger than in *S. woosteri*. They are not nearly so much thickened in front of the glabella, but have a wide, striated doublure. The genal spine is long and slender.

The pygidium assigned to *S. entella* also departs from that of the genotype. It has no trace of an axial furrow, its position being marked only by notches similar to those marking the position for the dorsal furrow in the cranidium. The shape of the pygidium and the existence of a long spine agree with the same characters in *S. woosteri*.

Formation and locality.—Ozarkian: (65w) Mons formation, 1d of section. North side of Clearwater Canyon, two miles (3.2 km.) from divide at head of canyon and about 21 miles (33.8 km.) in an air line north 2° west of Lake Louise Station, on the Canadian Pacific Railway, Alberta, Canada.

SYMPHYSURINA EUGENIA, new species

Plate 21, figs. 25-29, 31, 32

Observations.—This species agrees in all essential respects with the genotype and is about of average size. All the available material is more or less fragmentary.

Cranidium usual size and shape and differs very little from that of *S. spicata* Ulrich, being a little more square across the front. Free cheeks without genal spines. Spine on pygidium shorter than in *S. spicata*.

Formation and locality.—Ozarkian: (65v): Mons formation. Same as *Symphysurina entella* in 1e of section.

SYMPHYSURINA SPICATA Ulrich (MSS.)

Plate 21, figs. 12-18

Ampyx ? Walcott, 1884, Pal. Eureka District, Monogr. U. S. Geol. Surv., Vol. 8, pl. 12, fig. 19. (Pygidium only, not described.)

Quotation from Dr. Ulrich's manuscript:

"Trilobite small, the typical variety probably not exceeding 25 mm. in length. Cranidium relatively a little longer than the average for the genus, moderately convex, arching (in longitudinal direction) uniformly from the posterior edge to within a fifth of the length from the anterior edge where the profile straightens and finally becomes concave as it passes through the hollow, frontal border; sutural edges diverging very slightly and almost straight in the first halves of their courses forward from the eyes, then turning inward around the antero-lateral angles which, therefore, are broadly rounded; front part of

outline slightly angulated medially, the outer part of the flat border with a delicately tri-striated band forming a barely raised rim; dorsal furrows moderately impressed between the posterior edge and the eyes, obsolete forward; neck furrow unrecognizable exteriorly, but a very narrow neck ring is suggested on interior casts; palpebral lobes of medium size, drooping but slightly, situated entirely behind the midlength; posterior limbs short and not much attenuated laterally.

"Free cheeks, subtriangular, depressed convex, without elevated border; but having a long genal spine which is directed more outward than backward. The anterior edge of the cheek is bent near its middle and nearly straight on either side, the outer of the straight halves extending to the tip of the genal spine, the other to the facial suture. Here the edge passes to the doublure, the direction at the same time having to bend a little forward so as to conform with the obtusely angular frontal edge of the cranidium.

"Thoracic segments narrow, nearly smooth or at least not deeply furrowed, the axial and pleural parts approximately equal in width, the extremities tapering almost to a point without recurving.

"Pygidium, exclusive of spine, broadly triangular, fully twice as wide as long, unsegmented exteriorly; axis convex though obscurely defined exteriorly, fairly well defined and with traces of three or four segments in casts of the interior, extending to the posterior edge beyond which it is prolonged as a slender and relatively long spine; pleural lobes gently convex, divided obliquely into subequal parts by an obscure linear depression or groove, otherwise smooth."

Observations.—"Intimately associated with the typical form of the species are two other kinds of cranidia, but only one other kind of pygidium has been observed with them. Though distinguishable, this pygidium and at least two of the cranidia seem too closely allied to warrant specific discrimination with the material in hand. Provisionally, then, I propose to distinguish them as varieties. The third is so much shorter and more convex than the others as to suggest a distinct, though doubtless allied, species. However, as only a single example has been observed, it seems advisable to recognize it provisionally as another variety.

"The rock in which the type specimens occur is a light-gray, laminose limestone, filled with fossils. The same layer contains *Apatokephalus finalis* (Walcott)."

Formation and locality.—Ozarkian: (201a) Goodwin formation. East slope of the ridge east of Hamburg Ridge, Eureka District, Eureka County, Nevada.

SYMPHYSURINA WOOSTERI Ulrich (MSS.)

Plate 21, figs. 1-11

Symphysurina woosteri Ulrich in Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 1, p. 37, fig. 8. (Illustrated but not described.)

Quotation from Dr. Ulrich's manuscript:

"Carapace of medium size, approximately three cm. in length and two cm. in width.

"Cranidium strongly convex, arching uniformly from front to back, with a low median ridge, the outline expanding decidedly forward from the eyes, the sutural edge here making a gently sigmoid curve; anterior edge moderately accurate in both dorsal and front views, distinctly rimmed by a marginal furrow: palpebral lobes of medium size, contracted behind, situated mostly behind the midlength, convex in the inner part, then concave, and finally curving upward to the edge: posterior limbs small, narrowly tapering and declining outward: neck ring narrow, obscurely defined in casts of the interior and perhaps unrecognizable on the exterior: dorsal furrows moderately deep near the posterior edge, quite obsolete in passing the palpebral lobes, but reappearing faintly impressed in front of them, thus obscurely separating the glabellar region from the anterior fixed cheeks.

"Free cheeks sub-triangular, terminating outwardly in a strong compressed genal spine: inner area moderately convex, separated by a narrow furrow from the outer border, which is narrow and wire-like at the front, but widens and flattens rapidly in approaching the genal angle, beyond which it becomes obsolete before reaching the posterior edge: eye prominent, rising abruptly out of a flattened or slightly concave area, the minutely ocellated band at the top comprising less than half of the rounded ocular elevation: anterior edge thick, especially in the part that projects under the front of the cranidium, the thinner lateral part with nine pits for the reception of the ends of the thoracic segments.

"Pygidium rounded sub-triangular, rather strongly convex, the axis prominent, distinctly outlined by the dorsal furrows, extending to the posterior edge where it tapers rapidly and is further produced as a slender sharply pointed free spine: tip of spine rising to the level of the axis and reaching a point one-fourth or less of the total length of the pygidium behind its margin: pleural lobes convex in the inner parts, thence sloping somewhat steeply, and commonly through an obscurely developed marginal concavity, to the edge: segmentation obsolete or very obscurely indicated excepting the first

rib inside of the anterior edge. A second and occasionally a third rib may be observed on the interior of the axis, especially in young specimens.

" Surface of test smooth or very minutely punctate."

Observations.—Named after L. C. Wooster, the Wisconsin geologist, who collected most of the material from which this species was worked out.

Of all the known species, *S. eurekensis* (Walcott), doubtless agrees best with *S. woosteri.* For comparisons see the description of the Nevada species.

Formation and locality.—Ozarkian: (193) Oneota dolomite, in partly decomposed white chert, about 15 feet (4.6 m.) above the base, in Rudolph's quarry, at Trempealeau, Wisconsin.

TAENICEPHALUS Ulrich and Resser

Taenicephalus Ulrich and Resser in Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 59.

This genus has been established to incude those forms which Hall assigned to his genus *Conaspis,* that are congeneric with *Conaspis shumardi* (Hall).

The genus is characterized by the presence of glabellar furrows, eye lines, medium-sized eyes situated well forward toward the front of the glabella. Posterior to the eyes the suture diverges quite rapidly, giving a broad base to this head. The suture diverges much less rapidly in front of the eyes, and is intramarginal.

Free cheeks are fairly large with a border more or less well defined.

Pygidium with axial and pleural furrows, and a narrow rim.

Derivation of name.—Greek Ταινια=bound with a fillet; and Κεφαλη=head.

Genotype.—*Conocephalites shumardi* Hall.

Range.—Upper Cambrian: Mississippi Valley and Rocky Mountains.

Observations.—*Taenicephalus* differs from *Conaspis*[1] in that the fixed cheeks, palpebral lobes and border surround the glabella, which is cut off square in front, as an elevated ridge. The facial suture is intramarginal to the center, whereas it cuts the margin half way in *Conaspis.* In *Conaspis* the posterior pair of glabellar furrows are united across the glabella. The pygidium assigned to *Taenicephalus* differs from that of *Conaspis* by having a flat rim, and this also occurs along the outer edge of the free cheeks.

[1] Hall, 1863, 16th Ann. Report New York State Cab. Nat. History, p. 152. Walcott, 1914, Smithsonian Misc. Coll., Vol. 57, No. 13, p. 357.

TAENICEPHALUS SHUMARDI (Hall) Ulrich and Resser

Plate 17, figs. 15-17

Conocephalites shumardi Hall, 1863, 16th Ann. Rept. New York State Cab. Nat. Hist., p. 154, pl. 7, figs. 1, 2; pl. 8, figs. 32, 19?. 1867, Trans. Albany Inst., Vol. 5, p. 138, pl. 2, figs. 1, 2; pl. 3, figs. 32, 19?.

Conaspis shumardi Hall, 1863, 16th Ann. Rept. New York State Cab. Nat. Hist., p. 152. Walcott, 1914, Smithsonian Misc. Coll., Vol. 57, No. 13, p. 357. (List.)

