SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 67, NUMBER 9

CAMBRIAN GEOLOGY AND PALEONTOLOGY

IV

No. 9.—CAMBRIAN AND OZARKIAN BRACHIOPODA, OZARKIAN CEPHALOPODA AND NOTOSTRACA

(With Plates 106 to 126)

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(Publication 2753)

CITY OF WASHINGTON
PUBLISHED BY THE SMITHSONIAN INSTITUTION
JUNE 3, 1924

The Lord Baltimore Press
BALTIMORE, MD., U. S. A.

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[1] C. and M. = Chushina and Mons formations.

ILLUSTRATIONS

INTRODUCTION

The field reconnaissance of the pre-Devonian formations of Alberta and British Columbia, Canada, that I have been conducting the past six seasons has resulted in the accumulation of collections that have received preliminary study and are now being prepared for illustration and description.

The first paper resulting from this field-work was issued in March, 1923, on the "Nomenclature of Some post-Cambrian and pre-Cambrian Formations."[1] In this, preliminary lists of fossils are given and among them three brachiopods that are described in this paper, *Lingulella ibicus* Walcott, *Eoorthis iones* Walcott, *Syntrophia isis* Walcott. *E. iones* is now referred to *Protorthis*.

In addition to the above there are 50 new species and one variety listed in the table of contents. These include not only those from the Cordilleran area of Canada, but a few from various localities in the United States that have been found in older collections from various sources now in the U. S. National Museum.

[1] Smithsonian Misc. Coll., Vol. 67, No. 8.

The species are distributed as follows:

Ordovician	6
Ozarkian	26
Cambrian	20
	52
Common to Ozarkian and Ordovician	2
Total new species	50

One new variety.

Brachiopods are relatively rare in genera and species in the formations in which I have been working in Alberta and British Columbia. This in a measure is owing to their destruction by wave and current action, and also to the fact that conditions accompanying the great calcareous deposits do not appear to have afforded them a favorable habitat. An occasional quiet bay or inlet provided food and shelter from the strong tides and currents, and in these, colonies of a few species flourished in great numbers.

The species described by me since the preparation of Monograph 51, published in 1912 are

Obolus mollisonensis Walcott[2]
Lingulella moosensis Walcott[2]
Lingulella ? allani Walcott[2]
Mickwitzia muralensis Walcott[3]
Lingulella chapa Walcott[3]
Lingulella hitka Walcott[3]
Obolella nuda Walcott[3]
Micromitra (Paterina) charon Walcott[4]
Obolus damo Walcott[4]
Acrothele clitus Walcott[4]
Wimanella catulus Walcott[4]

The present paper also includes the only two cephalopods, and one Notostracan thus far discovered in the Mons formation. The study of the gasteropoda of the Sarceen[5] formations is well advanced, also the description and illustration of new genera of trilobites. It is planned to include these papers in Volume 75 of Smithsonian Miscellaneous Collections.

Through the courtesy of Dr. Olaf Holtedahl, I have had the opportunity of studying a small collection of brachiopods from Novaya

[1] Mong. U. S. Geol. Surv., No. 51, 1912.
[2] Smithsonian Misc. Coll., Vol. 57, No. 7, 1912, pp. 231, 232.
[3] Idem, No. 11, 1913, pp. 310-312.
[4] Smithsonian Misc. Coll., Vol. 67, No. 3, pp. 69-70.
[5] Smithsonian Misc. Coll., Vol. 67, No. 8, 1923, p. 471.

Zemlya, Russia, which he discovered there.[1] The brachiopods are described and illustrated in this paper and they will also be published later in Norway with the associated trilobites. The fauna is essentially of a lower Ozarkian Mons facies and belongs, as Dr. Holtedahl states, with the Pacific Province and not the Atlantic. The genera and species of brachiopods include *Lingulella cf. desiderata* Walcott, *L. arctica* n. sp., *Acrotreta* sp. undt., *Obolus* (*Westonia*) sp. undt., *Billingsella holtedahli* n. sp., *B. ? oppius* n. sp., *Eoorthis sabus* n. sp., *Huenella triplicata* n. sp.

The photographs of brachiopods illustrated in this paper were made by Dr. Charles E. Resser, of the U. S. National Museum, and the retouching of photographs was done by Miss Francis Wieser.

BRACHIOPODA

DESCRIPTION OF SPECIES

Genus MICROMITRA Meek

See Mong. U. S. Geol. Surv., No. 51, 1912, p. 332, for synonymy, description and illustration.

MICROMITRA ZENOBIA Walcott

Plate 106, figs. 1-7

Micromitra zenobia Walcott, 1912, Mong. U. S. Geol. Surv., No. 51, p. 342, text fig. 23. Describes and illustrates species with one text figure.

The type of this species occurs in the Burgess shale of the Stephen formation, and the specimens illustrated in this paper occur in a calcareous shale about 1,000 feet (304.8 m.) distant from the type locality and a little above the horizon at the type locality. All the shells are flattened and more or less distorted; none of them exhibit the interior surface and only traces of the pseudo cardinal area are preserved; they afford, however, fine illustrations of distortion with considerable fracturing of the test of the shell, and are worth illustrating on that account.

The associated fossils are:

Pirania muricata Walcott
Obolus sp. undt.
Hyolithellus flagellum Matthew
Hyolithes sp. undt.
Scenella varians Walcott
Ptychoparia ? cordilleræ (Rominger)
Neolenus serratus (Rominger)

[1] Amer. Jour. Sci., 5th Ser., Vol. 3, 1922, pp. 343-348.

Formation and locality.—Middle Cambrian: (61j) Stephen formation. Buff weathering band of calcareo-argillaceous shale. West slope of Mt. Field, near Burgess Pass Ridge about 3,200 feet (975.3 m.) above Field on the Canadian Pacific Railway, British Columbia, Canada.

MICROMITRA (IPHIDELLA) PANNULA (White)

Plate 106, figs. 16, 17

For synonymy see Mong. U. S. Geol. Surv. No. 51, 1912, p. 361.

Two specimens of this species are illustrated on account of the fine preservation of the delicate spines or setæ attached to the surface of the shell. Many hundreds of these shells from calcareous shales were without a trace of the spines, but in the fine silicious Burgess shale several have them attached.

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

Genus OBOLUS Eichwald

See Mong. U. S. Geol. Surv., No. 51, 1912, for synonymy and description.

OBOLUS ION, new species

Plate 106, figs. 8-10

This is a medium size species of *Obolus* comparable with *O. tetonensis* Walcott.[1] It has similarly shaped valves except that some of the ventral valves of *O. ion* are more acuminate, in this respect resembling the ventral valve of *Lingulella acutangula* Roemer,[2] but the dorsal valves have more the outline of those of *Lingulepis*.

Dimensions.—Ventral valve 7 mm. in length, maximum width 6 mm. Dorsal valve 6 mm. in length, 5.5 mm. maximum width.

Formation and locality.—Ozarkian: (16q) Mons formation. Thin-bedded gray limestone. Brisco range, about 2 miles (3.2 km.) up Sinclair Canyon from Radium Hot Springs on north side of canyon near north end of 3d bridge on Banff-Windermere motor road. About 15 miles (24.1 km.) from Lake Windermere in Columbia River Valley.

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[1] Mong. U. S. Geol. Surv. No. 51, 1912, p. 417, pl. 9, figs. 5, 5*a-c*.

[2] *Idem*, pl. 17, fig. 1.

(16y) Mons formation; compact gray limestone crowded with broken fossils; Brisco Range, north side of Sinclair Canyon about 500 feet (152.4 m.) above stream on edge of cliff and about 400 feet (121.9 m.) up the canyon from the first bridge west on Banff-Windermere motor road.

(17n) Mons formation; thin gray nodular limestone interbedded in argillaceous shale. 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, all in British Columbia, Canada.

OBOLUS LEDA Walcott

Plate 106, figs. 12-15

Obolus tetonensis leda Walcott, 1912, Mong. U. S. Geol. Surv., No. 51, p. 417. (Variety described but not illustrated.)

This is the representative in the basal portion of the Ozarkian Notch Peak formation of *Obolus tetonensis* Walcott which occurs in the Upper Cambrian of the Teton Mountains of Wyoming. It differs from *O. tetonensis* in its more elongate dorsal valve, thinner shell and finer concentric surface striæ.

Dimensions.—A large ventral valve 3.5 mm. in length has a maximum width of 2.5 mm. A dorsal valve 5 mm. long has a maximum width of 3.5 mm.

Formation and locality.—Ozarkian: (30 m.) Notch Peak formation. Compact dove colored limestone 140 feet (42.6 m.) from base of 1e of section. North slope of Notch Peak about 5 miles (8 km.) south of Marjum Pass, House Range, Millard County, Utah.

A shell that is closely related to *O. leda* occurs with the Hungaia faunule of the Stanford Range. It has the same thin, shiny shell and form, but is a little larger.

Ozarkian: (17p) Mons formation. Thin layer gray limestone interbedded in argillaceous shale, north side of Sinclair Canyon about 450 feet (137.1 m.) above creek, and a little west of Radium Hot Springs, Brisco Range.

(17v) Mons formation. Thin layer of soft gray limestone interbedded in shale 1g of section and 221 feet (67.3 m.) above base of section. Southwest angle of Sabine Mountain, 1 mile (1.6 km.) north of Kootenay River Bridge and about 2 miles (3.2 km.) northeast of Canal Flats Station on the Canadian Pacific Railway.

(21i) Mons formation. Thin-bedded gray limestone interbedded in shale. Kicking Horse Canyon above second bridge on Canadian Pacific Railway, about 1.5 mile (2.4 km.) east of Golden. All in British Columbia, Canada.

OBOLUS MYRON, new species

Plate 107, figs. 1-3

In outline of the valves, this species recalls *Obolus mcconnelli* Walcott from the Middle Cambrian, especially the variety *decipiens*,[1] but the nearest species is *Obolus tetonensis* Walcott and its variety *ninus*.[2] Both species are from the Upper Cambrian. *O. myron* differs from *O. tetonensis* in the broader outline of the valves and more obtuse apex of the ventral valve.

Dimensions.—A ventral valve 7.5 mm. long has a maximum width of 5.5 mm. A flattened and distorted dorsal valve is 5.5 mm. long and 7 mm. in width.

Formation and locality.—Upper Cambrian: (63x) Ottertail formation. Thin-bedded limestones about 500 feet (152.4 m.) above argillaceous shales of Chancellor formation; Wolverine Pass between Mounts Drysdale and Grey (11 miles (17.6 km.) southwest of Vermilion Pass, Alberta), in British Columbia, Canada.

OBOLUS PERONE, new species

Plate 106, fig. 11

This species is represented by a few fragments and one dorsal valve that proves it to have been a rather large and thick shell marked by concentric striæ and lines of growth. This dorsal valve is a little distorted but it appears to have been wider than long, the length being 11 mm. and maximum width 14 mm.

The one imperfect specimen indicates a species related to *Obolus maera* (Hall and Whitfield), (Mong. U. S. Geol. Surv., No. 51, 1912, pl. 10, figs. 2, 2*a-e*) and it may be compared with compressed forms of *Obolus apollinis* Eichwald (*idem*, pl. 14, figs. 6, 6*a*).

Formation and locality.—Upper Cambrian: Ottertail limestone on Moose river southeast of Field, British Columbia, Canada.

Type in collection of Geological Survey of Canada at Ottawa.

OBOLUS TETONENSIS Walcott

Plate 107, figs. 4, 5

Obolus tetonensis Walcott, 1901, Proc. U. S. Nat. Museum, Vol. 23, p. 684. (Described as a new species.)

Obolus tetonensis Walcott, 1905, *Idem*, Vol. 28, p. 327. (Same as above.)

Obolus tetonensis Walcott, 1912, Mong. U. S. Geol. Surv., No. 51, p. 417, pl. 9, figs. 5, 5*a-d*. (Species discussed, illustrated and localities given.)

This form of *Obolus* is widely distributed in the Cordillera of western North America. It occurs in the Bisbee District of Arizona,

[1] Mong. U. S. Geol. Surv., No. 51, 1912, pl. 23, figs. 3*a*, 4.

[2] *Loc. cit.*, pl. 9, figs. 5, 5*a-e*; pl. 11, figs. 1, 1*a-g*.

the Teton Mountains of Wyoming, and at several localities in Montana, and as far as I can determine from the ventral valves it is present in the Mount Robson section of British Columbia. The figures of the two valves illustrated on plate 107, figures 4, 5, may be compared with those of two of the ventral valves from the type locality. (See pl. 9, figs. 1, 1*a*, Mong. 51, U. S. Geol. Surv.)

The types of *O. tetonensis* occur in association with *Lingulepis acuminata meeki* Walcott, *Billingsella coloradoensis* (Shumard) and *Acrotreta microscopica tetonensis* Walcott. This fauna of locality 4e is referred to the Middle Cambrian by Walcott (Mong. 51, p. 417), but this is evidently a mistake as my field label has Upper Cambrian on it, and the fauna as I understood it in 1898 was of Upper Cambrian age. Now that this fauna has been removed from the Upper Cambrian and placed in the Ozarkian, *O. tetonensis* and its associates at locality 4e will be referred to the lower zone of the Ozarkian. All of the localities of *O. tetonensis* are either in the Upper Cambrian or basal Ozarkian. This is evidently the case with locality 4h (Mong. 51, p. 166) which also has *Lingulepis acuminata* Conrad, a species that occurs most abundantly in the Lower Ozarkian Hoyt limestone fauna of New York.

The stratigraphic references to Upper and Middle Cambrian in Monograph 51 are subject to revision as they were made at a time when the boundaries of the Upper Cambrian in the Cordilleran area were not well established. *O. tetonensis* appears to have lived in the Upper Cambrian seas and continued on into the Lower Ozarkian, and an almost identical form occurs in the lower Canadian fauna of Fossil Mountain (locality 67n) (pl. 107, figs. 7, 7*a*, 8), except that the latter has the exterior surface of a *Westonia*.

Dimensions.—A ventral valve 9 mm. in length has a maximum width of 7 mm. and an associated dorsal valve 7 mm. in length has a maximum width of 7 mm.

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.

OBOLUS cf. TETONENSIS Walcott

Obolus tetonensis Walcott, Mong. U. S. Geol. Surv., No. 51, 1912, p. 417, pl. 9, figs. 5, 5*a-d*. (Described and illustrated.)

A few fragmentary specimens of a species closely related to *O. tetonensis* were found in a hard gray limestone of the lower Mons

formation in the Glacier Lake section. Comparison may also be made with *Obolus matinalis* (Hall) from the Upper Cambrian, Franconia sandstone of Wisconsin. Better specimens are needed for study and illustration before a satisfactory specific identification can be made.

Formation and locality.—Ozarkian: (64n) Mons formation (Lower) near base of 1c 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 the Canadian Pacific Railway, Alberta, Canada. Similar specimens occur at the following localities:

(16u) Mons formation. Beds of dove gray limestones 30 inches (76.2 cm.) thick, interbedded in gray argillaceous shale. South end of Brisco Range, north side of Sinclair Canyon about 600 feet (182.8 m.) above the creek and 700 feet (213.3 m.) west of Radium Hot Springs.

(16y) Mons formation. Compact gray limestone crowded with broken fossils. Brisco Range, north side of Sinclair Canyon about 500 feet (152.4 m.) above stream on edge of cliff and about 400 feet (121.9 m.) up the canyon from the first bridge west on Banff-Windermere motor road.