Ptychoparia shumardi Miller, 1889, North American Geol. and Pal., p. 565. (Generic reference.)

Taenicephalus shumardi Ulrich and Resser in Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 59, pl. 13, fig. 1.

Hall's original description of this species is quite complete, so that nothing need be added for the present.

Formation and locality.—Upper Cambrian: Franconia formation, Trempealeau, Wisconsin.

Genus TOSTONIA Walcott

Tostonia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, pp. 59, 60.

Description.—Of this genus, only a few specimens of the cranidium and an associated pygidium have been found. The cranidium, by its almost quadrate outline, strong dorsal furrows, subquadrate glabella with two pairs of oblique furrows, narrow frontal limb and rim, small palpebral lobes and narrow fixed cheeks, relates the genus to *Olenus*. The associated pygidium has a strong convex axis, and pleural lobes with distinctly outlined segments that terminate in points without an intervening rim much as in the pygidia referred to *Apatokephalus*.

Genotype.—*Dicellocephalus iole* Walcott.

Range.—Upper ? Cambrian: Hamburg limestone, Eureka District, Nevada.

TOSTONIA IOLE (Walcott)

Plate 18, figs. 10-14

Dicellocephalus iole Walcott, 1884, Monogr. U. S. Geol. Surv., Vol. 8, p. 43, pl. 10, fig. 19. (Description and illustration of cranidium.)

Tostonia iole Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 60, pl. 13, fig. 2.

The original description outlines the characters of the cranidium.

Formation and locality.—Upper ? Cambrian: (64) Hamburg limestone, near the Bullwhacker Mine, Eureka District, Nevada.

Genus UCEBIA Walcott

Ucebia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 60.

Description.—The cranidium of *Ucebia* has a general resemblance in outline of that of *Kingstonia,* but differs in important respects; it lacks a frontal limb, as the glabella extends forward to the frontal rim. Another important difference is that both the dorsal and occipital furrows are more clearly impressed so as to be readily determinable on the exterior of the test. The suture follows about the same course as in *Kingstonia,* passing very nearly through the genal angles. The eyes are also small and hold about the same position with respect to the anterior and posterior ends of the suture, but not as regards the anterior extremity of the glabella.

Genotype.—*Ucebia ara* Walcott.

Range.—Upper Cambrian: Warrior limestone, central Pennsylvania.

UCEBIA ARA Walcott

Plate 17, figs. 7, 8

Ucebia ara Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 60, pl. 14, fig. 4.

The illustrations and generic comparisons give the principal characters of this species.

Formation and locality.—Upper Cambrian: (107k) Warrior limestone, two miles (3.2 km.) north of Benore Post Office, Center County, Pennsylvania.

Genus UTIA Walcott

Utia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 60.

Description.—This is a very peculiar trilobite, of which only the cephalon and a portion of the thorax of the type species are known.

The cranidium is subquadrate in shape with the glabella marked off by a deep dorsal furrow: the latter is rectangular in outline and a little more than three-fourths the length of the cranidium. There are no apparent glabellar furrows, but the occipital furrow is strongly impressed.

Fixed cheeks as wide as the glabella: on some of the specimens there is a fairly strong ocular ridge. Eyes small, and situated about opposite the middle of the glabella. An unusual feature of this trilobite consists of the peculiar depressions in the fixed cheeks which run parallel to the dorsal furrow and the glabella. These depressions begin just back of the ocular ridge and widen out posteriorly. The

slope of the side toward the glabella is much steeper than the one on the outside. Surface covered with fine, irregular lines.

The frontal border is quite distinct. It is wide in reality but appears narrower than it is, due to the fact that it first rises sharply from the frontal portion of the dorsal furrow into a ridge, then drops off very steeply, which results in the unusual appearance of this trilobite. Viewed from the front there is only a vertical band. In some specimens a narrow, poorly defined rim seems to be indicated.

Free cheeks unknown.

About nine segments of the thorax are preserved on one specimen. The pleural furrows are fairly deep and seem to divide the pleuræ into two approximately equal portions.

Pygidium unknown at present, but futher investigation of the large collections from the type locality may result in its determination as well as of the free cheeks.

Genotype.—*Utia curio* Walcott.

Stratigraphic range.—Middle Cambrian: Spence shale member of the Ute formation.

Geographic distribution.—In a ravine 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho.

Observations.—The characters of the type species of the genus as far as known are given in the specific description of *Utio curio* Walcott. The rectangular glabella, tumid frontal limb, and its great downward extension in front give an assemblage of characters unknown to me in any other trilobite. The small palpebral lobe and strong ocular ridge with the rectangular glabella suggest *Inouyia capax* Walcott,[1] but the downward extension of the frontal border is unlike anything referred to *Inouyia*.

The only known species is a small one, indicating a size for the genus about the same as for *Agraulos* and *Inouyia*.

UTIA CURIO Walcott

Plate 15, figs. 11-14

Utia curio Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 60, pl. 13, fig. 3.

Dorsal shield.—Dorsal shield small, regularly elliptical in outline, the breadth more than two-thirds the length. Axial lobe moderately wide, strongly convex, rising well above the pleural lobes which were

[1] Research in China, Carnegie Inst. of Washington, Vol. 3, 1913, p. 151, pl. 14, f. 11.

probably flattened even before compression in the shaly matrix in which they are preserved.

Cephalon.—Cephalon relatively large, more than half as long as the entire shield. Cranidium only preserved, broadly convex, rudely semi-circular in outline, the relative proportions varying quite widely with the degree and direction of compression. Glabella about three-fourths as long as the cranidium, subrectangular in outline; dorsal furrows rather broad but deeply impressed, converging very slightly toward the front; anterior furrow transverse not quite so deep as the dorsal; antero-lateral margins of glabella sharply rounded; glabellar furrows obscure and often obliterated, the posterior pair inclined to the axis at an angle of about 45° and persisting almost, but not quite, to the occipital groove, the medial and anterior pair even more obscure than the posterior and more nearly at right angles to the axis, all three pairs of furrows disappearing rather abruptly so that the unsculptured medial portion of the glabella is of approximately the same width as the grooved lateral areas; a fourth pair of glabellar furrows perceptible in some individuals between the anterior extremity and the third pair counting from the occipital ring; occipital groove deep and quite wide, persistent across the crest of the glabella, the anterior margin of the groove more steeply cut than the posterior; occipital ring rather narrow, slightly expanded medially, apparently not nodose. Fixed cheeks broad and flattened, the distance from the palpebral lobe to the dorsal furrow equal approximately to the width of the glabella; postero-lateral lobe short, and sagittate in outline, the obtusely angulated extremity slightly inclined posteriorly; posterior groove deeply channeled and quite broad, its inner termination in line with the posterior portion of the occipital ring; posterior margin conspicuously elevated opposite the palpebral lobe, wedging out toward the axis. Palpebral lobe short, narrow, somewhat arcuate, about one-third as long as the glabella exclusive of the occipital groove and ring, placed rather far back opposite the lobe between the posterior and medial glabellar furrows. Ocular ridge narrow, cordate, arching obliquely across from the anterior extremity of the lobe and intercepting the dorsal furrows as the origin of the fourth pair of glabellar furrows. Frontal limb wide, sharply elevated in front of the glabella, and then abruptly turned down so as to form a semi-circular ridge that extends back beyond the ocular ridges. The fine venation radiating from in front of the glabella passes over the ridge and down the nearly perpendicular front slope to the narrow frontal border, which is a little thickened

and but slightly defined from the frontal limb. A narrow transversely lined doublure extends back beneath the frontal border.

Thorax.—Posterior extremity of thorax imperfectly known, so that the number of component segments cannot be definitely determined; nine are preserved on one specimen. Axial lobe not so wide as the flattened pleura, sharply defined both by the abrupt elevation and the lateral furrows: annulation rather coarse. Pleural segments slender, elongated, obtusely angulated at their extremities; pleural furrows linear and sharply incised.

Pygidium.—Pygidium not preserved, but from the narrowing of the thorax undoubtedly small.

Dimensions.—Length of dorsal shield, 7.1 mm.; greatest width of dorsal shield exclusive of the free cheeks, 5.0±mm.; length of cranidium, 3.7 mm.; length of glabella, 2.7 mm.

Surface.—Apparently nearly smooth.

Formation and locality.—Middle Cambrian: (55c) Spence shale member of the Ute formation; about 50 feet (15.2 m.) above the Brigham quartzite, and 2,755 feet (839.7 m.) below the Upper Cambrian, in a ravine running up into Danish Flat from Mill Canyon, about six miles (9.7 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho.

VISTOIA, new genus

Vistoia is proposed for a small trilobite from the lower portion of the Middle Cambrian limestones near the southwestern base of Robson Peak. The cranidium and thorax suggest *Corynexochus stephenensis* Walcott,[1] but the pygidium is more of the type of that of *Eodiscus punctatus* (Salter) with the transverse furrows omitted from the axial lobe. The presence of five thoracic segments also seems to distinguish it from *Corynexochus,* which has from 7 to 11 segments. *Eodiscus,* as far as known, has three thoracic segments.

Genotype.—*Vistoia prisca,* new species.

Dimensions.—The only entire specimen known has a length of 13 mm.

Range.—The one known species occurs in the lower portion of the Middle Cambrian of Robson Peak, British Columbia, Canada.

Observations.—All that is known of the genus is included in the description of the genotype.

[1] Smithsonian Misc. Coll., Vol. 64, No. 5, 1916, pp. 324, 325, pl. 55, fig. 5.

VISTOIA PRISCA, new species

Plate 17, fig. 14

Dorsal shield convex and strongly trilobed, elongate, elliptical in outline. The facial sutures cut the anterior margin almost directly in front of the sides of the expanded front of the glabella and then curve a little outward and backward to the anterior end of the eye; passing around and above the eye they then slope outward and backward with a gentle curve to the posterior margin so as to leave a strong postero-lateral limb. Glabella elongate, clavate in outline, expanded in front and narrowing gradually from about midway to the occipital ring, without glabellar furrows; occipital ring strong and separated from the glabella by a broad shallow furrow which is continued out across the postero-lateral limbs; its posterior margin rises at the center and may have carried a spine. Palpebral lobes elongate, prominent and nearly one-half the length of the cranidium. Fixed cheeks of medium width. Free cheeks unknown.

Thorax with five (5) segments; strongly trilobed and convex; pleural lobes narrow; pleural segments short with rather blunt backward curving ends; pleural furrows broad, straight out to the geniculation where they begin to narrow and curve backward with the end of the pleura.

Pygidium with a strong convex axial lobe extending nearly its entire length; an anterior ring is outlined by a faint narrow furrow that also extends across the lateral lobes just within the anterior margin; no other transverse furrows have been observed.

Dimensions.—Dorsal shield, length 13 mm., width about 6 to 7 mm., length of cephalon 5 mm., thorax 4 mm., pygidium, .4 mm.

Surface of outer test appears smooth.

Observations.—The type and only specimen of this species occurs in a calcareous shaly rock; it is slightly compressed laterally which makes it more than naturally convex. The expanded glabella, large eyes and narrow free cheeks suggest *Corynexochus*[1] as do the thoracic segments, but the pygidium with its elongate outline and smooth axial and pleural lobes gives the impression of a pygidium of *Eodiscus* with a smooth axial lobe.

Other specimens of this species will undoubtedly be found when the shales and limestones above the Lower Cambrian sandstones of the Robson District are searched for fossils.

[1] Smithsonian Misc. Coll., Vol. 64, No. 5, 1916, pls. 55-57.

Formation and locality.—Middle Cambrian: (62f) Chetang formation. Shaly bed in bluish gray limestones; Southwest base of Robson Peak about 600 feet (182.9 m.) from base and 300 feet (91.4 m.) above Lake Kinney, Robson Park, British Columbia, Canada.

Genus WILBERNIA Walcott

Wilbernia Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 60.

The glabella is about three-fourths as long as the cranidium and rectangular in outline, rounded in front. Two pairs of glabellar furrows are usually visible on the inner surface of the test, but are faint or absent on the outer surface. The occipital ring is fairly wide, and the furrow is usually strongly defined.

Fixed cheeks about one-third as wide as the glabella in advance of the eyes. Ocular ridges present or indicated on most specimens. Eyes moderately large, and the mid point is back of the middle of the glabella. The palpebral lobes have a tendency to rise above the fixed cheeks, and in some species they are raised into a boss-like protuberance.

The facial suture diverges considerably in front of the eyes and is intramarginal for some distance. The postero-lateral limbs are long and narrow.

Cranidium with a wide frontal limb, in which the border and rim occupy relatively varying portions of the whole. The rim is always wide and well defined by a shallow furrow.

Free cheeks with long genal spines and a rim as wide as that of the cranidium. A doublure of equal width extends all the way across beneath the head. No epistoma nor median suture has been seen.

The pygidia of the species of this genus have a high, very convex axis, and approximately flat sides. The axial rings clearly marked by deep furrows. The axis extends back more than three-fourths the length of the tail, and often widens out with a tendency toward the formation of small nodes at the end. A descending, narrow ridge connects the posterior end of the axis proper with a flattened border. Its width increases toward the anterior margins. Four or more lateral pleuræ are visible in the tail. They are closely fused but have the dividing furrows well marked. The pleural furrows are wide and clearly impressed.

Derivation of name.—Wilberns formation.

Genotype.—*Ptychoparia pero* Walcott.

Range.—Upper Cambrian: Mississippi Valley and Rocky Mountains.

Observations.—There are many species of the genus *Wilbernia* and all parts of the tests are known, but only the cranidium of the type species has been definitely identified in the preliminary study of the Texas collections. The best known species of the genus is Hall's *Ptychoparia diadem ata* from the Franconia formation of Wisconsin.

WILBERNIA PERO (Walcott)

Plate 15, figs. 22, 23

Ptychoparia pero Walcott, 1890, Proc. U. S. Nat. Mus., Vol. 13, p. 274, pl. 21, fig. 6. (Described and illustrated.)

Anomocare pero Walcott, 1912, Monogr. U. S. Geol. Surv., Vol. 51, p. 212. (Generic reference.)

Wilbernia pero Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 60, pl. 13, fig. 4.

More material of this species will be available after the collections from the type locality are more fully studied.

Formation and locality.—Upper Cambrian: (70) Wilberns formation. Morgans Creek, Burnet County, Texas.

Genus XENOSTEGIUM Walcott

Xenostegium Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 60.

The genus *Xenostegium* includes a number of trilobites which have long been known, usually being assigned to *Megalaspis*.

The cranidium expands in front and often at the same time increases in convexity. It is distinguished by this swelling rather than by any definite dorsal furrow. Border always present, usually a simple concave rim. Glabellar furrows absent. Occipital furrow absent unless represented by two pits. Fixed cheeks narrow. Palpebral lobes usually more or less erect. Free cheeks undetermined.

This type of pygidium, generally placed in the genus *Megalaspis,* is characterized by its triangular outline and median posterior spine; the axis is often not delimited at the posterior end by the dorsal furrow as it, after outlining the axis along the sides, turns slightly outward and usually disappears, a slight swelling carrying the axis back to the base of the terminal spine. A flattened border is defined by a shallow depression between it and the slope of the pleural lobe. Several transverse furrows are usually developed sufficiently to permit the recognition of several segments. Very faint pleural furrows are occasionally outlined at the anterior end.

Genotype.—*Megalaspis belemnurus* White.[1]

Range.—Ozarkian and possibly Canadian. Western Cordillera.

The narrow border on the cranidium places this group nearer the Asaphidae than to the family including *Megalaspis*. None of the pygidia assigned to *Xenostegium* possesses the pleural furrows characteristic of the species belonging to *Megalaspis*.

XENOSTEGIUM ALBERTENSIS, new species

Plate 24, figs. 10, 11

Observations.—Only a pygidium of this form has been thus far found in the collections. It differs from *X. goniocercum* in its greater general convexity and the strongly convex axis. No trace of axial or pleural furrows.

Formation and locality.—Ozarkian: (66v) Mons formation. Upper Johnson Creek Canyon, Sawback Range, Alberta, Canada.

XENOSTEGIUM BELEMNURUM (White)

Plate 24, figs. 3, 4

Megalaspis belemnurus White, 1877 (Rept. 1874, p. 11), Rept. U. S. Geol. Surv., West 100th Merid., War Dept., Vol. 4, p. 59, pl. 3, fig. 9. Miller, 1889, N. A. Geol. Pal., p. 556, fig. 1030.

Xenostegium goniocercum (Meek) Walcott, 1924, Smithsonian Misc. Coll., Vol. 75, No. 2, p. 60, pl. 13, fig. 5.

Observations.—A cranidium was discovered in the matrix lying quite close to the pygidium, which is the hologenotype. It is assumed that this cranidium belongs to the same animal as the pygidium (fig. 4) since it agrees quite closely with others at distant localities associated with pygidia congeneric with this one.

Formation and locality.—Canadian ? (67i) Queen Spring Hill, just south of Schellbourne Pass, Nevada.

XENOSTEGIUM DOUGLASENSIS, new species

Plate 24, figs. 22, 23

Observations.—This species resembles the genotype more closely than any other in the collections. The cranidium is a little more

[1] For several years *Megalaspis belemnurus* White and *Asaphus* (*M.*) *goniocercus* Meek were labeled as one species, in the collections of the National Museum, and the genus was published last year before completing the critical study, hence the older established name was chosen as the genotype, but the drawing was based on the proper specimen.

expanded and the associated pygidium is wider and less triangular. The axis is also outlined farther back.

Formation and locality.—Ozarkian: (67q) Mons formation. Douglas Lake Canyon Valley, Sawback Range, Alberta, Canada.

XENOSTEGIUM EUCLIDES, new species

Plate 24, figs. 13, 14

Observations.—The pygidium of *X. euclides* is readily distinguishable from *X. albertensis* which occurs in the same beds, being less convex and robust. The axis extends nearer to the posterior margin and both axial and pleural furrows are traceable on the anterior portion.

X. euclides differs from the genotype in its more sharply triangular outline, and longer, more slender median axis.

The associated hypostoma assigned to *Xenostegium* must be regarded as tentative, as it indicates the kind of hypostoma it may have had.