(21e) Mons formation. Gray thin-bedded limestones. South end of Brisco Range on northeast side of Sinclair Canyon about 800 feet (243.8 m.) up the canyon from the first bridge west of entrance to canyon on the Banff-Windermere motor road.

(17y) Mons formation. Hard gray limestone. West slope of Stanford Range, east side of Columbia River Valley, 5 miles (8 km.) south of Sinclair Canyon and .5 mile (.8 km.) north of Stoddart Creek. All in British Columbia, Canada.

OBOLUS TEUTA, new species

Plate 107, fig. 6

This is one of the *Obolus tetonensis*-like forms that occurs in a slightly different zone of the Mons formation than *O. ion*. It is much like the latter but differs in its less acuminate ventral valve and less elongate dorsal valve. The latter is somewhat like the dorsal valve of *O. tetonensis*.

Dimensions.—A ventral valve 9.5 mm. in length has a maximum width of 7 mm. A dorsal valve 10 mm. long has a width of 8 mm.

Formation and locality.—Ozarkian: (16r) Mons formation, Brisco Range, north side of Sinclair Canyon about 1,200 feet (365.7 m.) above bridge No. 5, on Banff-Windermere motor road, British Columbia, Canada.

(17y) Mons formation; west slope Stanford Range, east side of Columbia River Valley, 5 miles (8 km.) south of Sinclair Canyon and 0.5 mile (.8 km.) north of Stoddart Creek, British Columbia, Canada.

OBOLUS WHYMPERI, new species

Plate 121, figs. 4-7

This is one of the *Obolus mcconnelli* forms of *Obolus* that occurs at a lower stratigraphic horizon in the silicious shales beneath the upper calcareous beds of the Mt. Whyte formation. It differs principally from *O. mcconnelli* (Walcott) in the more elongate outline of the valves and average larger size. The shells are fairly abundant on the surface of a hard, fine, arenaceous, gray shale that occurs on the lower slopes of Mt. Whymper.

The species is named in honor of Edward Whymper, explorer and mountain climber in the Canadian Rockies.

Formation and locality.—Lower Cambrian: (68e) Mt. Whyte formation, east lower slope of Mt. Whymper, above Vermilion Pass, British Columbia, Canada.

OBOLUS (WESTONIA) OLLIUS, new species

Plate 121, figs. 8-10

Lingulella stoneana Weller, 1903, Geol. Surv. New Jersey, Rept. Pal., Vol. 3, p. 112, pl. 1, fig. 6. (Described and discussed.)

Lingulella stoneana Whitfield Weller, 1903, Geol. Surv. New Jersey, Rept. Pal., Vol. 3, p. 112, pl. 1, fig. 6. (Described and discussed.)

Obolus (Westonia) stoneanus Walcott, 1912, Mong. U. S. Geol. Surv. No. 51, p. 465, pl. 49, figs. 2, 2*a*. (Illustrates specimen from New Jersey now referred to *O. (W.) ollius*.)

This species differs from *O. (W.) stoneanus* (Whitfield) of the Upper Cambrian of Wisconsin in outline and in the direction of the raised transverse outlines which bend back on the cardinal and lateral slopes more towards the beak than in *O. (W.) ollius*.

Formation and locality.—Upper Cambrian (11c) "Hardystone Quartzite," Newton, New Jersey.

OBOLUS (WESTONIA) TERTIA, new species

Plate 107, figs. 7, 7*a*, 8

The striking difference between this species and *Obolus dolatus* Sardson[1] of the Oneota dolomite is in the character of the outer surface. On *O. (W.) tertia* the concentric raised lines of growth are strong, irregularly spaced, and the entire surface is slightly roughened

[1] Mong. U. S. Geol. Surv., No. 51, p. 390, text figs. 35*a-c*.

by very minute inosculating raised lines that give almost the same effect as similar lines on the surface of *Obolus* (*Westonia*) *ella* Hall and Whitfield.[1]

It is closely related to the latter widely distributed species by surface characters and form of ventral valve, but the outline of the dorsal valve is less transverse.

Dimensions.—A convex ventral valve 8 mm. long has a maximum width of 6.75 mm. A flattened ventral valve 6.5 mm. long is 7 mm. in maximum width.

Formation and locality.—Ordovician: (67n) Sarbach formation, in a hard, dirty gray, thick-bedded limestone weathering to a light buff color. Northeast slope of Fossil Mountain, 8.7 miles (13.9 km.) northeast of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada. Also (21 o) Buff brown and gray shaly limestone 75 feet (22.8 m.) below 21n. On low ridges southeast of lower end of Baker Lake and Fossil Mountain.

OBOLUS (FORDINIA) NESTOR, new species

Plate 108, figs. 1, 2

This species is founded on a dorsal valve showing the cast of a portion of the visceral area and the exterior of an associated ventral valve. The dorsal valve resembles that of *Elkania desiderata* (Billings) (Mong. 51, pl. 51, fig. 1*d*), and the ventral valve that of *Obolus* (*Fordinia*) *gilberti* Walcott (*loc. cit.*, pl. 51, fig. 5). The generic reference is doubtful as the dorsal valve does not show sufficient of the visceral area to clearly indicate whether it belongs to *Obolus* (*Fordinia*), *Elkania,* or *Dicellomus.*

Dimensions.—The dorsal valve is 6.5 mm. in length with a maximum of 7 mm. The associated ventral valve is smaller with a length of 3.5 mm. and a maximum width of 3 mm.

Formation and locality.—Upper Cambrian: (64w) Lyell formation. Drift blocks of limestone. Sawback Range, Ranger Brook Canyon, 10 miles (16 km.) in air line west-northwest of Banff, and 2 miles (3.2 km) north-northeast of Massive Switch on Canadian Pacific Railway, Alberta, Canada.

Genus LINGULEPIS Hall

See Mong. U. S. Geol. Surv., No. 51, 1912, p. 544, for synonymy and description.

For convenience of reference and listing of species I have during the past few years been using *Lingulepis* as a genus rather than as a

[1] *Loc. cit.*, pl. 47, fig. 10.

subgenus of *Lingulella*. The attenuate form of the posterior portion of the ventral valve is, however, so persistent and so well marked that it may be as well to return to the usage of the author of the genus and give *Lingulepis* full generic value. It is a very excellent horizon marker in the Lower Ozarkian and Upper Cambrian formations of the Cordilleran and Appalachian areas and of the Middle Cambrian in New Brunswick. The species *L. acuminata* (Conrad) is widely distributed in the Appalachian area and the Mississippi Valley, and similar forms occur at Mount Robson, British Columbia, and far to the south in the Cordilleran ranges of Utah and Nevada.

The species I have described as *L. nabis* is the only new one that has come to my attention since 1910.

LINGULEPIS NABIS, new species

Plate 109, figs. 4-7

This species differs from *Lingulepis acuminata* (Conrad) [1] in its uniformly smaller size, nearly straight lateral margins of the ventral valve and more elongate dorsal valve; it also appears to have had a thinner more flexible shell. The ventral valve resembles that of some forms of *Lingulepis exigua* (Matthew) (*loc. cit.*, pl. 43, figs. 1-1*b*) from the Middle Cambrian, but the dorsal valve is quite unlike the dorsal valve of *L. exigua*. The latter species is also much larger. It may also be compared with *L. spatula* Walcott (*loc. cit.*, pl. 19, figs. 5, 5*a*, 5*b*) from the Bright Angel shale formation.

A species closely resembling *L. nabis* occurs with a faunule of the Mons fauna in Sinclair Canyon. Unfortunately the specimens are all imperfect, which prevents close comparison and identification.

Dimensions.—A small ventral valve 4.25 mm. in length has a maximum width of 2.75 mm. A large dorsal valve 7.25 mm. in length has a maximum width of 4 mm.

Formation and locality.—Ozarkian: (16q) Mons formation in a thin-bedded gray limestone. Brisco Range, about 2 miles (3.2 km.) up Sinclair Canyon from Radium Hot Springs on north side of canyon near north end of third bridge on Banff-Windermere motor road. Also locality 16t which is about a mile further down Sinclair Canyon.

(16v) Mons formation. Soft gray thin-bedded limestone. Brisco Range, north side of Sinclair Canyon about 75 feet (22.8 m.) above the creek just below the fourth bridge on the Banff-Windermere motor road, which is 4 miles (6.4 km.) above the first bridge.

[1] See Mong. U. S. Geol. Surv., No. 51, pt. 2, 1912, pls. 40-42.

(17n) Mons formation. Thin layer gray nodular limestone interbedded in argillaceous shale. 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. All in British Columbia, Canada.

Genus LINGULELLA Salter

See Mong. U. S. Geol. Surv., No. 51, 1912, for synonymy and description.

LINGULELLA cf. DESIDERATA Walcott

Plate 108, figs. 3, 4

Lingulella desiderata Walcott, 1898, Proc. U. S. Nat. Mus., Vol. 21, pp. 399-400. (Described and discussed as a new species.)

Lingulella desiderata Walcott, 1921, Mong. U. S. Geol. Surv., No. 51, p. 492, pl. 20, figs. 4, 4*a-c*, 5, 5*a-j*.

This widely distributed species that ranges from the Upper Cambrian into the Lower Ozarkian in the United States, is represented in the Mons fauna by a small shell that cannot readily be separated from the typical forms of the species. The ventral valve is similar but the one associated dorsal valve is more like that of *L. rotundata* (*loc. cit.*, pl. 20, fig. 2*d*).

The shell is thin and marked by fine concentric striæ.

Dimensions.—Ventral valve 4.75 mm. in length with a maximum width of 2.75 mm.

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.

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.

(16y) Mons formation. Compact gray limestone crowded with broken fossils. Brisco Range, north side of Sinclair Canyon about 500 feet (152.4 m.) above stream on edge of cliff and about 400 feet (121.9 m.) up the canyon from the first bridge west on Banff-Windermere motor road.

(21d) Mons formation. Argillaceous shale and thin layers of dense gray limestone. Northern end of Stanford Range on southeast side of Sinclair Canyon just below Radium Hot Springs Pool. All in British Columbia, Canada.

LINGULELLA IBICUS, new species

Plate 108, figs. 5-8, plate 109, figs. 8, 9

The general form of this species is not unlike that of *L. bella* Walcott and *L. randomensis* Walcott[1] from the Upper Cambrian of Newfoundland. The valves of *L. ibicus* are more elongate than those of *L. bella,* and broader posteriorly than those of *L. randomensis.* Shell thin and marked by fine concentric striæ and lines of growth.

Dimensions.—A ventral valve 8.5 mm. in length has a maximum width of 4.75 mm., and a small dorsal valve 5.5 mm. long has a maximum width of 4.25 mm.

A dorsal valve of a *Lingulella* occurs in the Lyell formation of the Upper Cambrian (locality 64c) that is very similar to that of *L. ibicus* in outline and convexity. It may also be compared with the dorsal valve of *L. bella* Walcott (Mong. 51, pl. 19, figs. *2b, 2e*).

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.

(16q) Mons formation. Thin-bedded gray limestone. Brisco Range, about 2 miles (3.2 km.) up Sinclair Canyon from Radium Hot Springs on north side of canyon near north end of third bridge on Banff-Windermere motor road.

(16u) Mons formation. Beds of dove gray limestones 30 inches (76.2 cm.) thick, interbedded in gray argillaceous shale. South end of Brisco Range, north side of Sinclair Canyon about 600 feet (182.8 m.) above the creek and 700 feet (213.3 m.) west of Radium Hot Springs.

(16v) Mons formation. Soft gray thin-bedded limestone. Brisco Range, north side of Sinclair Canyon about 75 feet (22.8 m.) above the creek just below the fourth bridge on the Banff-Windermere motor road, which is 4 miles (6.4 km.) above the first bridge.

(16y′) Mons formation. Compact gray limestone crowded with broken fossils. Brisco Range, north side of Sinclair Canyon about 500 feet (152.4 m.) above stream on edge of cliff and about 400 feet (121.9 m.) up the canyon from the first bridge west on the Banff-Windermere motor road.

(17n) Mons formation. Thin layer gray nodular limestone interbedded in argillaceous shale. 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.

[1] *Loc. cit.,* pl. 19, figs. 2, *2a-f* and pl. 21, fig. 5.

(17y) Mons formation; west slope Stanford Range, east side of Columbia River Valley, 5 miles (8 km.) south of Sinclair Canyon and .5 mile (.8 km.) north of Stoddart Creek, British Columbia, Canada.

(21f) Mons formation. Hard gray limestone interbedded in shale. North end of Stanford Range on southeast side of Sinclair Canyon, 180 to 200 feet (54.8 to 60.9 m.) above first bridge from mouth of canyon. All in British Columbia, Canada.

LINGULELLA MILTONI, new species

Plate 122, figs. 1-4

This species is closely related to *L. remus* (p. 494) in form and convexity of the valves. It differs in the straighter cardinal slopes and more transverse front of the ventral valve and the proportionally narrower and more elongate dorsal valve. There is considerable variation in the widening of the ventral valve as illustrated by figures 1 and 3. The average length of the ventral valve is about 5 mm. This shell (*L. miltoni*) was compared with *L. manticula* White in a list of fossils from Mount Robson[1] and the statement made that the fauna was very close to if not within the base of the Ordovician. At that time the Mons formation had not been determined nor its fauna recognized as distinct from the Cambrian beneath and the Ordovician above.

L. miltoni is associated with a rather large species of *Acrotreta* closely allied to *A. sagittalis transversa* (Hartt)[2] from the Upper Cambrian of Newfoundland.

The specimens of *L. miltoni* were found in a block of limestone derived from the beds above the *Hungaia* zone as exposed in Billings Butte (Extinguisher) and in the upper beds of Iyatunga (rear-guard); these beds probably belong in the Chushina formation.[3]

Formation and locality.—Ozarkian: (61u) Chushina formation. Gray thin-bedded limestones, northeast slope of Robson Peak in moraine brought down from high on the mountain by Chupo Glacier terminating at the lower end of Berg Lake, northwest of Yellowhead Pass, in eastern British Columbia, Canada.

LINGULELLA NECHOS, new species

Plate 108, figs. 12, 12*a*

Fragments of a large species of *Lingulella* are associated with *Obolus (Westonia) tertia* (*ante*, p. 487) that suggest *Lingulella davisi*

[1] Smithsonian Misc. Coll., Vol. 57, 1913, p. 336.

[2] Mong. U. S. Geol. Surv. No. 51, 1912, p. 708, pl. 72, figs. 1, 1*a-k*.

[3] Smithsonian Misc. Coll., Vol. 67, No. 8, 1923, p. 458.

(McCoy) from the Lingula Flags of Wales. A dorsal valve has a length of 15 mm. with a maximum width of 10 mm. It is rather thick and its outer surface marked by strong concentric lines of growth following the edges of the laminated layers of the shell. The dorsal valve is more elongate and rounded subquadrate in outline than that of *Lingulella isse* Walcott.[1] The thick shell is like that of *Obolus* (*Lingulobolus*) *spissus* (Billings).[2]

Formation and locality.—Ordovician: (67n) Sarbach formation, in a hard, dirty gray, thick-bedded limestone weathering to a light buff color. Northeast slope of Fossil Mountain, 8.7 miles (13.9 km.) northeast of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

(21 o) Buff brown and gray shaly limestone. On low ridges southeast of lower end of Baker Lake and Fossil Mountain.

LINGULELLA NEPOS, new species

Plate 108, figs. 9-11

The ventral valve of *L. nepos* is similar to that of *L. ninus* (pl. 108, figs. 15, 16) except that it is proportionally broader and the apex is curved over in a less abrupt manner. The associated dorsal valves are proportionally narrower. Shell thin and marked by fine concentric striæ and lines of growth and fine radiating striæ.