Formation and locality.—Ozarkian: (66v) Mons formation. Upper Johnson Creek Canyon, Sawback Range, Alberta, Canada.

XENOSTEGIUM ? EUDOCIA, new species

Plate 24, fig. 12

Observations.—The cranidium on which this species is founded is unusual. It is referred tentatively to *Xenostegium,* as the one fragmentary specimen will not permit of an accurate determination. It departs from the genotype of *Xenostegium* in characters that might give it a different generic reference if better material were available. It may possibly be congeneric with *X. ? sulcatum* (fig. 9, pl. 24) from the same locality. The cranidium is long and narrow. A shallow dorsal furrow outlines the slightly expanded glabella; the frontal limb is concave as in *X. goniocercum* but it is shaped differently. Fixed cheeks very narrow. The greatest peculiarities in this strong cranidium are the depression occupying the position of the posterior pair of glabellar furrows and the occipital furrow. Between them lies a very pronounced swelling, and on the ridge between them is a median tubercle.

X. eudocia departs from typical forms of *Xenostegium* in the less expanded glabella, the narrowness of the cranidium and the peculiar furrow pits.

Formation and locality.—Ozarkian: (55z) St. Charles formation. Blacksmith Fork Canyon, 10 miles (16 km.) east of Hyrum, Cache County, Utah.

XENOSTEGIUM GONIOCERCUM (Meek)

Plate 24, figs. 5-8

Asaphus (Megalaspis) goniocercus Meek, 1873, 6th Ann. Rept. U. S. Geol. Surv., Terr., p. 480.

Observations.—Several additional specimens and the original types are figured for the first time, no previous illustrations of this species having even been published. This species, of which only the pygidium is known, differs from *Xenostegium belemnurum* with which it was regarded as synonymous for several years, mainly in the character of the axial and dorsal furrows delimiting the pygidial axis. The two sides of the dorsal furrow in *X. goniocercum* do not turn outward before ceasing in *X. belemnurum,* and the axis is carried further backward by a carinate ridge.

Formation and locality.—Canadian ? near Malad, Idaho. The exact locality is unknown.

XENOSTEGIUM KIRKI, new species

Plate 24, figs. 18-21

Observations.—This species is closely allied to *Xenostegium goniocercum.* The glabella is expanded to a slightly greater degree and its better preservation permits a more complete illustration of the characters of the genus. The pygidium is also quite similar.

Specific name given in recognition of the work of Dr. Edwin Kirk of the U. S. Geological Survey in the Beaverfoot-Brisco-Stanford Range area during the field season of 1923.

Formation and locality.—Ozarkian: (17a) Mons formation. .5 mile (.8 km.) north of Stoddart Creek, 5.5 miles (8.8 km.) south of Sinclair Canyon, British Columbia.

(67q) Douglas Lake Canyon Valley, Sawback Range, Alberta, Canada.

XENOSTEGIUM SCHOFIELDI, new species

Plate 24, fig. 15

Observations.—This species differs from *Xenostegium kirki* in the greater distance from the margin, where the axis terminates, and its longer triangular outline. Otherwise it is quite similar.

Specific name given in recognition of Dr. S. J. Schofield of the Geological Survey of Canada, in the southeastern portion of British Columbia.

Formation and locality.—Ozarkian: (19n) Mons formation. Swansea Mountain, northeast of Windermere, British Columbia, Canada.

XENOSTEGIUM SHEPHARDI (Raymond)

Plate 24, figs. 16, 17

Megalaspis shephardi Raymond, 1922, Amer. Journ. Sci., Vol. 3, p. 204 footnote.

Observations.—A better preserved specimen than the one available to Raymond is illustrated by figure 16. This species differs from known species of the genus in the length of the portion between the terminus of the axis and base of the longer posterior spine.

Formation and locality.—Ozarkian: Mons formation. Sinclair Canyon (Raymond's locality).

(21h) Sinclair Mountain on Wonah Ridge, one mile (1.6 km.) north of Sinclair Pass.

(65y) North side of Clearwater Canyon, two miles (3.2 km.) from divide at head of canyon and about 21 miles (33.8 km.) in an air line, 2° west of Lake Louise Station.

All in British Columbia, Canada.

XENOSTEGIUM ? SULCATUM, new species

Plate 24, fig. 9

Observations.—This cranidium is referred to *Xenostegium* with reservation because of the more convex, rounded frontal limb. The glabella expands slightly and is defined all around by a dorsal furrow, that makes a very peculiar indentation into the front of the glabella. Glabellar furrows indicated by shallow depressions. A small, rounded boss occurs back of the palpebral lobes. Fixed cheeks very narrow. Free cheek unknown. Surface covered with strong, transverse, irregular lines.

Formation and locality.—Ozarkian: (55z) St. Charles formation ? Blacksmith Fork Canyon, 10 miles (16 km.) east of Hyrum, Cache County, Utah.

XENOSTEGIUM TAURUS, new species

Plate 24, figs. 1, 2

Observations.—This species differs from *X. goniocercum* mainly in the deeper dorsal furrow in front of the glabella and the shorter,

wider pygidium. The central portion of the glabella is fairly well preserved and shows several depressions, indicating the position of the glabellar and occipital furrows. Eyes situated far back, and the manner in which the palpebral lobes are broken away indicates that they were somewhat erect.

The associated pygidium is shorter and wider than that of *X. goniocercum.*

Formation and locality.—Ozarkian: (61q) Chushina formation. Billings Butte (Extinguisher), above Hunga Glacier, Robson Peak District, British Columbia, Canada.

DESCRIPTION OF PLATE 15

PAGE

Elrathia kingii (Meek) 87

FIG. 1. (Natural size.) A large dorsal shield, somewhat crushed. U. S. Nat. Mus., Cat. No. 15439a.

2. (×2.) A smaller, less distorted specimen with right free cheek displaced. U. S. Nat. Mus., Cat. No. 15439b.

3. (×2.) A fine specimen without the free cheeks. U. S. Nat. Mus., Cat. No. 15439c.

4. (×2.) A small individual. U. S. Nat. Mus., Cat. No. 15439d.

Matrix, argillaceous shale. Specimens thickened by development of fibrous calcite or aragonite.

Middle Cambrian, Wheeler formation. (Loc. 4): Antelope Springs, House Range, Utah.

Crusoia cebes Walcott 82

FIG. 5. (×2.) A small specimen without free cheeks and the pleura on the right side. U. S. Nat. Mus., Cat. No. 70232.

6. (×2.) Large individual preserving the left free cheek. Tail bent under the body. U. S. Nat. Mus., Cat. No. 70233.

7. (×2.) Cranidium showing the up-turned front and general proportions. Glabella slightly flattened. U. S. Nat. Mus., Cat. No. 70234.

Matrix, soft olive shale.

Middle Cambrian, Wolsey shale. (Loc. 4g): 5 miles (8 km.) northeast of Logan, Montana.

Amecephalus piochensis (Walcott) 66

FIG. 8. (Natural size.) Large cranidium. U. S. Nat. Mus., Cat. No. 15434a.

9. (Natural size.) Entire individual. U. S. Nat. Mus., Cat. No. 15434b.

10. (Natural size.) Smaller but less distorted cranidium. U. S. Nat. Mus., Cat. No. 15434c.

Matrix, pink or buff calcareous shale. Fossils not completely flattened.

Middle Cambrian, Chisholm formation. (Loc. 31): Pioche, Nevada.

Utia curio Walcott 119

FIGS. 11, 12. (×2.) Dorsal view and side outline of a cranidium, illustrating the steep front, wide fixed cheeks with their peculiar grooves and the other characters of this species. U. S. Nat. Mus., Cat. No. 70235.

13. (×2.) Another cranidium. U. S. Nat. Mus., Cat. No. 70236.

14. (×2.) Cranidium with portion of thorax attached. U. S. Nat. Mus., Cat. No. 70237.

Matrix, soft brown shale. Fossils not flattened.

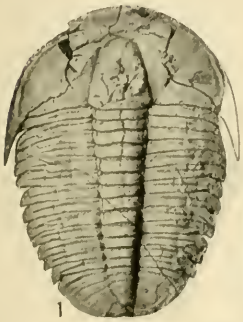
Middle Cambrian, Spence shale member of Ute formation. (Loc. 55c): Spence Gulch, 15 miles (24 km.) west of Montpelier, Idaho.

Bowmania americana (Walcott) 73

FIGS. 15, 16. (×2.) Dorsal view and side outline of the type cranidium. U. S. Nat. Mus., Cat. No. 24560.

Matrix, gray limestone.

Upper Cambrian, Hamburg limestone? (Loc. 66): Eureka District, Nevada.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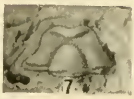
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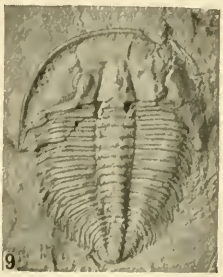
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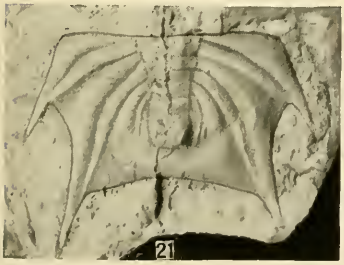
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CAMBRIAN TRILOBITES

PAGE

DESCRIPTION OF PLATE 16

PAGE

Modocia oweni (Meek and Hayden) 106

FIGS. 1, 2. Dorsal and side views of a cranidium in coarse sandstone. U. S. Nat. Mus., Cat. No. 24581.

Matrix, sandstone.
Upper Cambrian, Deadwood formation. Castle Creek, Black Hills, South Dakota.

3. Dorsal view of the type cranidium of the species. U. S. Nat. Mus., Cat. No. 1180.

Matrix, fine-grained sandstone.
Upper Cambrian, Deadwood formation. Head of Powder River, Big Horn Mountains, Wyoming.

Dunderbergia nitida (Hall and Whitfield) 85

FIG. 4. Dorsal view of a fairly complete cranidium. U. S. Nat. Mus., Cat. No. 24572a.

5. Side view of original type specimen. U. S. Nat. Mus., Cat. No. 24572b.

6, 7. Dorsal and side views of pygidium assigned to this species. U. S. Nat. Mus., Cat. No. 24572c.

Matrix, limestone lenses in shale.
Upper Cambrian, Secret Canyon shale. (Loc. 61): Eureka District, Nevada.

Iddingsia similis (Walcott) 97

FIGS. 8, 9. Dorsal and side views of the type cranidium. U. S. Nat. Mus., Cat. No. 24641.

Matrix, limestone.
Upper Cambrian, Secret Canyon shale. (Loc. 60): Eureka District, Nevada.

Iddingsia robusta (Walcott) 97

FIGS. 10, 11. Dorsal and side views of an imperfect cranidium. U. S. Nat. Mus., Cat. No. 24609.

Matrix, limestone.
Upper Cambrian, Secret Canyon shale. (Loc. 61): Eureka District, Nevada.

Eurekia dissimilis (Walcott) 90

FIG. 12. Dorsal view of a fragmentary cranidium which is the original type of the species. U. S. Nat. Mus., Cat. No. 24615.

Matrix, limestone.
Upper Cambrian, Secret Canyon shale. (Loc. 54): Prospect Mountain, New York Canyon, Eureka District, Nevada.

Eurekia granulosa Walcott 90

FIG. 13. A cranidium on which the missing parts have been restored. U. S. Nat. Mus., Cat. No. 70239.

14. Small cranidium with the front fairly complete, used in the restoration of fig. 13. U. S. Nat. Mus., Cat. No. 70240.

15, 16. Free cheeks. U. S. Nat. Mus., Cat. Nos. 70241, 70242.

17. Pygidium assigned to this species. Restored in outline on right side. U. S. Nat. Mus., Cat. No. 70243.

Matrix, granular limestone.
Upper Cambrian, Hamburg ? formation. (Loc. 88): West side of Highland Range, 17 miles (27.3 km.) southwest of Pioche, Nevada.


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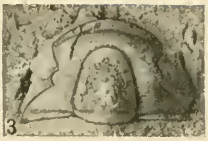
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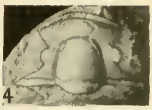
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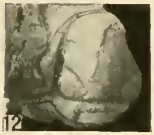
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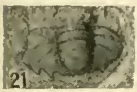
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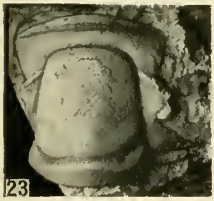
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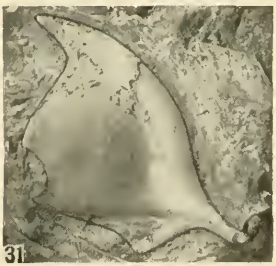
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CAMBRIAN TRILOBITES

PAGE

Corbinia valida Walcott..... 82
FIG. 18. Dorsal view of the single cranidium in the collections. U. S. Nat. Mus., Cat. No. 70244.

Matrix, limestone.
Ozarkian, Mons. formation. (Loc. 65x): Clearwater Canyon, Alberta.

Corbinia horatio Walcott..... 81
FIG. 19. Dorsal view of the type cranidium. U. S. Nat. Mus., Cat. No. 70245.
20. Associated free cheek. U. S. Nat. Mus., Cat. No. 70246.
21. A small imperfect associated pygidium. U. S. Nat. Mus., Cat. No. 70247.
22. Associated cranidium and pygidium. U. S. Nat. Mus., Cat. No. 70248.

Matrix, limestone.
Ozarkian, Mons formation. (Loc. 65x): Clearwater Canyon, Alberta.

Maladia americana Walcott..... 105
FIGS. 23, 24. Dorsal and side views of the type cranidium. U. S. Nat. Mus., Cat. No. 70249.
25. Associated free cheek assigned to this species. U. S. Nat. Mus., Cat. No. 70250.
26. An incomplete associated pygidium with outlines restored. U. S. Nat. Mus., Cat. No. 70251.

Matrix, coarse limestone.
Upper Cambrian, Ovid formation. (Loc. 54x): Two Mile Canyon, 2 miles (3.2 km.) southeast of Malad, Idaho.

Kingstonia apion Walcott..... 103
FIGS. 27, 27a. (×2.) Dorsal view and side outline of the type cranidium. U. S. Nat. Mus., Cat. No. 70252.
28, 28a. (×2.) Dorsal view and side outline of the associated pygidium assigned to this species. U. S. Nat. Mus., Cat. No. 70253.

Matrix, limestone.
Upper Cambrian, Maryville formation. (Loc. 127): 5 miles (8 km.) west of Cleveland, Tennessee.

Dokimocephalus pernasutus (Walcott)..... 84
FIGS. 29, 30. Dorsal and side views of the type cranidium. U. S. Nat. Mus., Cat. No. 24608a.
31. A nearly complete associated free cheek. U. S. Nat. Mus., Cat. No. 24608b.

Matrix, limestone.
Upper Cambrian, Secret Canyon shale. (Loc. 61): Eureka District, Nevada.

Dokimocephalus gregori Walcott..... 84
FIGS. 32, 33. Dorsal and side views of this remarkable cranidium. U. S. Nat. Mus., Cat. No. 70254.

Matrix, limestone.
Upper Cambrian. (Loc. 11e): Southwest of Potosi, Missouri.
(All figures natural size except 27 and 28.)

DESCRIPTION OF PLATE 17

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Burnetia urania (Walcott) 77

FIGS. 1, 2. (Natural size.) Dorsal and side views of the type cranidium. U. S. Nat. Mus., Cat. No. 23861a.

3. (Natural size.) Associated free cheek. U. S. Nat. Mus., Cat. No. 23861b.

Matrix, granular limestone.

Upper Cambrian, Cap Mountain formation. (Loc. 68): Packsaddle Mountain, Llano County, Texas.

Bynumia eumus (Walcott) 78

FIG. 4. (Natural size.) Dorsal view of a typical cranidium. U. S. Nat. Mus., Cat. No. 70255.

5, 6. (Natural size.) Dorsal view and side outline of an exfoliated cranidium. U. S. Nat. Mus., Cat. No. 70256.

Matrix, limestone.

Upper Cambrian, Lyell formation. (Locs. 66m, 64b): Sawback Range northwest of Lake Louise, Alberta, Canada.

Ucebia ara Walcott 118

FIG. 7. (×2.) Dorsal view of type cranidium. U. S. Nat. Mus., Cat. No. 70257.

8. (×2.) A second cranidium. U. S. Nat. Mus., Cat. No. 70258.

Matrix, limestone.

Upper Cambrian, Warrior limestone. (Loc. 107k): Center County, Pennsylvania.

Elvinia roemeri (Shumard) 88

FIGS. 9, 10. (Natural size.) Dorsal and side views of the cranidium chosen as representing Shumard's conception of this species. U. S. Nat. Mus., Cat. No. 70259.

11. (Natural size.) Associated free cheek. U. S. Nat. Mus., Cat. No. 70260.

12, 13. (Natural size.) Dorsal and side views of associated pygidium assigned to this species. U. S. Nat. Mus., Cat. No. 70261.

Matrix, granular limestone.

Upper Cambrian, Cap Mountain formation. (Loc. 68): Packsaddle Mountain; (Loc. 70): Morgans Creek, Texas.

Vistoia prisca Walcott 122

FIG. 14. (×2.) Dorsal view of an entire dorsal shield slightly compressed laterally. U. S. Nat. Mus., Cat. No. 70262.

Matrix, fine-grained siliceous shale.

Middle Cambrian, Chetang formation. (Loc. 62f): Southwest base of Robson Peak, British Columbia, Canada.

Taenicephalus shumardi (Hall) Ulrich and Resser 117

FIG. 15. (×2.) Cranidium with outlines restored. U. S. Nat. Mus., Cat. No. 70263.

16. (×2.) Free cheek. U. S. Nat. Mus., Cat. No. 70264.

17. (×2.) Pygidium assigned to the species. U. S. Nat. Mus., Cat. No. 70265.

Matrix, sandstone.

Upper Cambrian, Franconia formation. (Loc. 83): Trempealeau, Wisconsin.