Dimensions.—A ventral valve 5.5 mm. long has a maximum width of 3.5 mm. and a broad associated dorsal valve is 2.25 mm. long with a maximum width of 2 mm. (fig. 9). An elongate dorsal valve (fig. 10) has a length of 3.25 mm. and maximum width of 1.75 mm.

Formation and locality.—Ozarkian: (16q) Mons formation in thin-bedded gray limestone. Brisco Range, about 2 miles (3.2 km.) up Sinclair Canyon from Radium Hot Springs on north side of canyon near north end of third bridge on Banff-Windermere motor road, British Columbia, Canada.

LINGULELLA NERVA, new species

Plate 108, figs. 13, 13*a*, 14

This species of the upper Mons might be a descendant of *Lingulella ibicus* or *L. remus* (see pl. 108, figs. 5-8) of the Ozarkian Chushina formation, but if so it has changed the outline of the valves, and they are also much more convex and thicker than the older species. *L. nechos* (pl. 108, figs. 12, 12*a*) is a much larger and more elongate shell.

[1] *Loc. cit.*, p. 510.

[2] *Loc. cit.*, p. 432, pl. 16, fig. 2.

Dimensions.—A convex ventral valve has a length of 7 mm. and a maximum width of 4.5 mm. A smaller associated dorsal valve is 5.5 mm. in length with a maximum width of 4 mm.

Formation and locality.—Ozarkian (16r) Mons formation, Brisco Range. North side of Sinclair Canyon about 1,200 feet (365.7 m.) above bridge No. 5, on Banff-Windermere motor road, British Columbia, Canada.

LINGULELLA NINUS, new species

Plate 108, figs. 15, 16

L. ninus differs from the associated *L. ibicus* and *L. remus* in the more attenuate posterior half of the ventral valve and the broader dorsal valve. It is not unlike some examples of the shorter forms of *Lingulella perattenuata* Whitfield.[1] Shell very thin with outer surface marked by fine concentric and radiating striæ.

Dimensions.—A small ventral valve 5.5 mm. in length has a maximum width of 3.5 mm. A large dorsal valve is 7 mm. in length with a width of 5.5 mm.

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.

LINGULELLA REMUS, new species

Plate 109, figs. 2, 2a, 3

This is one of the *Lingulella acutangula*[2] type of shells in general form but it differs in details of outline and its thinner shell. The nearest species is the associated *L. ibicus* which differs from it in having proportionally more elongate and narrow valves. Shell thin with outer surface marked by fine concentric striæ and lines of growth and very fine lines radiating from the beak.

Dimensions.—Ventral valve 8 mm. long has a maximum width of 5 mm. A dorsal valve 6 mm. in length has a maximum width of 4 mm.

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,

[1] *Loc. cit.*, pl. 21, figs. 1*c*.

[2] *Loc. cit.*, pl. 17.

Robson Park, northwest of Yellowhead Pass, in eastern British Columbia, Canada.

Ozarkian (17y) Mons formation. Hard gray limestone. West slope of Stanford Range, east side of Columbia River Valley, 5 miles (8 km.) south of Sinclair Canyon and .5 mile (.8 km.) north of Stoddart Creek, British Columbia, Canada.

LINGULELLA SILIQUA, new species

Plate 108, figs. 17-19; pl. 109, fig. 1

This is one of the *Lingulella ibicus* (see pl. 108, figs. 5-8) group of shells in which the ventral valve is broad in front with the slightly rounded sides sloping back to form a somewhat acuminate beak. Most of the shells are flattened on the surface of a shaly limestone, but a few have a moderate convexity (fig. 5). The form of the ventral valve is somewhat like that of *L. ninus* (pl. 108, fig. 15). Flattened ventral valves are illustrated by figs. 17, 18, and what may be a dorsal valve by one of the shorter valves on fig. 19. Shells of medium thickness with outer surface marked by concentric striæ and lines of growth.

Dimensions.—A ventral valve 9 mm. in length has a maximum width of 5 mm. The associated dorsal valve is 8 mm. long with a maximum width of 5 mm.

Formation and locality.—Upper Cambrian: (63x) Ottertail formation. Thin-bedded limestones about 500 feet (152.4 m.) above argillaceous shales of Chancellor formation; Wolverine Pass between Mounts Drysdale and Grey (11 miles (17.6 km.) southwest of Vermilion Pass, Alberta), in British Columbia, Canada.

LINGULELLA cf. SIMILIS Walcott

See Mong., U. S. Geol. Surv. No. 51, 1912, p. 532, pl. 21, figs. 2, 3.

This little shell is abundant in the shales and thin layers of hard dove-colored interbedded limestone near the base of the Mons formation in Sinclair Canyon. It closely resembles *L. similis,* and as a similar form occurs in the Cordilleran Province in Nevada, it may have ranged from the Appalachian area of Tennessee across the Mississippi region and the Black Hills of South Dakota and up through the Cordilleran trough from the south.

Formation and locality.—Ozarkian: (21d) Mons formation; argillaceous shale and thin layers of dense gray limestone; northern end of Stanford Range on southeast side of Sinclair Canyon just below Radium Hot Springs Pool, British Columbia, Canada.

LINGULELLA WAPTAENSIS, new species

Plate 122, figs. 5-8

This is the Pacific Province representative of *L. ferruginea* Salter (see Mong. 51, U. S. Geol. Surv., 1912, pl. 29) of the Atlantic Province Middle and Upper Cambrian formations of eastern North America and northwestern Europe. It is a little less elongate and more rotund in outline but otherwise is very closely related to *L. ferruginea.* Nearly all the shells are also a little smaller as they average about 4 mm. in length and breadth as flattened in the shale. Often a group of the ventral valves are not over 3 mm. in length, with a slightly less width. Comparison should also be made with *L. lepis* Salter, which is a thicker shell with a somewhat different outline.

These shells often occur in groups on some of the partings of the dark silicious shale in the same manner as *Obolus mcconnelli.*

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

Genus ACROTRETA Kutorga

See Mong. U. S. Geol. Surv., No. 51, 1912, p. 671, for synonymy, description, and illustration.

ACROTRETA ATTICUS, new species

Plate 109, figs. 10-12

The ventral valve of this species recalls some of the more elevated ventral valves of *A, sagittalis* Salter (Mong. 51, pl. 71, figs. 2, 2*a*) but it is more elevated and has a stronger apical callosity; the scars of the cardinal muscles are relatively smaller and more elongate. The exterior form and elevation of the valve is quite similar to the less elevated valves of *A. idahoensis* (Mong. 51, pls. 65 and 68) but the interior of the ventral valve of the latter species differs in the apical callosity, main vasular sinuses, and cardinal muscle scars. The associated dorsal valve has a long median ridge extending nearly to the front margin, which is another character of *A. sagittalis* that indicates the close relationship of the two species.

A. atticus is one of the largest species of the genus. A ventral valve 2.75 mm. in height has a transverse diameter at the margin of 4.5 mm. and a length of 4 mm. The dorsal valve is gently convex,

the highest part is on the umbo, in advance of the slope to the minute beak that terminates on the margin of the valve.

A. atticus is relatively abundant in a hard gray limestone matrix in which the *Hungaia billingsi* fauna occurs.

Formation and locality.—Ozarkian: (61q) Chushina formation. Gray limestone in beds of varying thickness, one or two layers quite ferruginous. 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.

ACROTRETA DISCOIDEA, new species

Plate 109, figs. 13, 14

This form of *Acrotreta* is represented by three specimens of the ventral valve that are more depressed than the ventral valve of *A. sagittalis* (Salter) (Mong. 51, pl. 70, figs. 2 and 3) but unlike that species they have a very small apical callosity and weak vascular sinuses. The interior of the shell is marked by fine radiating lines and a shallow, narrow depression extending from the apical callosity to the front margin. Cardinal muscle scars small and not prominent as in *A. sagittalis* and many other species. The depressed beak curves over to the posterior margin.

The type specimen of the ventral valve has a length and width of 3.5 mm. which give a circular outline to the margin of the valve.

One ventral valve that has the circular outline, depressed beak and low convexity of the casts of the interior of this species has a slight median depression on the umbo and a surface slightly roughened by fine raised radiating lines broken by concentric lines of growth that give the appearance of the surface of *A. spinosa* Walcott (Mong. 51, p. 713, pl. 79, figs. 4*a*, 4*b*) but I am not sure that spines are present on *A. discoidea*. *A. spinosa* is an Upper Cambrian species from the Dunderberg shale of the Eureka District of Nevada.

Formation and locality.—Ozarkian: (61q) Chushina formation. Gray limestone in beds of varying thickness, one or two layers quite ferruginous. 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.

ACROTRETA cf. MICROSCOPICA Shumard

See Mong. U. S. Geol. Surv. No. 51, 1912, p. 693, pl. 67, figs. 1 to 10.

A small species of *Acrotreta* occurs in the *Hungaia* faunule of the Mons formation that is about the size and form of *A. microscopica*

(Shumard) from Packsaddle Mountain, Texas, in strata that are either high in the Upper Cambrian or in the Lower Ozarkian. This form has a wide range, and what appear to be similar forms occur in Oklahoma, Nevada, and British Columbia.

Formation and locality.—Ozarkian: (21i) Mons formation. Kicking Horse Canyon, above second bridge on Canadian Pacific Railway, about 1.5 miles (2.4 km.) east of Golden, British Columbia, Canada.

Genus ACROTHYRA Matthew

See Mong. U. S. Geol. Surv., No. 51, 1912, p. 715-716.

ACROTHYRA GREGARIA, new species

Plate 122, figs. 9-12

This species would be referred to *Acrotreta* if it were not for the visceral area of the ventral valve (fig. 9). The dorsal valve has a long median septum and in convexity and outline is similar to the dorsal valve of several species of *Acrotreta;* the cast of the visceral area of the ventral valve is similar to that of *Acrothyra signata* Matthew (see Mong. 51, pl. 80, figs. 1*a* and 2). Nearly all of the ventral valves are compressed in the hard silicious shale but a few preserve the umbo and a beak that extends over a low area. The dorsal valve is slightly transverse and the ventral valve a little longer than wide.

Dimensions.—A large ventral valve has a length of 2 mm. with a width of 1.75 mm. A dorsal valve is 2 mm. in width and nearly as long. Large numbers of the valves are not over 1 mm. in diameter.

As far as known to me all the species of *Acrothyra* are of Middle Cambrian age. *A. gregaria* is the only species from the Pacific Province.

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

Genus NISUSIA Walcott

See Mong. U. S. Geol. Surv., No. 51, 1912, p. 725, for synonymy, description and illustration.

NISUSIA SPINIGERA, new species

Plate 109, figs. 15-17

This is the only species of *Nisusia* known to me from an Upper Cambrian formation. In outline it suggests some of the smaller shells

of *Nisusia festinata* (Billings) (Mong. 51, pl. 100, figs. 1*a*, and 1*h*) from the Lower Cambrian, but it differs from that and the Middle Cambrian species in details of area of ventral valve and outer surface. The area of the ventral valve recalls that of *N. festinata transversa* Walcott (*loc. cit.*, fig. 4 *b*). The area is high and with a broad delthyrium. The deltidium is not preserved. The outer surface (fig. 16) has long strong spines on the stronger radiating costæ and fine spines on the more delicate intermediate costæ.

Dimensions.—A large fragment of a ventral valve indicates a shell 10 to 11 mm. in length with a width of 11 to 13 mm. The other three specimens are much smaller.

Formation and locality.—Upper Cambrian: (63x) Ottertail formation. Wolverine Pass, British Columbia, 11 miles (17.6 km.) southwest of Vermilion Pass, on the Continental Divide.

NISUSIA BURGESSENSIS, new species

Plate 110, figs. 1-8

This species differs from *Nisusia alberta* Walcott (pl. 111, figs. 1, 1*a* and Mong. 51, p. 726, pl. 100, figs. 3, 3*a-d*) in its somewhat finer radiating costæ and concentric lines of growth. As far as can be determined from the compressed shells the area of the ventral valve is also lower and the valves are smaller.

A small specimen (fig. 1) has a few long, slender, curved spines attached to its outer margin, and older shells show small nodes on the costæ that served as the base of the spines.

The ventral valve is quite convex and the dorsal moderately so; usually the dorsal valves are flattened and the ventral valves more or less distorted.

Dimensions.—A large dorsal valve 15.5 mm. in length has a maximum width of 23 mm. The ventral valves are so flattened and distorted by compression in the hard shale that none of them preserve their original form.

This fine species of *Nisusia* is the Middle Cambrian representative of *N. festinata* (Billings) (Mong. 51, pl. 100) from the Lower Cambrian. As far as now known it occurs only with the Burgess shale fauna near Burgess Pass.

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

NISUSIA (JAMESELLA) ORIENS, new species

Plate 110, figs. 9-14*a*

Among described species *N.* (*J.*) *oriens* may be compared in form with *N.* (*J.*) *perpasta* (Pompecki) (Mong. 51, pl. 101, figs. 1, 2, 3) from the Lower Cambrian of Bohemia, but it differs greatly in not having strong radiating costæ and an elevated apex to the ventral valve; it also differs from all described species of *Nisusia* and *Jamesella* in the character of the surface costæ which are very fine and but slightly elevated.

The cardinal area of the ventral valve is high and divided midway by a large delthyrium that has a convex deltidium, but how far the latter extends over the delthyrium has not been determined; the cardinal area of the dorsal valve is low and divided by a broad delthyrium that was more or less covered by a convex deltidium.

Dimensions.—A large ventral valve 9 mm. in length has a maximum width of 12.5 mm., and the tongue of the median furrow extends 4.5 mm. beyond the plane of the side margin of the valve. A convex dorsal valve 8 mm. in length has a maximum width of 12.5 mm. Marked characters of this species are the deep, broad median sinus with its prolonged tongue and the high area of the ventral valve, the strongly and uniformly convex dorsal valve with its low area, and almost entire absence of a median range. Young shells have subequally convex valves and only traces of a median sinus on the ventral valve.

N. (*J.*) *oriens* ranges through quite a thickness of sandstone and arenaceous limestone about Forteau Bay.

Formation and locality.—Lower Cambrian: (41d) Reddish gray limestones of lower part of Archæocyathinæ zone, west side of Forteau Bay. The species also occurs (41b) in the lower 30 feet (9.1 m.) of the section at Forteau Point; (41c) 65 and 80 feet (19.8 and 24.3 m.) above base of Archæocyathinæ reef at Point Armour on the east side of Forteau Bay, and at 41v, Schooner Cave on west side of L'Anse au Loop.

All localities on north shore of Straits of Belle Isle, Labrador, Canada.

Genus WIMANELLA Walcott

See Mong. U. S. Geol. Surv., No. 51, 1912, p. 745 for synonymy, description, and illustration.

WIMANELLA BOREALIS, new species

Plate 111, figs. 2-4

This shell in general form resembles *Wimanella ? anomala* from the Middle Cambrian shales of Alabama (Mong. 51, p. 745, pl. 87, figs. 1, 1*a-c*). It differs in having slightly stronger radiating ribs and in the sharper extension of the cardinal angles. Traces of the main vascular trunks occur on the natural cast of the interior of a ventral valve. This feature and the fine radiating ribs serve to bring the species near to the finer ribbed species of *Billingsella.*

Formation and locality.—Middle Cambrian: (61v) Titkana formation; gray shaly limestone in massive beds, on west slope of Titkana Peak, above Hunga Glacier, 3.75 miles (6 km.) northeast of summit of Robson Peak, northwest of Yellowstone Pass, western Alberta, Canada.