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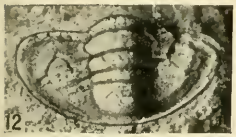
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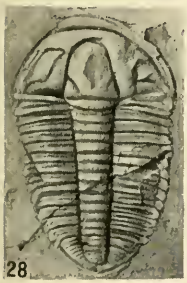
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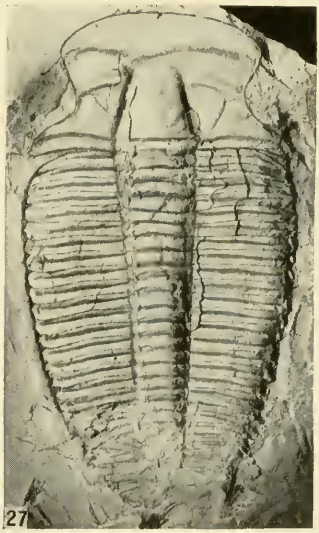
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DESCRIPTION OF PLATE 18

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Elkia nasuta (Walcott) 85

FIG. 1. (Natural size.) Dorsal view of the type cranidium. U. S. Nat. Mus., Cat. No. 24607.

2. (Natural size.) Dorsal view of a slightly smaller cranidium. U. S. Nat. Mus., Cat. No. 70280.

3. (Natural size.) Smaller cranidium preserving the posterior portion of the palpebral lobe. U. S. Nat. Mus., Cat. No. 70281.

Matrix, limestone.

Upper Cambrian, Secret Canyon shale ? Eureka District, Nevada.

Housia varro (Walcott) 95

FIG. 4. (Natural size.) Dorsal view of the type cranidium. U. S. Nat. Mus., Cat. No. 62831.

5, 6. (Natural size.) Free cheeks assigned to this species. U. S. Nat. Mus., Cat. Nos. 62833, 62832.

7. (Natural size.) Associated pygidium slightly distorted. U. S. Nat. Mus., Cat. No. 62836.

8. (Natural size.) Associated thoracic segment. U. S. Nat. Mus., Cat. No. 62834.

Matrix, siliceous shale.

Upper Cambrian, Orr formation. (Loc. 30y): Orr Ridge, House Range, Utah.

Hardyia metion Walcott 91

FIG. 9. (× 3.) Dorsal view of the type cranidium. U. S. Nat. Mus., Cat. No. 70282.

Matrix, limestone.

Ozarkian, Mons formation. (Loc. 66k): Ranger Canyon, Sawback Range, Alberta, Canada.

Tostonia iole (Walcott) 117

FIGS. 10, 11. (× 2.) Dorsal and side views of the type cranidium. U. S. Nat. Mus., Cat. No. 24566a.

12. (× 2.) A somewhat larger head. U. S. Nat. Mus., Cat. No. 24566b.

13. (× 2.) Small pygidium. U. S. Nat. Mus., Cat. No. 70283.

14. (× 2.) A larger and more complete pygidium. U. S. Nat. Mus., Cat. No. 70284.

Matrix, limestone.

Upper Cambrian, Secret Canyon shale. (Loc. 64): Adams Hill, Eureka District, Nevada.

Anoria tontoensis (Walcott) 68

FIG. 15. (Natural size.) A small broken specimen illustrating the main characters. U. S. Nat. Mus., Cat. No. 62686.

16. (Natural size.) View of the mould of a larger crushed specimen, which retains the free cheeks. U. S. Nat. Mus., Cat. No. 62685.

17, 18. (Natural size.) Dorsal and side views of a small cranidium. U. S. Nat. Mus., Cat. No. 62688.

19. (Natural size.) A slightly larger cranidium. U. S. Nat. Mus., Cat. No. 70285.

20. (Natural size.) Large head partly broken away along posterior edge. U. S. Nat. Mus., Cat. No. 70286.

21. (Natural size.) Free cheek posed to show the thickened frontal extension of the doublure. U. S. Nat. Mus., Cat. No. 70287.

22. (Natural size.) A second free cheek, preserving the genal spine and showing to what extent the suture is intramarginal. U. S. Nat. Mus., Cat. No. 70288.


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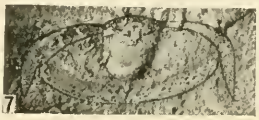
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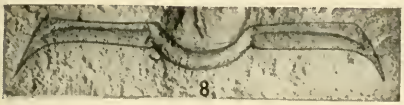
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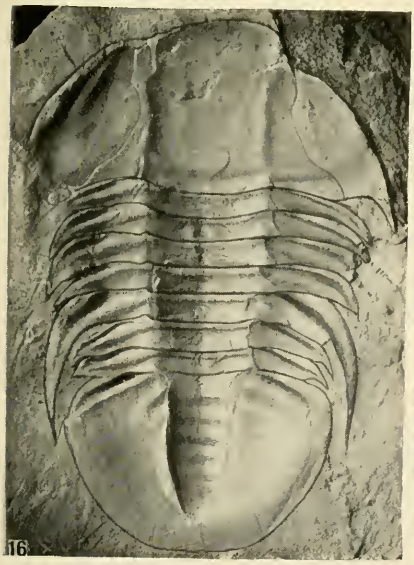
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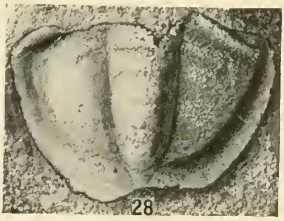
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UPPER CAMBRIAN TRILOBITES

Anoria tontoensis (Walcott)—Continued

FIG. 23. (Natural size.) Portion of a thoracic segment. U. S. Nat. Mus., Cat. No. 62692.

24, 25. (Natural size.) Ventral and side views of the associated hypostoma. U. S. Nat. Mus., Cat. No. 62689.

26, 27. (Natural size.) Dorsal and side views of a typical pygidium. U. S. Nat. Mus., Cat. No. 62694.

28. (Natural size.) A larger, but somewhat broken tail. U. S. Nat. Mus., Cat. No. 62693.

Matrix, sandstone and olive micaceous shale.

Upper Cambrian, Bright Angel shale. (Locs. 74 and 74e): Grand Canyon, Arizona. Specimens represented by figs. 15 and 16 compressed in shale, others in sandstone, with natural convexity preserved.

DESCRIPTION OF PLATE 19

PAGE

Idahoia scrapio Walcott..... 96

FIGS. 1, 2. (Natural size.) Dorsal and side views of an almost complete cranidium. Outlines restored. U. S. Nat. Mus., Cat. No. 70289.

3. (Natural size.) Broken and distorted cranidium but with the occipital spine well preserved. U. S. Nat. Mus., Cat. No. 70290.

4, 5. (Natural size.) Associated free cheek and cast from mould of same, preserving the general characters. U. S. Nat. Mus., Cat. Nos. 70291, 70292.

6. (Natural size.) Portion of large, free cheek with genal spines. U. S. Nat. Mus., Cat. No. 70293.

7. (Natural size.) Cast of the outer portion of a free cheek preserving several small patches of test. Note the striations on the rim. U. S. Nat. Mus., Cat. No. 70294.

8. (Natural size.) Smaller free cheek showing outer surface. U. S. Nat. Mus., Cat. No. 70295.

9, 10. (Natural size.) Associated hypostoma referred to the species. U. S. Nat. Mus., Cat. No. 70296.

11. (Natural size.) Pygidium somewhat doubtfully referred to this species. U. S. Nat. Mus., Cat. No. 70297.

12. (Natural size.) Cast of an associated broken pygidium. U. S. Nat. Mus., Cat. No. 70298.

Matrix, limestone.

Upper Cambrian, Ovid formation. (Locs. 54w, 4y): Near Malad, Idaho.

Idahoia maladensis Walcott..... 99

FIG. 13. (Natural size.) Large incomplete cranidium. U. S. Nat. Mus., Cat. No. 70299.

14. (Natural size.) Well preserved pygidium referred to the species. U. S. Nat. Mus., Cat. No. 70300.

Matrix, limestone.

Upper Cambrian, Ovid formation. (Loc. 5e): 2 miles (3.2 km.) southeast of Malad, Idaho.


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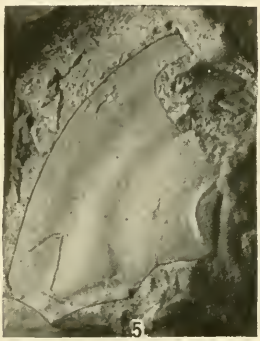
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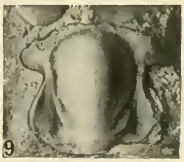
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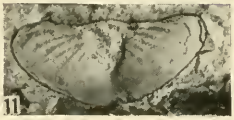
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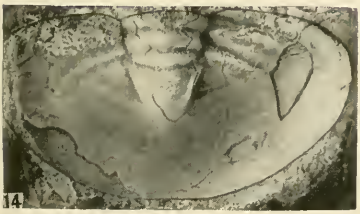
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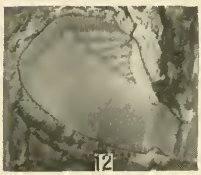
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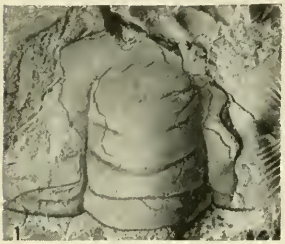
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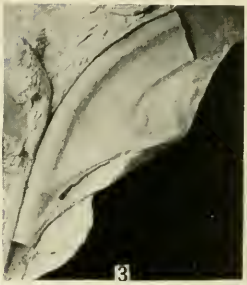
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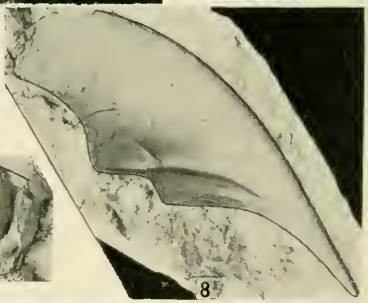
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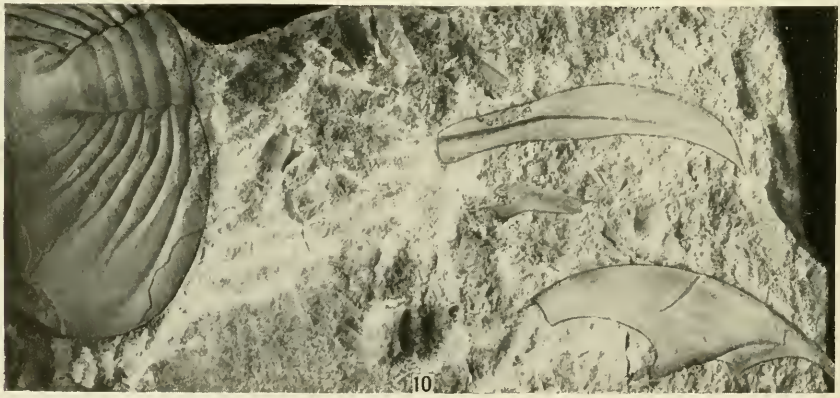
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BRISCOIA

DESCRIPTION OF PLATE 20

PAGE

Briscoia sinclairensis Walcott 75

FIG. 1. (Natural size.) Dorsal view of a fairly complete cranidium. U. S. Nat. Mus., Cat. No. 70301.

2. (Natural size.) Front portion of a large cranidium. U. S. Nat. Mus., Cat. No. 70302.

3. (Natural size.) Associated free cheek assigned to the species. U. S. Nat. Mus., Cat. No. 70303.

4, 5. (Natural size.) Dorsal and side views of a large pygidium, illustrating the course of the pleural furrows. U. S. Nat. Mus., Cat. No. 70304.

6, 7. (Natural size.) Side and dorsal views of an associated hypostoma referred to the species. U. S. Nat. Mus., Cat. No. 70305.

8. (Natural size.) An associated free cheek preserving most of the genal spine. U. S. Nat. Mus., Cat. No. 70306.

9. (Natural size.) Cast of a fairly complete pygidium. U. S. Nat. Mus., Cat. No. 70307.

10. (Natural size.) Slab with free cheek, thoracic segment and portion of a pygidium. Note surface ornamentation. U. S. Nat. Mus., Cat. No. 70308.

Matrix, limestone.

The specimens represented by figs. 1 to 7 are from Lower Ozarkian, Mons formation. (Loc. 16t'): Sinclair Canyon, British Columbia, and figs. 8 to 10 are from Lower Ozarkian, Mons formation. (Loc. 64n): Near base of 1e of field section. Glacier Lake Section, Alberta, Canada.

DESCRIPTION OF PLATE 21

PAGE

Symphysurina woosteri Ulrich (MSS.) 115

FIGS. 1, 2. (×2.) Dorsal and side views of a fairly complete cranidium, showing shape, position and size of eyes and median tubercle. U. S. Nat. Mus., Cat. No. 70309.

3. (×2.) Dorsal view of associated free cheek, border broken away at genal spine. U. S. Nat. Mus., Cat. No. 70310.

4. (×2.) Front view of cheek showing extension of rim and doublure under front of cranidium. U. S. Nat. Mus., Cat. No. 70311.

5. (×2.) Broken free cheek, with border removed, exposing the peculiar depressions in the under side of the doublure. U. S. Nat. Mus., Cat. No. 70312.

6. (Natural size.) Free cheek, giving general aspect. U. S. Nat. Mus., Cat. No. 70313.

7. (Natural size.) Another small free cheek, with rim removed, more complete than fig. 5. U. S. Nat. Mus., Cat. No. 70314.

8. (×2.) Associated thoracic segment. U. S. Nat. Mus., Cat. No. 70315.

9. (×2.) Pygidium, general aspect with test preserved. U. S. Nat. Mus., Cat. No. 70316.

10, 11. (Natural size.) Dorsal and side views of the interior cast of an associated pygidium. U. S. Nat. Mus., Cat. No. 70317.

Matrix, white chert.

Upper Ozarkian, Oneota dolomite. (Loc. 193): Rudolph's Quarry, Trempealeau, Wisconsin.

Symphysurina spicata Ulrich (MSS.) 113

FIGS. 12, 12a. (×2.) Dorsal view of a cranidium showing general aspect. U. S. Nat. Mus., Cat. No. 70318.

13. (×2.) Small broken cranidium. U. S. Nat. Mus., Cat. No. 70319.

14. (×2.) Another small cranidium, poorly preserved. U. S. Nat. Mus., Cat. No. 70320.

15. (×2.) Nearly complete free cheek. U. S. Nat. Mus., Cat. No. 70321.

16, 17. (×2.) Dorsal and side views of an associated pygidium, partly exfoliated. U. S. Nat. Mus., Cat. No. 24647.

18. (×2.) Small pygidium. U. S. Nat. Mus., Cat. No. 70322.

Matrix, thin-bedded limestone.

Ozarkian, Goodwin formation. (Loc. 201a): Eureka District, Nevada.

Symphysurina ? entella Walcott 112

FIGS. 19, 19a. (Natural size.) Cranidium showing course of facial suture. U. S. Nat. Mus., Cat. No. 70323.

20. (Natural size.) Broken cranidium showing posterior portion and palpebral lobes. U. S. Nat. Mus., Cat. No. 70324.

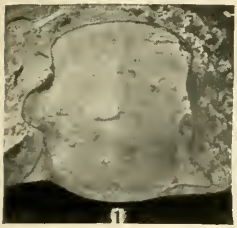
21. (Natural size.) Free cheek and pygidium referred to this species. U. S. Nat. Mus., Cat. No. 70325.

22-24. (Natural size.) Associated pygidia with test more or less exfoliated. U. S. Nat. Mus., Cat. Nos. 70326, 70327, 70328.

30. (×2.) Small pygidium. U. S. Nat. Mus., Cat. No. 70329.

Matrix, limestone.

Ozarkian, Mons formation. (Loc. 65w): Clearwater Canyon, Alberta, Canada.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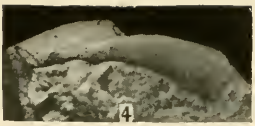
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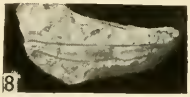
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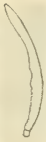
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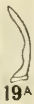
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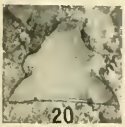
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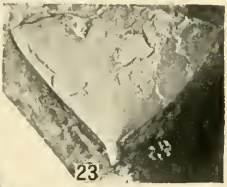
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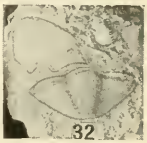
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SYMPHYSURINA

PAGE

Symphysurina eugenia Walcott..... 113

FIGS. 25-28. (Natural size.) More or less broken cranidia preserving general shape. U. S. Nat. Mus., Cat. No. 70330.

29. (Natural size.) A small free cheek. U. S. Nat. Mus., Cat. No. 70331.

31. (Natural size.) Small associated pygidia. U. S. Nat. Mus., Cat. No. 70332.

32. (Natural size.) An associated broken free cheek and pygidium. U. S. Nat. Mus., Cat. No. 70333.

Matrix, limestone.

Ozarkian, Mons formation. (Loc. 65v): Clearwater Canyon, Alberta, Canada.

DESCRIPTION OF PLATE 22

PAGE

Kainella billingsi (Walcott) 102

FIG. 1. (Natural size.) Large cranidium, the outlines of which have been restored, illustrating the main characters of the species and genus. U. S. Nat. Mus., Cat. No. 70334.

2. (Natural size.) Side view fig. 1.

3. (Natural size.) Associated free cheek, supposed to belong to this species. Border broken away all around, exposing the doublure. General direction of facial suture indicated. U. S. Nat. Mus., Cat. No. 70335.

4, 5. (Natural size.) Dorsal and posterior views of an associated pygidium referred to this species. Outline restored. U. S. Nat. Mus., Cat. No. 70336.

6. (Natural size.) Associated thoracic segment from near the posterior end of the thorax. U. S. Nat. Mus., Cat. No. 70337.

7. (Natural size.) Associated segment from the anterior end of the thorax. U. S. Nat. Mus., Cat. No. 70338.