WIMANELLA OCCIDENS, new species

Plate 111, figs. 5-7

This is a rather thick calcareous shell with a smooth outer surface, high area on the ventral valve, a strong tripartite umbonal area and a well marked visceral area on both valves and a general outline like that of *Wimanella harlanensis* (Walcott) (Mong. 51, pl. 87, figs. 5, 5*a-c*). It is a smaller shell than the latter and occurs well up in the Upper Cambrian. There are a number of specimens in the collection but none finely preserved.

Dimensions.—The average size of the ventral valve is about 10 mm. in length by 10 mm. in maximum breadth. A dorsal valve 7.5 mm. long has a maximum width of 10 mm.

Formation and locality.—Upper Cambrian: (641) Lyell formation. Gray limestone of upper part of 1b of section. Locality: South slope of ridge of Sullivan Peak, north side of Glacier Lake Canyon about 0.25 mile (0.4 km.) east of foot of Southeast Lyell glacier and about 48 miles (77.3 km.) northwest of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

Genus BILLINGSELLA Hall and Clarke

See Mong. U. S. Geol. Surv., No. 51, 1912, p. 749, for synonymy, description and illustration.

BILLINGSELLA ARCHIAS, new species

Plate 112, figs. 1-5

This species is known only from more or less exfoliated biconvex valves showing imperfectly the cast of the visceral areas and main

vascular sinuses. The interior of the ventral valve has a trifid, umbonal cavity, and strong main vascular trunks. The interior of the dorsal valve has an elongate visceral area with well defined lines of advance of the anterior and posterior adductor muscle scars extending far toward the front of the valve. Surface with fine, rounded radiating ribs with interspaces about the same width as the ribs. Shell thin, structure unknown. The shell usually adheres to the matrix to such an extent that only a few fragments of the outer surface are shown by the specimens in the collection.

Dimensions.—A ventral valve 10 mm. in length has a maximum width of 10.5 mm. on the plane of the margins of the valves.

The cardinal margin is a little shorter than the maximum width of the valve, which gives the shell a slightly rounded outline.

Among known species *B. archias* recalls *B. striata* Walcott (Mong. 51, pl. 86, fig. 4, 4*a-c*) by its surface ribs, and *B. exporecta Linnarsson* (Mong. 51, pl. 88, figs. 1, 1*a-l*) by the strongly marked interiors of the valves.

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.

Ozarkian: (16u) Mons formation. Beds of dove gray limestones 30 inches (76.2 cm.) thick, interbedded in gray argillaceous shale. South end of Brisco Range, north side of Sinclair Canyon about 600 feet (182.8 m.) above the creek and 700 feet (213.3 m.) west of Radium Hot Springs, British Columbia, Canada.

BILLINGSELLA OLEN, new species

Plate 111, figs. 8, 9

The specimens of this species are not well preserved, but they indicate a shell with clearly defined rounded radiating ribs such as occur on *B. retroflexa* (Matthew)[1] and *B. rominger* Barrande.[1] Partial casts of the interior of the dorsal valve outline an umbonal cavity and rather strong vascular sinuses that extend nearly to the anterior margin of the valve.

The largest specimen, a dorsal valve, has a length of 6 mm., with a width of 8.5 mm. at the hinge line.

[1] See Mong. U. S. Geol. Surv., pt. 11, 1912, pl. 90, figs. 1, 1*a*, 1*b*, and figs. 2*e*, 2*f*.

This is the most recent species of the genus known to me, and the second in the Mons formation. It is in the faunule next above the *Hungaia* faunule in which *B. archias* occurs. It differs from the latter species in its smaller size, outline of the valves, and more coarsely ribbed outer surface.

Formation and locality.—Ozarkian: (21j) Mons formation. Kicking Horse Canyon above third bridge on Canadian Pacific Railway, about 2.5 miles (4 km.) east of Golden, British Columbia, Canada.

BILLINGSELLA ORIGEN, new species

Plate 121, figs. 1-3

This is a small shell with fine radiating surface costæ and a well defined median sinus on the dorsal valve. It differs from *B. archias* and *B. olen* Walcott in being more transverse and in having finer radiating surface costæ.

Formation and locality.—Ozarkian: (17t) Mons formation; in thick layers of gray limestone near top of Mons outcrop interbedded in hard shale; west slope of Sabine Mountain, 400 feet (121.9 m.) above south end of Columbia Lake, 2.25 miles (3.6 km.) north of Kootenay River Bridge, and about 2 miles (3.2 km.) northeast of Canal Flat Station, Canadian Pacific Railway, British Columbia, Canada.

Genus PROTORTHIS Hall and Clarke

See Mong. U. S. Geol. Surv., No. 51, 1912, p. 738, for synonymy, description and illustration of species.

PROTORTHIS IONES, new species

Plate 113, figs. 1-7

All of the larger shells are more or less compressed in the somewhat shaly limestone, but from the small shells we learn that the ventral valve was moderately convex and with the beak extending over a rather low area the character of which is unknown. The dorsal valve is slightly convex with a shallow median sinus gradually widening from the beak to the front; cardinal area low with indication of a broad delthyrium. The outline of the valves is transversely subquadrate and roughly semicircular.

Outer surface marked by fine, rather sharp radiating ribs that increase in number towards the front by interstitial ribs coming in between the long ribs. Shell substance fibrous and finely punctate at least in the outer layer. An imperfect interior of the ventral valve indicates a trifed umbonal cavity with strong main vascular sinuses

extending forward to the anterior third of the length of the valve. The interior of the dorsal valve shows a broad, short median septum, the impression of the posterior adductor muscle scars and the main vascular sinuses.

Dimensions.—A ventral valve 14 mm. in length has a maximum width of 18 mm. The proportions of the dorsal valve are the same except it is a little shorter.

The reference of this species to *Protorthis* is based on its fibrous, punctate shell, finely ribbed exterior surface, and the interior of the dorsal valve.

Formation and locality.—Ozarkian: (65w) Mons formation in 1d of section. North side of Clearwater Canyon, 2 miles (3.2 km.) from divide at head of canyon and about 21 miles (33.7 km.) in an air line north, 2° west, of Lake Louise Station on the Canadian Pacific Railway. (66 o) Mons formation in light gray limestone of 1a of section. 8.7 miles (13.9 km.) northeast in an air line of Lake Louise Station on the Canadian Pacific Railway at the east foot of Fossil Mountain, Alberta, Canada.

A single fragmentary specimen from the upper Saskatchewan River appears to belong to this species. It comes from a ridge on east side of canyon 3 miles (4.8 km.) south of Wilcox Pass, North Fork of Saskatchewan River, Alberta, Canada.

Ordovician: (16z) Sarbach formation; thin-bedded dark argillaceous limestone in thick bands; Brisco-Stanford Range, about half way between second and third bridges, from mouth of Sinclair Canyon, in cliff on both sides of canyon, British Columbia, Canada.

Ordovician: (21 o) Sarbach formation; buff brown and gray shaly limestone 75 feet (22.8 m.) below 21n, on low ridges southeast of lower end of Baker Lake and Fossil Mountain about 7 miles (11.2 km.) northeast of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

PROTORTHIS PORCIAS, new species

Plate 111, figs. 10-11

This species which is associated with *Protorthis iones* Walcott, differs from the latter in having very fine, even and regular radiating ribs. A small ventral valve has a strong cardinal area with an open delthyrium, but as the beak is broken off there is no evidence of the presence of plates closing a part of the delthyrium.

The specimens of the dorsal valve indicate that this is a more transverse and smaller shell than *P. iones*.

Formation and locality.—Ozarkian: (65w) Mons formation in 1d of section. North side of Clearwater Canyon, 2 miles (3.2 km.) from divide at head of canyon and about 21 miles (33.7 km.) in an air line north, 2° west, of Lake Louise Station on the Canadian Pacific Railway. (65l) Same as 65w, but in 1c of section. (66p) Light gray limestone of 1b of section 8.7 miles (13.9 km.) northeast in an air line of Lake Louise Station on the Canadian Pacific Railway at the east foot of Fossil Mountain, Alberta, Canada. (16q) Thin-bedded gray limestone, Brisco Range, about 2 miles (3.2 km.) up Sinclair Canyon from Radium Hot Springs on north side of canyon near north end of 3d bridge on Banff-Windermere motor road, British Columbia, Canada.

A specimen from the upper Saskatchewan River (67h) indicates the presence of this species 3 miles (4.8 km.) south of Wilcox Pass, Alberta, in cliffs of the Mons limestones.

Ordovician: (67k) Sarbach formation; gray limestone, 2.5 miles (4 km.) from divide at head of Clearwater River Canyon, 21 miles (33.7 km.) north, 5° west of Lake Louise Station on the Canadian Pacific Railway. (21 o) Sarbach formation; buff brown and gray shaly limestone 75 feet (22.8 m.) below 21n, on low ridges southeast of lower end of Baker Lake and Fossil Mountain, about 7 miles (11.2 km.) northeast of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

P. porcias and *iones* Walcott are the only species found both in the upper Mons formation of the Ozarkian and the superjacent Sarbach formation of the Ordovician. This occurs in the Clearwater Canyon section, also to the south, where the species is found in the Mons of Fossil Mountain, just north of Baker Lake, and in the Sarbach of Brachiopod Mountain on the south side of Baker Lake. The presence of a fibrous shell in the Mons is the first instance known to me of its occurrence below the Ordovician (Canadian).

Genus EOORTHIS Walcott

See Mong. U. S. Geol. Surv., No. 51, 1912, p. 772, for synonymy, description and illustrations.

EOORTHIS BELLICOSTATA, new species

Plate 113, figs. 8-14

In general outline and size this species is most like *E. wichitaensis* (pl. 116 figs. 1-10). It differs in its uniform, regular and delicate sharp radiating surface costæ, which are beautifully preserved in the fine, hard Burgess shale. The surface costæ recall in their uniform

size and regular arrangement the costæ of some specimens of *Billingsella coloradoensis* (Shumard). See Mong. 51, pl. 85, fig. 1b.

A few casts of the interior of ventral valves show the rather narrow cardinal area with a delthyrium of medium width and apparently open, as no traces of a deltidium appeared in the compressed shells; a narrow, short cardinal process extends from the posterior margin to a short distance in front of the delthyrium; teeth short and small. The interior of the dorsal valve has a narrow cardinal area, broad delthyrium and short cardinal process; anterior adductor muscle scars rather large.

Dimensions.—The largest ventral valve among several hundred specimens has a length of 13.5 mm. with a maximum width of 13.5 mm.; a dorsal valve with a length of 9.5 mm. has a maximum width of 12.5 mm. The average shell is from 2 to 3 mm. smaller.

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

EOORTHIS DESMOPLEURA (Meek)

See Mong. U. S. Geol. Surv., No. 51, 1912, p. 777, pl. 96, figs. 1, 1*a-r*, for synonymy, description, and illustration.

This species is strongly characterized by its "sharply defined, slightly curved, unequal radiating plications, and finer unequal striæ, which on the central region of the valves are more or less gathered into five or six fascicles, the middle one of which corresponds to the sinus in the other valve" (Meek). In 1912 I illustrated one of the type specimens of *E. desmopleura* (*loc. cit.*, pl. 96, fig. 1*h*) along with a number of other specimens from the same general horizon and locality. In restudying the species in connection with somewhat similar forms from the Lower Ozarkian of Alberta, I find that two species are figured on plate 96 of 1912 as *E. desmopleura*. As now restricted the latter species is represented by figures 1, 1*a*, 1*b*, 1*c*, 1*d*, 1*e*, 1*g*, 1*h*. Figures 1*i-r* represent a new species *E. fascigera* and figure 2, which is designated as the variety *nympha* of *E. desmopleura*, is now raised to the rank of species.

With the above changes *E. desmopleura* (Meek) is restricted to localities 186, 186a, 187, 360f, as listed in 1912 (Mong. 51, p. 777), all of which are in the Lower Ozarkian west of Colorado Springs, Colorado. A somewhat similar form occurs at locality 30w, Notch Peak, House Range, Utah. With better specimens it is not improb-

able that the 30u specimens would be found to belong to some other species.

EOORTHIS FASCIGERA, new species

Plate 117, figs. 1-9

Eoorthis desmopleura (Meek), Mong. U. S. Geol. Surv., 1912, No. 51, pt. ii, pl. 96, figs. 1*i* to 1*r*.

This species was included by Walcott with *Eoorthis desmopleura* (Meek), but with further study of the types of that species and the group of shells having a more or less fasciculate arrangement of the radiating surface ribs it becomes necessary to remove the latter from *E. desmopleura*. They differ in being more transverse in outline, uniformly smaller size, and in the peculiar grouping of the surface radiating plications and raised lines. Usually there are four or five sharply sloping ridges radiating from the apex to the anterior margin of the shell, with the cardinal slopes ornamented only by the very fine radial raised lines; these lines cover the slopes of the strong plications and any spaces that may exist between them. The lines are well shown on figures 1-5. Some of the specimens referred to *E. desmopleura* have fascicles of sharp plications with very fine raised lines between them but none of them are exactly similar to those of *E. fascigera*.

Dimensions.—A ventral valve 6.5 mm. in length has a maximum width of 7.5 mm. Dorsal valve 6 mm. long by 8 mm. in maximum width.

E. desmopleura occurs in the Lower Ozarkian and *E. fascigera* in the Upper Cambrian where it is associated with *Syntrophia rotundata* Walcott (Mong. 51, p. 804, pl. 103, figs. 4, 4*a-e*). The horizon indicated is about that of the Franconia formation of Wisconsin which carries *Syntrophia primordialis* Whitfield and the fine species *Eoorthis remnicha* N. H. Winchell.

Formation and locality.—Upper Cambrian: (14k) Deadwood formation, Wolf Creek, Big Horn Mountains, 15 miles (24.1 km.) west-southwest of Sheridan, Wyoming.

(168) Deadwood formation. Tepee Creek, south-southwest of Sheridan, on road to Dome Rock, Sheridan County, Wyoming.

EOORTHIS IOPHON, new species

Plate 114, figs. 1-5; pl. 119, fig. 14

This species is one that has the general form and surface ribs and striæ of *Eoorthis wichitaensis* Walcott (pl. 116, figs. 1-10), from which it differs mainly in the extension of the cardinal angles.

Most of the valves are evenly and gently convex but a few ventral valves have a low mesial fold, and dorsal valves occur with a broad and shallow mesial sinus. The radiating ribs of the outer surface are very narrow, rounded close together and uniform in size, but in some specimens two or three fine ribs occur between the stronger and more elevated ribs. (See fig. 2.)

Dimensions.—The average ventral valve has a length of 8 to 10 mm. and width of 8 to 10 mm., and dorsal valve 7 to 9 mm. in length with a width of 8 to 10 mm.

Formation and locality.—Ozarkian: (65e) Mons formation. Drift block of soft, almost granular gray limestone. Above motor road at Ten Mile Canyon on southwest side of Sawback Range, 10 miles (16 km.) by motor road west-northwest of Banff. (67w) Gray limestone in loose blocks on debris slope of Mons formation. South side of Upper Ranger Brook Canyon, 10 miles (16 km.) in air line west-northwest of Banff, and 2 miles (3.2 km.) north-northeast of Massive Switch on Canadian Pacific Railway. (66q) Light gray limestone, base of 1b of section. 8.7 miles (13.9 km.) northeast in air line of Lake Louise Station on the Canadian Pacific Railway at the east foot of Fossil Mountain, Alberta, Canada.

Mons formation: (17r) Gray limestone interbedded in shale. West slope of 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 Flat Station on Canadian Pacific Railway. (21d) Argillaceous shale and thin layers of dense gray limestone. Northern end of Stanford Range on southeast side of Sinclair Canyon just below Radium Hot Springs Pool, British Columbia, Canada.

EOORTHIS LINEOCOSTA, new species

Plate 115, figs. 3-5

This is one of the largest of the Ozarkian species of *Eoorthis*. The valves are gently convex with a shallow sinus on the dorsal valve. It differs from *E. desmopleura* by its straight, fine ribs that radiate from the umbo just above the apex of the valves to the outer margin. A few fine ribs arise between the long ribs and extend to the front margin. This surface is more like that of *Eoorthis iophon* (pl. 114, fig. 1) than any other species from the Lower Ozarkian known to me.

Dimensions.—A ventral valve 12 mm. in length has a maximum width of 14.5 mm. The dorsal valve is from 1 to 1.5 mm. shorter in length than the ventral valve.

Formation and locality.—Ozarkian: (360a) Manitou formation. Red silicious limestone on west side of Trout Creek below Bergen Park, 7 miles (11.2 km.) north-northwest of Manitou, El Paso County, Colorado.

EOORTHIS OCHUS, new species

Plate 117, figs. 10-13

This species is the representative of *Eoorthis desmopleura* (Meek) which occurs in the Ozarkian of Colorado, Utah, Montana, etc.[1] It differs in having more regularly arranged sharp ribs that have uniform fine, radiating, elevated striæ on their slopes, the striæ also extending over the cardinal slope on the postero-lateral surface of the valves. The ribs and elevated striæ of *E. desmopleura* are not only more irregular in arrangement and number but also less prominent; one example, however, has very regular strong ribs but the elevated striæ are absent. *E. ochus* is a larger shell than *E. fascigera* Walcott (pl. 117 figs. 1-9) and its ribs and elevated striæ are more regular in distribution and character. It has developed the sharp radiating surface fascicles farther than in *E. fascigera;* is less transverse in outline of its valves, and occurs in a considerably higher horizon.

Formation and locality.—Ozarkian: (16u) Mons formation, south end of Brisco Range, north side of Sinclair Canyon about 600 feet (182.8 m.) above the creek and 700 feet (213.3 m.) west of Radium Hot Springs, British Columbia, Canada.

(67t) Gray limestone *2e* of section. Southeast side of Douglas Lake Canyon Valley, 12.75 miles (20.5 km.) east, 5° north of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

EOORTHIS PUTILLUS, new species

Plate 114, figs. 6, 7; pl. 115, fig. 9

There is a wide variation in the strength and character of the radiating ribs of the shells referred to *Eoorthis desmopleura* (Meek) by Walcott (Mong. 51, U. S. Geol. Surv., pl 96). With the accumulation of material from widely separated localities some of the variations may be grouped as indicating distinct species and varieties. One of these that resembles the plano-convex small shells of *E. desmopleura,* occurs in large numbers in a layer of limestone of the Chushina formation. Among these, ventral valves average 5.5 to

[1] See Mong. 51, U. S. Geol. Surv., pt. 1, 1912, p. 777-778.

6.5 mm. in length and width and the dorsal valves 5 to 6 mm. in length and 5 to 6.5 mm. in maximum width. A few are larger and some below the average. None of them equal the size of the type specimens of *E. desmopleura.*

The surface of *E. putillus* is marked by sharply defined radiating plications that increase in number by the intercalation of additional ribs between the main ribs that originate on the umbo just in advance of the beak. The ribs or plications are grouped in fascicles on the central portion of the valves. A shallow median sinus occurs on the dorsal valve and a strong median fascicle of ribs represents a median fold on the ventral valve. There is considerable variation in the strength of the plications or ribs on different shells but all of them are sharp when on a well preserved surface.

When imperfect or abraded the young shells of *E. wichitaensis* Walcott may be mistaken for this species and it is often difficult to decide to which species many of the shells should be referred. *E. putillus* represents a widely distributed species in the Cordilleran area. On the north it occurs in the Mt. Robson District (61q) and to the south in British Columbia it occurs in the Lower Mons fauna (16q) of Sinclair Canyon. It is represented at the following localities.

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, northwest of Yellowhead Pass, in eastern British Columbia, Canada.

Mons formation: (65f) Hard, light gray limestone, upper portion of 1a of section. Block that fell from cliff above southeast Lyell Glacier, about 50 miles (80.4 km.) northwest of Lake Louise Station on the Canadian Pacific Railway. (67w) Gray limestone in loose blocks on slope of Mons formation. South side of Upper Ranger Brook Canyon, 10 miles (16 km.) in air line west-northwest of Banff, and 2 miles (3.2 km.) north-northeast of Massive Switch on Canadian Pacific Railway. (21m) Thick-bedded hard dove colored limestone. On side of brook .5 mile (.8 km.) below Baker Lake at east base of Brachiopod Mountain and east-southeast of Fossil Mountain, 8 miles (12.8 km.) northeast in an air line of Lake Louise Station on the Canadian Pacific Railway. (21m') Thick-bedded hard dove colored limestone 21 feet (6.4 m.) below 21 m. On side of brook .5 mile (.8 km.) below Baker Lake and east-

southeast of Fossil Mountain, 8 miles (12.8 km.) northeast in an air line of Lake Louise Station on the Canadian Pacific Railway.

(16v) Soft gray thin-bedded limestone. Brisco Range north side of Sinclair Canyon about 75 feet (22.8 m.) above the creek just below the fourth bridge on the Banff-Windermere motor road, which is 4 miles (6.4 km.) above the first bridge.

Mons formation: (16y) Compact gray limestone crowded with broken fossils. Brisco Range, north side of Sinclair Canyon about 500 feet (152.4 m.) above stream on edge of cliff and about 400 feet (121.9 m.) up the canyon from the first bridge west on Banff-Windermere motor road. (16y') Compact gray limestone crowded with broken fossils from 25 to 30 feet (7.6 to 9.1 m.) above 16y. Brisco Range, north side of Sinclair Canyon about 500 feet (152.4 m.) above stream on edge of cliff and about 400 feet (121.9 m.) up the canyon from the first bridge west on the Banff-Windermere motor road. (21e) Gray thin-bedded limestones. South end of Brisco Range on northeast side of Sinclair Canyon about 800 feet (243.8 m.) up the canyon from the first bridge west on the Banff-Windermere motor road. (21f) Hard gray limestone interbedded in shale. North end of Stanford Range on southeast side of Sinclair Canyon, 180 to 200 feet (54.8 to 60.9 m.) above first bridge from mouth of canyon, British Columbia, Canada.

A variety closely related to this species occurs at several localities.

Mons formation: (17n) Thin layer gray nodular limestone interbedded in argillaceous shale. North side of Stoddart Creek Canyon near its mouth, six miles (9.6 km.) south of Sinclair Canyon, Stanford Range, on east side of Columbia River Valley. (21i) Thin-bedded gray limestone interbedded in shale. Kicking Horse Canyon above second bridge on Canadian Pacific Railway about 1.6 mile (2.6 km.) east of Golden. (21j) Hard gray limestone interbedded in shales. Kicking Horse Canyon above third bridge on Canadian Pacific Railway, about 2.25 miles (3.6 km.) east of Golden, British Columbia, Canada.

EOORTHIS PUTILLUS LAEVIUSCULA, new variety

Plate 115, figs. 1, 2

This shell averages smaller than *E. putillus* and differs from it in having somewhat finer surface ribs or costæ, and may be considered a finely ribbed variety of the species, although some of the smaller shells of the latter closely resemble it.

Formation and locality. Ozarkian: (67q) Mons formation. Compact gray limestone 200 feet (60.9 m.) from top of 1a of section.

Southeast side of head of Douglas Lake Canyon Valley, 12.75 miles (20.5 km.) east, 5° north of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

(17y) Mons formation; west slope Stanford Range, east side of Columbia River Valley, 5 miles (8 km.) south of Sinclair Canyon and .5 mile (.8 km.) north of Stoddart Creek, British Columbia, Canada.

A very closely allied shell occurs at locality (16y), Mons formation. Compact gray limestone crowded with broken fossils. Brisco Range, north side of Sinclair Canyon about 500 feet (152.4 m.) above stream on edge of cliff and about 400 feet (121.9 m.) up the canyon from the first bridge west on Banff-Windermere motor road. (17x) Gray finely granular limestone. West slope of Stanford Range, east side Columbia River Valley, 5.25 miles (8.4 km.) south of Sinclair Canyon and .25 mile (.4 km.) north of Stoddart Creek. Both in British Columbia, Canada.

EOORTHIS VICINA, new species

Plate 112, figs. 6-9

This is the Lower Ozarkian representative of *E. fascigera* (ante p. 507) of the subjacent Upper Cambrian. Both species have about the same range of variation in the gathering of the fine radiating ribs into fascicles except that in *E. vicina* the fascicles are depressed and less prominent and the average shells are much longer. The valves are rather uniformly and moderately convex and with only a slight mesial fold on the ventral valve and a slight flattening represents the mesial sinus on the dorsal valve.

Dimensions.—A ventral valve 7.5 mm. in length has a maximum width of 9 mm. A dorsal valve 8 mm. in length has a maximum width of 10.5 mm.

Formation and locality.—Ozarkian: (65x) Lower portion of Mons formation, 1f of section in a gray limestone. North side of Clearwater Canyon, 2 miles (3.2 km.) from divide at head of canyon and about 21 miles (33.7 km.) in an air line north, 2° west, of Lake Louise Station on the Canadian Pacific Railway. (67w) Loose blocks of light gray limestone in slopes beneath cliff of Mons formation. South side of Upper Ranger Brook Canyon, 10 miles (16 km.) in air line west-northwest of Banff, and 2 miles (3.2 km.) north-northeast of Massive Switch on Canadian Pacific Railway, Alberta, Canada.

(16u) Mons formation. Beds of dove gray limestone 30 inches (76.2 cm.) thick, interbedded in gray argillaceous shale. South end

of Brisco Range, north side of Sinclair Canyon about 600 feet (182.8 m.) above the creek and 700 feet (213.3 m.) west of Radium Hot Springs, British Columbia, Canada.

EOORTHIS WICHITAENSIS Walcott

Plate 116, figs. 1-10

See Mong. U. S. Geol. Surv., No. 51, 1912, p. 790, pl. 94, figs. 1, 1*a-o*, for synonymy, description, and illustration.

This species is widely distributed and has a considerable range of variation in outline and convexity of the valves and surface ribs and striæ. It is probable that a detailed study of large collections from various localities and stratigraphic zones of the Upper Cambrian and Lower Ozarkian would result in recognizing some variations as typical of certain stratigraphic zones. Such a study is needed not only for this species but for all species and in many cases genera of the Cambrian and Lower Ozarkian faunas.

By an error the specimen represented by figure 1, plate 94, of Mong. 51, was designated as the type of this species although it is more like *E. indianola* Walcott (pl. 97, figs. 2, 2*a-b*) in having a high apex and in the character of its rounded surface ribs. In view of this I wish to designate figure 1f, plate 94, as having the typical form and surface of *E. wichitaensis*. The same type of surface is shown by figures 1*b*, 1*d*, 1*e*, 1*g*, 1*h*, 1*i*. On figures 1, 1*a*, 1*c*, the fine radiating ribs are uniform and close together. On figure 1*d* stronger ribs occur and this feature is increased on figures 1*e-n*. The almost smooth, finely ribbed variety of surface represented by figures 1*p*, 1*q*, 1*r*, 1*s* is designated as the variety *laeviuscula* (Mong. 51, description of pl. 94).

Shells that appear to be identical with or closely related to *O. wichitaensis* Walcott occur at the following localities in Alberta:

Upper Cambrian.—Lyell formation: (64l) Head of Glacier Lake Canyon Valley about 2 miles (3.2 km.) above head of lake. Cliff on north side next to moraine of ice foot of Southeast Lyell glacier; about 48 miles (77.2 km.) northwest of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

(66m) Sawback Range, second canyon northwest of Mount Edith, 4.75 miles (7.6 km.) west-northwest of Banff. (64t) Sawback Range, Ranger Brook Canyon, 10 miles (16 km.) in air line north-northwest of Banff, and 2 miles (3.2 km.) north-northeast of Massive Switch, on Canadian Pacific Railway, Alberta, Canada.

Ozarkian.—The Ozarkian form of this species is similar in average size, surface markings, and outline to the Upper Cambrian specimens, but it scarcely seems probable that the species has so great a vertical range in the formations and that it is the only surviving species of the Upper Cambrian Lyell fauna far up in the Mons formation. On this account I call attention to its presence in the Mons with considerable doubt as to its actual identity with *E. wichitaensis.*

(66q) Mons formation, in 1b of section. 8.7 miles (13.9 km.) northeast in air line of Lake Louise Station on the Canadian Pacific Railway, at the east foot of Fossil Mountain, Alberta, Canada.

(17r) West slope of 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 Flat Station on the Canadian Pacific Railway, British Columbia, Canada.

Genus FINKELNBURGIA Walcott

See Mong. U. S. Geol. Surv., No. 51, 1912, p. 793.

FINKELNBURGIA NOBLEI, new species

Plate 115, figs. 6, 6*a*, 7, 8, 8*a*

Of this species we have portions of the exterior of the valves, two casts of the interior of the ventral valve and fragments of the cast of the interior of a dorsal valve.

The shell was relatively thick with the outer surface marked by fine flattened radiating costæ outlined by sharp, very narrow incised lines; the costæ vary from .5 to .75 mm. in width on the central portions of the shell.

A ventral valve 20 mm. in width has a length of 10 mm. and a depth at the umbo of 5 mm. The cast of the interior of the ventral valve shows a strongly defined umbonal cavity (pseudospondilium) and two strong vascular trunks. A fragment of a cast of the interior of the dorsal valve has the impression of the two anterior adductor muscle scars and the cast of the bases of the main vascular sinuses.

F. noblei is a larger shell than either *F. finkelnburgia* or *F. oscola* Walcott (Mong. 51, pl. 93). Its transverse outline recalls that of *F. oscola* but it differs from the latter in details of the interior of the valves and exterior surface.

Formation and locality.—Upper Cambrian: (73c) Muav formation. Hard gray limestone 200 feet (60.9 m.) above the base. Hermit Creek, Bright Angel Quadrangle (U. S. G. S.), Grand Canyon of the Colorado River, Arizona.

SYNTROPHIDÆ

The family *Syntrophidæ* is represented in the Cordilleran area by the following genera and species:[1]

Swantonia meeki Walcott	(Mong. 51, p. 797)	Lower Cambrian
Syntrophia cambria Walcott	(" " p. 800)	Middle Cambrian
" *nundina* Walcott	(" " p. 802)	Ozarkian
" *? unzia* Walcott	(" " p. 804)	Middle Cambrian
" *isis* Walcott	(*loc. cit.* p. 517)	Ozarkian
" *nisis* Walcott	(" " p. 517)	"
" *nonus* Walcott	(" " p. 518)	"
" *perilla* Walcott	(" " p. 519)	"
Huenella abnormis Walcott	(Mong. 51, p. 805)	Upper Cambrian
" *icetas* Walcott	(*loc. cit.* p. 520)	Ozarkian
" *juba* Walcott	(" " p. 521)	Ozarkian
" *hera* Walcott	(" " p. 520)	Upper Cambrian
" *lesleyi* Walcott	(Mong. 51, p. 807)	Ozarkian
" *simon* Walcott	(*loc. cit.* p. 521)	"
" *texana* Walcott	(" " p. 522)	Upper Cambrian
" *? wcedi* Walcott	(p. 522)	" "
Clarkella montanensis Walcott	(Mong. 51, p. 810)	Ozarkian

For genera and species from other localities see Cambrian Brachiopoda, 1912.[2]

Genus SYNTROPHIA Hall and Clarke

Synonymy. See Mong. U. S. Geol. Surv. No. 51, 1912, p. 798.