Matrix, limestone.

Ozarkian, Chushina formation. (Loc. 61q): Robson Peak District, British Columbia.

Moxomia angulata (Hall and Whitfield) 107

FIGS. 8, 9. (Natural size.) Dorsal and side views of the cranidium, the only portion of this trilobite known. U. S. Nat. Mus., Cat. No. 70339.

Matrix, limestone.

Ozarkian, Chushina formation. (Loc. 61q): Robson Peak District, British Columbia.

Housia canadensis Walcott (see pl. 7, figs. 4, 8) 94

FIGS. 10, 11. (Natural size.) Shaly limestone with various parts of this species. These are better preserved than the previously illustrated specimen. U. S. Nat. Mus., Cat. No. 70340.

Matrix, siliceous shale.

Upper Cambrian, Goodsir formation. Mount Goodsir, British Columbia.


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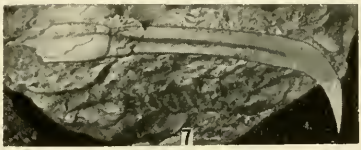
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KAINELLA—MOXOMIA—HOUSIA


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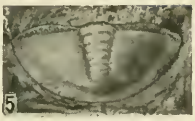
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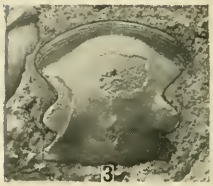
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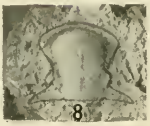
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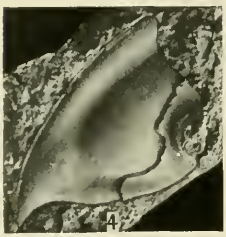
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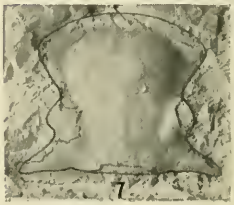
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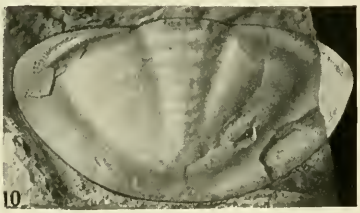
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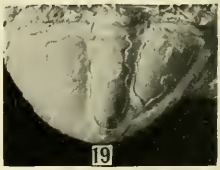
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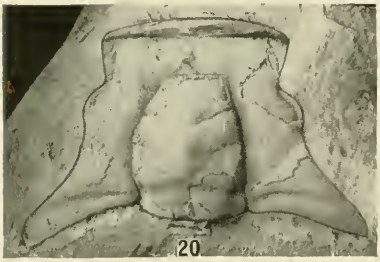
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BELLEFONTIA—LEIOSTEGIUM—MOOSIA

DESCRIPTION OF PLATE 23

PAGE

Bellefontia collieana (Raymond) Ulrich..... 72

FIGS. 1, 2. (×2.) Dorsal and side views of a small but fairly complete cranidium. U. S. Nat. Mus., Cat. No. 70341.

3. (×2.) Dorsal view of a less complete head. U. S. Nat. Mus., Cat. No. 70342.

4. (×2.) A small, partly exfoliated free cheek. U. S. Nat. Mus., Cat. No. 70343.

5, 6. (Natural size.) Dorsal and side views of an associated pygidium, from which the test has been exfoliated. U. S. Nat. Mus., Cat. No. 70344.

Matrix, limestone.

Canadian, Lower Stonehenge. (Loc. 271r): Bellefonte, Pennsylvania.

Bellefontia nonius Walcott..... 72

FIG. 7. (Natural size.) Cranidium with outlines restored. U. S. Nat. Mus., Cat. No. 70345.

8. (Natural size.) Small head. U. S. Nat. Mus., Cat. No. 70346.

9. (Natural size.) Free cheek found in association with this form. U. S. Nat. Mus., Cat. No. 70347.

10, 11. (Natural size.) Pygidia showing the characters of the species. U. S. Nat. Mus., Cat. Nos. 70348, 70349.

Matrix, limestone.

Ozarkian, Mons formation. (Loc. 65y): North side of Clearwater Canyon, 2 miles (3.2 km.) from divide at head of canyon and about 21 miles (33.8 km.) in an air line north, 2° west, of Lake Louise Station, on the Canadian Pacific Railway, Alberta, Canada.

Leiostegium manitouensis Walcott..... 104

FIGS. 12-14. (Natural size.) Dorsal, side, and front views of a fairly complete cranidium illustrating the generic and specific characters. U. S. Nat. Mus., Cat. No. 70350.

15. (Natural size.) Free cheek. Rim broken away, exposing the doublure for most of the distance. U. S. Nat. Mus., Cat. No. 70351.

16. (Natural size.) Dorsal view of an associated pygidium. U. S. Nat. Mus., Cat. No. 70352.

17. (Natural size.) Dorsal view of a well preserved associated pygidium. U. S. Nat. Mus., Cat. No. 70353.

18. (Natural size.) Small, slightly distorted cranidium. U. S. Nat. Mus., Cat. No. 70818.

19. (Natural size.) Pygidium preserving most of the test. U. S. Nat. Mus., Cat. No. 70817.

Matrix, red siliceous limestone.

Ozarkian (Manitou limestone). (Loc. 187): Manitou Park, Colorado. Ozarkian (Chushina formation). (Loc. 61q): Billings Butte, east, near base of Robson Peak, British Columbia.

Moosia grandis Walcott..... 107

FIG. 20. (Natural size.) A large cranidium somewhat distorted, illustrating the characters of the species. U. S. Nat. Mus., Cat. No. 70355.

21. (Natural size.) Pygidium associated and referred to this species. U. S. Nat. Mus., Cat. No. 70356.

Matrix, siliceous shale.

Upper Cambrian, Goodsir formation. Moose Creek, British Columbia.

DESCRIPTION OF PLATE 24

PAGE

Xenostegium taurus Walcott 128

FIG. 1. (Natural size.) Dorsal view of the pygidium and an oblique view of the cranidium. U. S. Nat. Mus., Cat. No. 70357.

2. (×2.) Dorsal view of the type cranidium.

Matrix, limestone.

Ozarkian, Chushina formation. (Loc. 61q): Billings Butte (Extinguisher), above Hunga Glacier, Robson Peak District, British Columbia, Canada.

Xenostegium belemnurum (White) 125

FIG. 3. (×2.) Cranidium with test badly eroded on same rock with fig. 4, the original type. U. S. Nat. Mus., Cat. No. 70358.

4. (Natural size.) Dorsal view of White's original type specimen. Hologenotype, U. S. Nat. Mus., Cat. No. 8562.

Matrix, limestone.

Canadian ? (Loc. 67i): Queen Spring Hill, southeast of Schellbourne, Nevada.

Xenostegium goniocercum (Meek) 127

FIGS. 5, 6. (Natural size.) Dorsal views of the original type pygidia of the species. U. S. Nat. Mus., Cat. No. 11600.

7. (Natural size.) Cast of another pygidium. U. S. Nat. Mus., Cat. No. 70361.

8. (Natural size.) Small pygidium doubtfully referred to the species. U. S. Nat. Mus., Cat. No. 70360.

Matrix, limestone.

Canadian ? Near Malad, Idaho.

Xenostegium ? sulcatum Walcott 128

FIG. 9. (×2.) Dorsal view of only cranidium discovered. U. S. Nat. Mus., Cat. No. 70359.

Matrix, limestone.

Ozarkian, St. Charles formation ?. (Loc. 55z): Blacksmith Fork Canyon, Utah.

Xenostegium albertensis Walcott 125

FIGS. 10, 11. (Natural size.) Dorsal and side views of the type pygidium. U. S. Nat. Mus., Cat. No. 70362.

Matrix, limestone.

Ozarkian, Mons formation. (Loc. 66v): Upper Johnson Creek Canyon, Sawback Range, Alberta, Canada.

Xenostegium ? eudocia Walcott 126

FIG. 12. (Natural size.) Central portion of the cranidium. U. S. Nat. Mus., Cat. No. 70363.

Matrix, limestone.

Ozarkian, St. Charles formation. (Loc. 55z): Blacksmith Fork Canyon, Utah.

Xenostegium euclides Walcott 126

FIG. 13. (×2.) Associated hypostoma which may belong to this species. U. S. Nat. Mus., Cat. No. 70364.

14. (×2.) Large and small pygidium. U. S. Nat. Mus., Cat. No. 70365.

Matrix, limestone.

Ozarkian, Mons formation. (Loc. 66v): Upper Johnson Creek Canyon, Sawback Range, Alberta, Canada.


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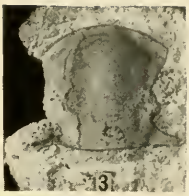
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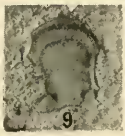
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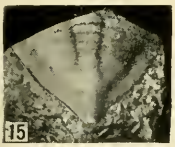
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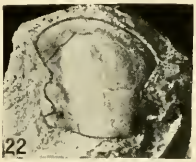
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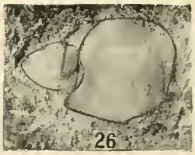
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CAMBRIAN TRILOBITES