In referring to this genus in 1912 I wrote: "The Cambrian type of *Syntrophia* is *S. rotundata* Walcott of the Upper Cambrian. It has a spondilium in each valve supported by a median septum, and a short area divided by a large open delthyrium." A second species was described and illustrated, *S. alata* Walcott, which has a similar structure. Several other species, notably *S. calcifera* Billings, were referred to *Syntrophia* on account of their external form, and in the case of *S. calcifera* the apparent evidence in one of the types (Mong. 51, pl. 104, fig. 1*b*) of a spondilium and median septum. Several species were found to have a pseudospondilium attached directly to the inner surface of each valve and at the same time to have a more or less radially plicated or ribbed surface; for these the genus *Huenella* was proposed (*loc. cit.*, p. 805) and seven species referred to it, *H. texana* being selected as the genotype. This species has a wide range in the radial plication of its surface on both valves. They may

[1] Reference to Mong. U. S. Geol. Surv., No. 51, 1912, will be indicated in this list by Mong. 51 and page, and to this paper by *loc. cit.* and page.

[2] Mong. U. S. Geol. Surv. No. 51, 1912, pp. 796-810

be covered with plications (Mong. 51, pl. 103, fig. 1*e*) or they may have a few (figs. 1*f*, 1*g*) or only a single plication (fig. 1*c*). Another species *H. abnormis* Walcott (Mong. 51, pl. 103, figs. 2, 2*a-e*) has a similar variation in surface character. This variation from the completely plicated or ribbed surface to the smooth shell has made it very difficult to assign the smooth surfaced species to either genus with certainty if the interior of the valves is unknown. I referred several of them to *Syntrophia* (Mong. 51, pp. 798-804) but with the discovery of interiors showing a pseudodeltidium they should be referred to *Huenella* or, if a new genus is to be created for the smooth nonplicate shells, to that new genus. At present I am not prepared to propose such a genus. Specimens of *Huenella texana* with a smooth surface largely predominate in a limestone from Cold Creek Canyon, Texas, (Loc. 71) while the plicated surface predominates among the shells from the limestone of Pack Saddle Mountain (Loc. 68). For the smooth shells I proposed the name of *H. texana laeviuscula* (Mong. 51, p. 808) but this name would equally well apply to the smooth shells from other localities where the plicated shells predominate. Among other species *Camerella calcifera* Billings (Mong. 51, p. 800, pl. 104, figs. 1, 1*a-i*) appears to be a smooth form of *Huenella* but one of the type specimens and a transverse section cut across in front of the beak appears to show a septum supporting a spondilium.

The new species described in this paper and referred to *Syntrophia* may be smooth surface forms of *Huenella* but this cannot now be determined.

SYNTROPHIA cf. CALCIFERA

Syntrophia calcifera (Billings), see Mong. U. S. Geol. Surv., No. 51, 1912, p. 800, pl. 104, figs. 1, 1*a-i*.

A number of specimens of a species of *Syntrophia* that cannot be readily separated from typical forms of *S. calcifera* occur in the central portion of the Mons formation. The species is referred to the Lower Ordovician in Monograph 51, but at present it is referred to the Ozarkian as defined by Ulrich.

Formation and locality.—Ozarkian: (16u) Mons formation. Dove gray limestone on north side of Sinclair Canyon, 600 feet (182.8 m.) above the creek and 700 feet (213.3 m.) west of Radium Hot Springs.

(16y) Compact gray limestone, Sinclair Canyon, 500 feet (152.4 m.) above stream on edge of cliff and about 400 feet (121.9 m.) up the canyon from the first bridge west on Banff-Windermere motor road.

(21e) Gray, thin-bedded limestones, Sinclair Canyon, about 800 feet (243.8 m.) up the canyon from the first bridge west on Banff-Windermere motor road. South end of Brisco Range, British Columbia, Canada.

SYNTROPHIA ISIS, new species

Plate 117, figs. 14-17

The general form of the valves is much like that of *Syntrophia campbelli* Walcott and *S. rotundata* Walcott (Mong. 51, p. 801 and pl. 103, figs. 4, 4*a-c*) except that the mesial fold of the dorsal valve extends from near the beak to the front margin and the ridges on the side of the mesial furrow of the ventral valve are much stronger, in this respect resembling the dorsal valve of *Huenella billingsi* Walcott (Mong. 51, pl. 102, figs. 5, 5*a, b*).

Dimensions.—A ventral valve 5.5 mm. in length on the median line has a maximum width of 6.25 mm. Dorsal valve 7 mm. long on the median line has a maximum width of 9 mm. Measurements on plane of the margins of the shell.

S. isis is fairly abundant and it occurs in the Cordilleran area from Glacier Lake southeast for 49 miles (78.8 km.) where it is found at Fossil Mountain and also at Ranger Canyon in the Sawback Range.

Formation and locality.—Ozarkian: (65f) Mons formation (Upper) in hard light gray limestone, upper portion of 1a of section. Block that fell from cliff above southeast Lyell Glacier, about 50 miles (80.4 km.) northwest of Lake Louise Station on the Canadian Pacific Railway. (66 o) Light gray limestone 1*a* of section 10 feet (3.0 m.) from top. 8.7 miles (13.9 km.) northeast in air line of Lake Louise Station on the Canadian Pacific Railway at the east foot of Fossil Mountain. (64y) Sawback Range, Ranger Brook Canyon, 10 miles (16 km.) in air line west-northwest of Banff, and 2 miles (3.2 km.) north-northeast of Massive Switch, on Canadian Pacific Railway, Alberta, Canada.

A closely related form occurs at locality 16u, Mons formation; beds of dove gray limestone 30 inches (76.2 cm.) thick, interbedded in gray argillaceous shale. South end of Brisco Range, north side of Sinclair Canyon about 600 feet (182.8 m.) above the creek and 700 feet (213.3 m.) west of Radium Hot Springs, British Columbia, Canada.

SYNTROPHIA NISIS, new species

Plate 119, figs. 1-3

This species is strongly characterized by having a median groove on the mesial fold of the dorsal valve, in this respect resembling

Huenella billingsi Walcott (Mong. 51, pl. 102, fig. 5*c*). The ventral valve has a deep broad mesial furrow that starts very near the apex of the valve and extends to the front margin.

This species is rare at Fossil Mountain and has not been recognized elsewhere.

Dimensions.—The largest dorsal valve has a length of 7 mm. on the median line; maximum width 9 mm., with a convexity of about 3.5 mm. Measurements on plane of the margin of the shell.

Formation and locality.—Ozarkian: (66 o) Mons formation (Upper) in light gray limestone of 1a of section, 10 feet (3 m.) from top. 8.7 miles (13.9 km.) northeast in air line from Lake Louise Station on the Canadian Pacific Railway at the east foot of Fossil Mountain, Alberta, Canada.

SYNTROPHIA NONUS, new species

Plate 119, figs. 4-9

S. nonus is a relatively broad transverse form with a short anterior median fold on the dorsal valve and a rather shallow mesial furrow on the ventral valve. The valves are less convex than those of *S. isis*, *S. perilla* and *S. nisis*, in this respect resembling the Ordovician species *S. lateralis* (Whitfield) (Mong. 51, pl. 102, figs. 6*a-e*).

Dimensions.—The largest dorsal valve has a length of 7 mm. and a maximum width of 9 mm. Another dorsal valve is 5.75 mm. in length with a maximum width of 7.75 mm. A ventral valve with a maximum width of 11.5 mm. has a length of 7 mm. Measurements on the plane of the margins of the shell.

The short mesial fold of the dorsal valve is not unlike that of *S. nundina* Walcott (Mong. 51, pl. 102, fig. 4a) but it differs from the latter species in its transverse outline and less convex valves.

Formation and locality.—Ozarkian: (66 o and 66n) Mons formation (Upper) in light gray limestone. 8.7 miles (13.9 km.) northeast in air line from Lake Louise Station on the Canadian Pacific Railway at the east foot of Fossil Mountain. (21m, 21m′) Thick-bedded hard dove colored limestone. On side of brook .5 mile (.8 km.) below Baker Lake at east base of Brachiopod Mountain and east-southeast of Fossil Mountain, 8 miles (12.8 km) northeast in an air line of Lake Louise Station on the Canadian Pacific Railway. (67t) Gray limestone, 2*e* of section, southeast side of head of Douglas Lake Canyon Valley, 12 miles (19.3 km.) east, 5° north, of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

(16y′) Mons formation. Compact gray limestone crowded with broken fossils. Brisco Range, north side of Sinclair Canyon about

500 feet (152.4 m.) above stream on edge of cliff and about 400 feet (121.9 m.) up the canyon from the first bridge west on the Banff-Windermere motor road, British Columbia, Canada.

(17x) Mons formation. Gray finely granular limestone. West slope Stanford Range, east side Columbia River Valley, 5.25 miles (8.4 km.) south of Sinclair Canyon and .25 mile (.4 km.) north of Stoddart Creek, British Columbia, Canada.

SYNTROPHIA PERILLA, new species

Plate 118, figs. 1-7

This is the largest and most abundant species of *Syntrophia* known to me from the Mons formation. It suggests *S. calcifera* (Billings) (Mong. 51, pl. 104, fig. 1, 1*a-i*) in some of its variations and like that species it changes greatly in convexity and outline from the young to its mature stage. This is most marked in the increase of convexity of the valves and the development of the mesial fold and sinus. The older and large shells are rare in the collection, while the young and smaller shells occur in large numbers.

Dimensions.—A large dorsal valve has a length on the median line of 13 mm., with a maximum width of 15.5 mm. A large ventral valve is 14.5 mm. long on the median line and 12.5 mm. in maximum width. Measurements on the plane of the margins of the shell.

Formation and locality.—Ozarkian: (65x) Mons formation (Lower), 1f of section. North side of Clearwater Canyon, 2 miles (3.2 km.) from divide at head of canyon and about 21 miles (33.7 km.) in an air line north, 2° west, of Lake Louise Station on the Canadian Pacific Railway. (66n) Thin-bedded gray limestone, 1a of section 255 feet (77.7 m.) from summit of Mons. 8.7 miles (13.9 km.) northeast in air line of Lake Louise Station on the Canadian Pacific Railway at the east foot of Fossil Mountain, Alberta, Canada.

Shells that appear to be identical with this species occur in the Mons formation, Sinclair Canyon section (16q), and in the upper portion of the Upper Cambrian (64u, 64v) its presence is suggested by three rather small ventral valves.

(16q) Ozarkian: Mons formation. Thin-bedded gray limestone. Brisco Range, about 2 miles (3.2 km.) up Sinclair Canyon from Radium Hot Springs on north side of canyon near north end of 3d bridge on Banff-Windermere motor road and about 15 miles (24.1 km.) from Lake Windermere in Columbia River Valley, British Columbia, Canada.

(64u, v.) Upper Cambrian: Lyell formation Sawback Range, at head of northeast branch of Ranger Brook Canyon, 10 miles (16

km.) north-northwest of Banff and 3 miles (4.8 km.) north-northeast of Massive Switch on Canadian Pacific Railway, Alberta, Canada.

Genus HUENELLA Walcott

Huenella Walcott, 1908. See Mong. U. S. Geol. Surv., No. 51, p. 805.

Huenella differs from *Syntrophia* in having a more or less radial plicate surface and a sessile pseudospondilium instead of a free spondilium supported on a median septum.

There appear to be two species from the typical Mons formation and two that may be from the Upper Cambrian Lyell formation.

The fine ridges or raised lines on the surface of the two species may mean that they represent a genus distinct from *Huenella*. This type of outer surface is unknown to me on any of the species of *Syntrophia*.

HUENELLA HERA, new species

Plate 119, fig. 10

This species is represented by a specimen of the exterior and a natural cast of the ventral valve; it is moderately convex with a strong sinus that at the front is a little wider than the greatest width of the valve; a slight rounded ridge occurs on each side of the sinus and a few low narrow plications occur on the outer slopes and in the sinus. The general appearance of the valve is not unlike that of some ventral valves of *H. texana* Walcott and *H. abnormis* except that it is shorter and more transverse. The shell is exfoliated near the apex so as to show a cast of the pseudospondilium.

Dimensions.—Length 7 mm., maximum width 8 mm., measured on the plane of the margin of the valves.

Compared with other species this ventral valve approaches in form that of *H. simon* (pl. 118), but it is more transverse in outline and the surface plications are much stronger. It is more like some varieties of *H. texana* in its plications.

Formation and locality.—Upper Cambrian: (64w) Lyell formation. Drift blocks of limestone. Sawback Range, Ranger Brook Canyon, 10 miles (16 km.) in air line west-northwest of Banff, and 2 miles (3.2 km.) north-northeast of Massive Switch on Canadian Pacific Railway, Alberta, Canada.

HUENELLA ICETAS, new species

Plate 120, figs. 1-3

This species is characterized by a deep, broad median sinus on the ventral valve and a rather acutely ridged mesial fold on the dorsal

valve that extends from near the posterior margin to the front margin. The surface is marked by about 14 narrow fine radiating ridges each side of the mesial fold of the dorsal valve and slight traces of similar ridges on the mesial fold. The entire surface of the ventral valve is marked by fine radiating ridges similar to those on the dorsal valve.

Dimensions.—A dorsal valve 7.5 mm. in length has a maximum width of 9.5 mm. and a ventral valve 7 mm. long has a maximum width of 9 mm., measured on the plane of the margins of the valves. There is considerable range in the proportions of length and breadth between the young and old shells, also in the strength of the mesial fold and sinus.

The ventral valve may be compared with that of *H. hera* (pl. 119, fig. 10) and the dorsal with that of *H. orientalis* Walcott (Mong. 51, pl. 104, figs. 3*a*, *b*).

Formation and locality.—Ozarkian: (65e) Mons formation (Lower) in soft, almost granular gray limestone. Above motor road at Ten Mile Canyon on southwest side of Sawback Range, 10 miles (16 km.) by motor road west-northwest of Banff, Alberta, Canada.

HUENELLA JUBA, new species

Plate 119, figs. 11-13

This species is characterized by the alate postero-lateral angles of the valves and strong mesial fold and sinus. The outer surface is marked by many fine radiating ridges or raised lines.

The largest shell is represented by a ventral valve 8.5 mm. in length with a width at the hinge line of 19 mm.

Formation and locality.—Ozarkian: (65e) Mons formation (Lower) in soft, almost granular gray limestone. Above motor road at Ten Mile Canyon on southwest side of Sawback Range, 10 miles (16 km.) by motor road west-northwest of Banff, Alberta, Canada.

(17t) Mons formation. Thick layers of gray limestone near top of Mons outcrop, interbedded in hard shale. West slope of Sabine Mountain 400 feet (121.9 m.) above south end of Columbia Lake, and 2.25 miles (3.6 km.) north of Kootenay River Bridge and about 2 miles (3.2 km.) northeast of Canal Flat Station, Canadian Pacific Railway, British Columbia, Canada.

HUENELLA SIMON, new species

Plate 118, figs. 8, 9

This species is based on a ventral valve that has the outline of *H. icetas* (pl 120, figs.1-3.) It differs in having in shells of similar

size a broad, shallow mesial sinus instead of a deep, broad sinus. Surface marked by many radiating fine ridges or raised lines.

Dimensions.—A ventral valve has a maximum width of 10.5 mm. and a length of about 9 mm.

Formation and locality.—Upper Cambrian: (64z) Lyell formation in drift blocks of limestone. Ten Mile Canyon above motor road on southwest side of Sawback Range, 10 miles (16 km.) by motor road west-northwest of Banff, Alberta, Canada.

HUENELLA TEXANA Walcott

Plate 120, figs. 4, 6, 7, 8

Camerella sp. ? Shumard, 1861, Am. Jour. Sci., 2d ser., vol. 32, p. 221.
Syntrophia texana Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28 p. 294.

Since the publication of "Cambrian Brachiopoda" (Mong. U. S. Geol. Surv., No. 51, 1912) two small slabs of limestone collected by Dr. Walter H. Weed have come to hand on which there are a number of beautifully weathered-out valves of this species. These include about the same range of variation in form and outer surface as for *H. texana,* and there are also a number of interiors showing the pseudospondilium, one of which is illustrated in figure 6. Comparison should be made between the illustrations of this species as it occurs in Texas (Mong. 51, pl. 103, figs. 1, 1*a-i*) and those from Wyoming.

Dimensions.—The average length of the Wyoming shells is about 7 mm. and maximum width 8.5 mm., measured on the plane of the margins of the valves. This is about the size of the specimens from Texas.

Formation and locality.—Upper Cambrian: (302g) Gallatin formation. Limestone on north slope of Crowfoot Ridge, south of Gallatin Valley, Yellowstone National Park, Wyoming.

On the same surface with *H. texana* a number of specimens of a finely ribbed species of *Huenella* occur, to which I have given the name *H. weedi.*

HUENELLA ? WEEDI, new species

Plate 120, figs. 5, 7, 8

This species occurs more or less abundantly weathered in relief on the surface of gray limestone in association with *Huenella texana* Walcott. The valves are less convex than those of *H. texana,* in this respect resembling those of *H. simon* (pl. 118, figs. 8, 9). The outer surface is similar to that of some specimens of *Eoorthis, E. wichitaensis* Walcott in having sharp narrow raised radiating ribs with

one or more intercalated ribs between them. The type of surface also occurs in *H. juba* (pl. 119, fig. 13) and *H. icetas* (pl. 120, figs. 2, 3).

Dimensions.—A large, somewhat crushed ventral valve has a length of 8 mm. and a maximum width of 11.5 mm. A dorsal valve 8 mm. in length has a maximum width of 10.5 mm., measured on the plane of the margins of the valves.

Formation and locality.—Upper Cambrian: (302g) Gallatin formation. Limestone on north slope of Crowfoot Ridge, south of Gallatin Valley, Yellowstone National Park, Wyoming.

BRACHIOPODS FROM ISLAND OF NOVAYA ZEMLYA, RUSSIA

Dr. Olaf Holtedahl announced in 1922 the discovery by a Norwegian scientific expedition led by him, of an "Upper Cambrian Fauna of Pacific Type in the European Arctic Region" near the west coast of the southern island of Novaya Zemlya on the peninsula between Bessimyanni and Gribovii Fjords.[1] He noted the presence in the collections of several species of brachiopods and trilobites and correlated them with forms from western North America. Subsequently he sent the collection to me for examination and description.

The rock containing the specimens was carefully broken up in order to secure all the material possible for study. It was soon discovered that the brachiopods were related to species from the lower Ozarkian Mons fauna of the Cordilleran Province, and the trilobites were of post-Cambrian age. The entire fauna will be published in a report of the expedition. Meantime Dr. Holtedahl very kindly gave me permission to publish the brachiopods in this paper.

The brachiopods include: *Lingulella* cf. *desiderata* Walcott, *L. artica* n. sp., *Acrotreta* sp. undt., *Obolus* (*Westonia*) sp. undt., *Billingsella holtedahli* n. sp., *B. ? oppius* n. sp., *Eoorthis sabus* n. sp., *Huenella triplicata* n. sp. All of these have their representatives in the Upper Cambrian, also in the lower Ozarkian.

Most of the associated trilobites are distinctly of a Lower Ozarkian type and some may belong higher in the series.

Sub-genus WESTONIA Walcott

OBOLUS (WESTONIA) sp. undt.

A fragment of shell suggesting the outline of *O.* (*W.*) *finlandensis* Walcott[2] preserves the outer surface with the characteristic irre-

[1] Amer. Jour. Sci., 5th Ser., Vol. 3, 1922, pp. 343-348.

[2] Mong. U. S. Geol. Surv., No. 51, 1912, pl. 48, fig. 3.

gular inosculating transverse surface lines of *Westonia aurora* (Hall),[1] an Upper Cambrian shell.

Formation and locality.—Ozarkian: (67y) Russia, Island of Novaya Zemlya, west coast of southern island, north side of Gribovii Fjord.

Genus LINGULELLA Salter

LINGULELLA cf. DESIDERATA Walcott

Plate 123, figs. 3-5

This species belongs with a group of small forms that are represented by *Lingulella desiderata* Walcott[2] which has a wide area distribution and ranges from the Upper Cambrian into the Mons fornation of the Ozarkian. The Novaya Zemlya specimens are fairly well preserved and appear to be within the range of variation of the western North American species.

Formation and locality.—Ozarkian: (68b) Russia; Island of Novaya Zemlya; west coast of southern island; Mountains 7 km. northwest of the head of Bessimyanni Fjord.

LINGULELLA ARCTICA, new species

Plate 123, figs. 1, 2

This species agrees in size and outline with the various forms of *Lingulella bella* Walcott,[3] except that it is more elongate. There are only two specimens of the dorsal valve. The shell is largely exfoliated and on the cast of the interior the lines of advance of the central and anterior lateral muscle scars and median septum are outlined; the anterior lateral muscle scars extended into the anterior third of the valve. Fragments of the shell show it to have been of medium thickness and marked on the outer surface by fine concentric lines and striæ of growth.

A valve somewhat flattened by compression is 13 mm. in length and has a maximum width of 6.5 mm.

There is no closely related species to *L. arctica* in the Upper Cambrian or in the Mons formation of the Lower Ozarkian. Some of the smaller species from the latter formation are elongate, notably *L. ibicus,*[4] but they are quite distinct in outline of the valves.

Formation and locality.—Lower Ozarkian: (67y) Russia; Island of Novaya Zemlya, west coast of southern island; Gribovii Fjord.

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[1] *Loc. cit.*, pl. 46, 1h.

[2] Mong. U. S. Geol. Surv., No. 51, 1912, pl. 51, figs. 4 and 5.

[3] Mong. U. S. Geol. Surv., No. 51, 1912, p. 481, pl. 19, figs. 2*d-f*.

[4] Smithsonian Misc. Coll., Vol. 67, No. 9, 1924, pl. 108, figs. 5-8.

Genus ACROTRETA KUTORGA

ACROTRETA, sp. undt.

A very small species of *Acrotreta* is represented by several dorsal valves and crushed ventral valves from which the shell has been exfoliated. The cast of the interior of the dorsal valve shows a long, strong median septum such as occurs in both Middle and Upper Cambrian species, also the Mons formation of the Lower Ozarkian, which has two species *A. atticus* Walcott and *A. discoidea* Walcott. The dorsal valve of *A. atticus* is very much like that of the Novaya Zemlya species. The dorsal valves vary from 2 to 3 mm. in diameter.

Formation and locality.—Ozarkian: (67y) Russia, Island of Novaya Zemlya, west coast of southern island, north side of Gribovii Fjord, and (68b) Mountains 7 km. northwest of the head of Bessimyanni Fjord.

Genus BILLINGSELLA Hall and Clarke

BILLINGSELLA HOLTEDAHLI, new species

Plate 123, figs. 6-16

Dr. Holtedahl calls attention to a shell "that may be nearly related to *Billingsella coloradoensis*[1] that is quite abundant. I find that while the species resembles *B. coloradoensis* (Shumard) closely, it differs in its larger size, outline of cardinal angles, and more uniform surface plications.

Some of the smaller shells may belong to another species, but with the material available it seems best to retain them with the larger shells. The surface characters vary owing to the varying amount of exfoliation caused by adhering to the matrix. It is exceptional to find a specimen with the outer surface uninjured.

Formation and locality.—Ozarkian: (67y) Russia, Island of Novaya Zemlya, west coast of southern island, Gribovii Fjord.

BILLINGSELLA ? OPPIUS, new species

Plate 124, figs. 1-8

This species is characterized by the transverse outline of the valve and uniform rather coarse plications which increase in number by intercalation from near the beak towards the front of the valves. The transverse outline and plication of the valves is more like that of *Protorthis billingsi* (Hartt)[2] than either *Billingsella* or *Eoorthis*.

[1] Amer. Jour. Sci., 5th Ser., Vol. 3, 1922, p. 345.

[2] Mong. U. S. Geol. Surv., No. 51, 1912, pl. 99, figs. 1, 1*a-f*.

Formation and locality.—Ozarkian: (67y) Russia, Island of Novaya Zemlya, west coast of southern island, north side of Gribovii Fjord.

Genus EOORTHIS Walcott

Eoorthis Walcott, Mong. U. S. Geol. Surv., No. 51, 1912, p. 772.

EOORTHIS SABUS, new species

Plate 124, figs. 9-15

This species recalls, as Dr. Holtedahl mentions, *Eoorthis wichitaensis* (Walcott). It differs from it in its stronger higher umbo and more abrupt cardinal slopes on the ventral valve. The surface plications and elevated radiating lines vary considerably.

Formation and locality.—Ozarkian: (68b) Russia, Island of Novaya Zemlya, west coast of southern island, mountains 7 km. northwest of the head of Bessimyanni Fjord.

Genus HUENELLA Walcott

See Mong. U. S. Geol. Surv., Vol. 51, 1912, p. 805.

HUENELLA TRIPLICATA, new species

Plate 125, figs. 1-15

Huenella cf. *texana* Holtedahl, 1922, Amer. Jour. Sci., 5th Ser., Vol. III, p. 345, fig. 1. (Illustrates dorsal and ventral valves and compares them with *H. texana* Walcott.)

This species differs from *H. texana,* its nearest representative, in the more uniform distribution of narrow plications on the cardinal slopes, the presence of one or two narrow plications in the strong mesial sinus of the ventral valve, and three strong narrow plications on the high median fold of the dorsal valve.

The cast of the spondilium of the ventral valve is finely preserved in a number of specimens but the main vascular sinuses are somewhat indistinct. The cast of the interior of the dorsal valve shows a small shallow spondilium, anterior and posterior adductor muscle impressions; a rather low area and open delthyrium is preserved on a ventral valve.

The discovery of the genus *Huenella* in Novaya Zemlya by Holtedahl is most interesting, as it is there associated with a lower Ozarkian fauna. In western North America the genus occurs in both the Upper Cambrian and Lower Ozarkian. The species from the latter are *H. orientalis* Walcott, *H. texana* Walcott, and var. *laeviuscula*. *H. icetas* Walcott, and *H. juba* Walcott.

Formation and locality.—Ozarkian: (68b) Russia, Island of Novaya Zemlya, west coast of southern island, mountains 7 km. northwest of the head of Bessimyanni Fjord.

CEPHALOPODA

I have not met with any cephalopods in the Cambrian formations of America. They first appear in the Hungaia zone of the superjacent Lower Ozarkian of the Mt. Robson section and higher up in the upper part of the Mons formation which corresponds in a general way with Etage 3aγ of Brögger's section.[1] He illustrates two species, *Orthoceras attavus,* plate 4, figure 9, by a fragment of a phragmacone of a small conch, and *Orthoceras* n. sp. (pl. 4, figs. 8 and 10) by fragments of a larger conch preserving a portion of the living chamber and the phragmacone. Both of these species may fall in the genus *Ellesmeroceras* Foerste.

The range of variation among the specimens of *Ellesmeroceras robsonensis* from the Chushina formation in the Robson district appears to include the specimens referred to the latter species that occur in association with a different grouping of genera and species which may be several hundred feet higher in the section of the Mons formation in the Glacier Lake district. It is possible that the cephalopods came from the Arctic province and did not reach the Glacier Lake district until long after appearing in the Robson district. In any event their presence with the Hungaia fauna in association with *Symphysurina* indicates a somewhat older fauna than that of the Upper Mons to the southeast.

The identity of *Endoceras (?) monsensis* of the Upper Mons fauna in the Hungaia fauna of the Robson district is more uncertain than that of *Ellesmeroceras robsonensis,* but it is a similar form and strengthens the view that the *Hungaia* fauna of the Chushina formation of the Robson district is allied to that of the Upper Mons.

Genus ELLESMEROCERAS Foerste

See Davidson University Bull., Vol. 19, 1921, p. 265. (Description and illustration of type species *E. scheii.*)

ELLESMEROCERAS ROBSONENSIS, new species

Plate 126, figs. 5-9*a*

Conch straight on both the ventral and dorsal sides. Apical angle 8° as viewed from the ventral side. Conch sometimes compressed

[1] Die Silurischen Etagen 2 und 3, 1882, pp. 30-177.

laterally so as to give a slightly oval transverse section but in most specimens the section is circular. Shell thin and readily broken. No trace of surface ornamentation has been observed.

A round conch 6.5 mm. in diameter at the base of the living chamber has five cameræ of almost equal length on a distance of 5 mm. from the living chamber. In a specimen 4 mm. in transverse diameter there are 5 cameræ in a distance of 4 mm., and another 5.25 mm.in diameter at the apical end has 16 cameræ in a distance of 18 mm. The sutures of the septa slope from the siphuncle along the median line of the ventral side downward and arch slightly backward at the sides and then forward so as to be slightly in advance of their position on the ventral side where they meet the median line on the dorsal side. On some specimens the sutures are almost at right angles to the axis of the conch.

The siphuncle is small, round and oval in compressed conchs; it is in contact with the ventral wall of the conch; in a compressed septum 6 mm. in its dorso-ventral diameter the siphuncle has a dorso-ventral diameter of 2.25 mm. by 1.75 mm. The septa are rather strongly concave so that their depth is equal to the space between the sutures. The siphuncle contracts a little between the septa, which gives it a slightly beaded appearance.

The outer chamber of the conch is not fully preserved, but one specimen indicates that it was slightly expanded towards the upper end.

Observations.—This is a small species of which many fragments are found in association with brachiopods and fragments of trilobites. The largest living chamber in the collection has a diameter of 8 mm. a little in advance of the last cameræ which indicates that the conch was not over 6 to 6.5 cm. in length.

This conch seems to fall within the genus *Ellesmeroceras* as described and illustrated by Foerste. The exact stratigraphic horizon of the type species is in doubt, but as the closely allied form *E. robsonensis* is from the Lower Ozarkian, it may be that the genotype is from the Lower Ozarkian, as it is a straight conch and not curved as are most of the Upper Ozarkian conches in which the siphuncle is in contact with the ventral wall. *E. scheii* Foerste is from Ellesmereland and is tentatively referred to the Canadian (Ordovician) by Foerste.

Formation and locality.—Lower 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.

Mons formation: (64p) Cliff on southeast side of Mons Glacier, above head of Glacier Lake canyon valley, about 50 miles (80.4 km.) northwest of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

Mons formation: (65z) *1a* of section. North side of Clearwater Canyon, 2 miles (3.2 km.) from divide at head of canyon and about 21 miles (33.6 km.) in an air line north, 2° west, of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

Ozarkian: (66n) Mons formation. Thin-bedded gray limestone, *1a* of section, 255 feet (77.7 m.) from summit of Mons. 8.7 miles (13.9 km.) northeast in air line of Lake Louise Station on the Canadian Pacific Railway at the east foot of Fossil Mountain, Alberta, Canada.

A fragment of a somewhat similar form of conch that may belong to *Ellesmeroceras* occurs at locality 30w. Lower Ozarkian: Notch Peak formation. Drift boulder supposed to have been derived from *1a* of section. About 2 miles (3.2 km.) south of Marjum Pass, House Range, Millard County, Utah.

ENDOCERAS (?) MONSENSIS, new species

Plate 126, figs. 4, 4*a*, 4*b*

Conch annulated, straight, laterally compressed so as to give an oval dorso-ventral section. A septum with a major axis of 3.75 mm. has a transverse axis of 2.75 mm.; this specimen of the phragmacone has 5 strong narrow annulations in a distance of 8 mm., with rounded depressions between. No trace of surface ornamentation has been observed. Living chamber and siphuncle unknown.

A specimen 9 mm. in length has 5 cameræ of almost equal length: the sutures of the septa cross the ventral side at the foot of the lower (apical) slope of the annular ridge and slope backward so as to cross the front slope of the next posterior annular ridge midway between the ventral and dorsal median axial line and then curve forward to meet at the dorsal median axial line on the back slope of the annular ridge directly opposite the suture on the ventral side. Septa concave and nearly as deep as the length of the cameræ.

A portion of a phragmacone occurs with the Lower Ozarkian fauna at locality 185z that is similar to that of *E.* (*?*) *monsensis* except that the annular ridges are not as prominent, but as this may result from the condition of preservation, I am tentatively referring the specimen to this species.

Observations.—The largest conch in the collection has a dorso-ventral diameter of 3.75 mm. The outer shell of the conch was thin and readily crushed so as to throw the septa at a very oblique angle to the axis. Specimens are rarely seen even as fragments.

In the absence of surface markings, siphuncle and living chamber, I refer the species to *Endoceras,* pending the discovery of more complete specimens. It has some of the characters of *Ellesmeroceras* but the strong annulations may indicate other differences that may be of generic importance.

Formation and locality.—Lower Ozarkian: (64p) Mons formation, 18 feet (5.4 m.) from top of 1a of field section. Cliff on southeast side of Mons Glacier, above head of Glacier Lake Canyon Valley, about 50 miles (80.4 km.) northwest of Lake Louise Station on Canadian Pacific Railway. (66n) Thin-bedded gray limestone, 1a of section, 255 feet (77.7 m.) from summit of Mons. 8.7 miles (13.9 km.) northeast in air line of Lake Louise Station on the Canadian Pacific Railway at the east foot of Fossil Mountain, Alberta, Canada.

(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.

The specimens from the Chushina formation are very small and slender and may possibly belong to another species.

Lower Ozarkian: (185z) St. Charles formation. Blacksmith Fork Canyon about 9 miles (14.4 km.) east of Hyrum, Cache County, Utah.

NOTOSTRACA SARS

Family TECHNOPHORIDÆ Miller

Technophoridæ Miller, 1889, North Amer. Geol. and Pal., p. 458.

S. A. Miller proposed this term to include the genus *Technophorus,* and referred one species to it, *T. faberi* Miller. He considered the species to be a lamellibranch, where it remained until 1913 when Dr. R. S. Bassler placed *Technophorus* along with *Euchasma, Eopteria* and *Ischyrina* Billings under the Branchiopoda and order *Notostraca,*[1] as he considered that the carapace was folded over on the

[1] Text Book pal. Zittle, Eastman, 1913, p. 733.

median ventral line as in *Apus* and that there was not any hinge line present.

All of the genera of the *Technophoridæ* have the dorsal shield folded sharply over the ventral median line so as to form a bivalve appearing shell that was considered to be that of a lamellibranch; this deception was accentuated by the interior of the carapace, which has on each side a ridge extending down from near the ventral median line more or less obliquely towards the margin of the carapace, and the casts of the interior showed also a strong beak projecting anteriorly. It was quite natural to compare the supposed lamellibranch with *Nuculites* and to refer it to the family *Ctenodontidæ*.

All of the genera mentioned have a strong rib or ribs extending from the highest point on the antero-ventral fold to the postero-lateral angle of the carapace, that gives them a very distinct character that is unlike that of the genus *Ozomia* now proposed for the species occurring in the Lower Ozarkian.

Genus OZOMIA, new genus

Carapace as folded on the median ventral line, equivalue, inequilateral, transverse; rounded subquadrilateral in outline on each side; moderately convex on each side; the margins of the carapace met beneath the dorsal side and gapped a little at the anterior and posterior ends; outer surface smooth. Interior of carapace on each side with a short clavicular-like ridge; adductor muscle scar between the ridge and anterior margin of the carapace.

Genotype.—*Ozomia lucan* Walcott.

Stratigraphic range.—Upper 50 feet (15.2 m.) of the Lower Ozarkian Mons formation.

Geographic distribution.—Cordilleran area from Glacier Lake near the head of the Saskatchewan River, Alberta, Canada, southeast 49 miles (78.8 km.) to Fossil Mountain and head of Douglas Lake Canyon north of Bonnett Peak; also about 800 miles (1287 km.) south in Blacksmith Fork canyon in northern Utah.

OZOMIA LUCAN, new species

Plate 126 figs. 1, 2, 3, 3*a*

This species is known only from natural casts of the interior of the two sides of the carapace; the casts indicate a moderate convexity; a rounded outline with a straight ventral margin from the high point out

to the broadly rounded posterior ends; in some specimens the posterior fourth of the margin slopes upward and the anterior end is almost as broadly rounded as the posterior. The length of the carapace is a little greater than the distance from the median ventral fold to the margins. The largest undistorted specimen in the collection has a height of 9.25 mm. on each side and length of 11.5 mm. The sides gaped slightly at both the anterior and posterior ends, as indicated by the casts. The test was thin on the sides and in all localities and condition of preservation in the different layers of limestone it adheres to the matrix so closely that no traces have been observed of its outer surface; it was probably smooth or finely lined as the casts show only a faint trace of lines radiating from the anterior crest of the fold toward the postero-lateral margins.

The cast of the interior indicates a narrow deep clavicular-like ridge that extends about one-fourth the distance towards the antero-basal margin, or it may be directed towards the postero-basal margin; the two extremes of direction are illustrated by figures 1, 2, 3, pl. 121.

A rather large adductor muscle scar is faintly outlined between the clavicular-like ridge and the anterior margin.

Observations.—This is the only species of the genus known to me.

The type specimens of *O. lucan* are from the upper portion of the Mons formation, locality 66n. The species is also known from the Glacier Lake—Saskatchewan River area and southeast to the northern section of the Sawback Range, Alberta, and in the Blacksmith Fork section of northern Utah.

Formation and locality.—Ozarkian: (66n) Mons formation. Thin-bedded gray limestone, 1a of section, 255 feet (77.7 m.) from summit of Mons. 8.7 miles (13.9 km.) northeast in air line of Lake Louise Station on the Canadian Pacific Railway at the east foot of Fossil Mountain. (64p) 18 feet (5.4 m.) from top of 1a of field section. Cliff on southeast side of Mons glacier, above head of Glacier Lake Canyon Valley, about 50 miles (80.4 km.) northwest of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada. (65g) Block that fell from cliff above southeast Lyell Glacier, about 50 miles (80.4 km.) northwest of Lake Louise Station on the Canadian Pacific Railway. (65z) 1a of section. North side of Clearwater Canyon, 2 miles (3.2 km.) from divide at head of canyon and about 21 miles (33.6 km.) in an air line north, 2° west, of Lake Louise Station on the Canadian Pacific Railway. (67r) Gray limestone in upper portion of Mons 16 feet (4.8 m.) from top of formation.

Southeast side of head of Douglas Lake Canyon Valley, 12.75 miles (20.5 km.) east, 5° north, of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

(185z) St. Charles formation, in limestones about 200 feet (60.9 m.) below No. 1 of section of 1912. Blacksmith Fork Canyon about 9 miles (14.4 km.) east of Hyrum, Cache County, Utah.

DESCRIPTION OF PLATE 106

PAGE

Micromitra zenobia Walcott 481

FIG. 1. (×2.) Ventral and dorsal valve, flattened, broken and a little distorted on the surface of shaly limestone. U. S. Nat. Mus., Cat. No. 69631.

2. (×2.) A ventral and dorsal valve compressed, broken and transversely distorted on surface of shaly limestone. U. S. Nat. Mus., Cat. No. 69632.

3. (×2.) A small ventral and dorsal valve illustrating transverse distortion. U. S. Nat. Mus., Cat. No. 69633.

4. (×3.) A ventral and dorsal valve vertically distorted. U. S. Nat. Mus., Cat. No. 69634.

5. (Natural size.) A distorted dorsal valve preserving concentric surface striæ. U. S. Nat. Mus., Cat. No. 69635.

6. (Natural size.) A dorsal valve shortened by distortion. U. S. Nat. Mus., Cat. No. 69636.

7. (Natural size.) A distorted ventral valve that has the outline of a dorsal valve of *Lingulella*. U. S. Nat. Mus., Cat. No. 69637.

The specimens represented by figs. 1-7 are from locality 61j, Middle Cambrian: Stephen formation; buff weathering band of calcareo-argillaceous shale; west slope of Mt. Field, B. C., Can.

Obolus ion Walcott 482

FIG. 8. (×4.) A less acuminate ventral valve than fig. 9. U. S. Nat. Mus., Cat. No. 69638

9. (×4.) A broad form of ventral valve. U. S. Nat. Mus., Cat. No. 69639.

10. (×4.) A partially exfoliated dorsal valve. U. S. Nat. Mus., Cat. No. 69640.

The specimens represented by figs. 8-10 are from locality 16q, Ozarkian: Mons formation; thin-bedded gray limestone; Brisco Range, Sinclair Canyon, B. C., Can.

Obolus perone Walcott 484

FIG. 11. (×2.) Flattened and partially eroded dorsal valve. U. S. Nat. Mus., Cat. No. 69641.

The specimen represented by fig. 11 is from the Upper Cambrian: Ottertail limestone, Moose Creek, southeast of Field, B. C., Can.

Obolus leda Walcott 483

FIG. 12. (×6.) A ventral valve doubtfully referred to this species. U. S. Nat. Mus., Cat. No. 69642.

13. (×6.) Ventral valve. The front margin outlined from fig. 14. U. S. Nat. Mus., Cat. No. 69643.

14. (×6.) Interior of ventral valve. U. S. Nat. Mus., Cat. No. 69644.

15. (×6.) Exterior of dorsal valve. U. S. Nat. Mus., Cat. No. 69645.

The specimens represented by figs. 12-15 are from locality 30m, Ozarkian: Notch Peak formation; compact dove-colored limestone, north slope of Notch Peak, House Range, Utah.

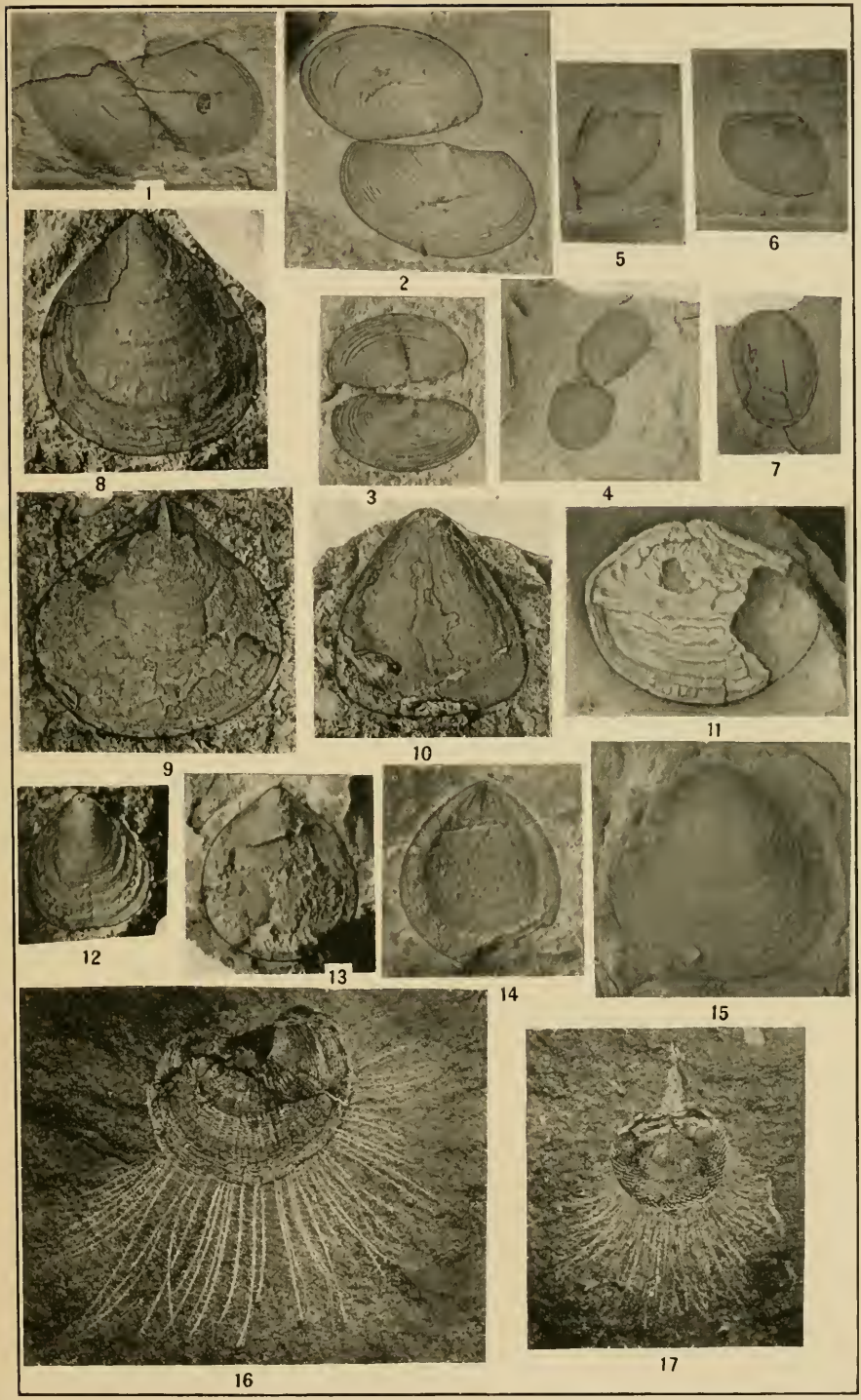
Micromitra (Iphidella) pannula (White) 481

FIG. 16. (×3.) A ventral valve with fine setæ beautifully preserved. U. S. Nat. Mus., Cat. No. 69646.

17. (×3.) Ventral valve preserving pedicle and setæ. U. S. Nat. Mus., Cat. No. 59801.

This specimen was illustrated in 1913, Research in China, Vol. 3, Cambrian Faunas of China, pl. 1, fig. 13.

The two specimens represented by figs. 16 and 17 are from locality 35k, Middle Cambrian: Burgess Shale, north of Field, B. C., Can.



MICROMITRA-OBOLUS.

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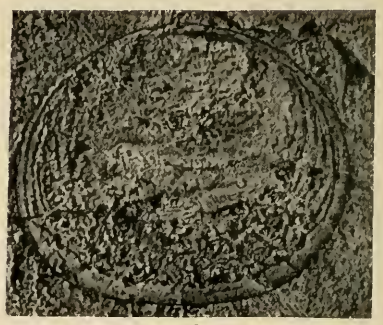

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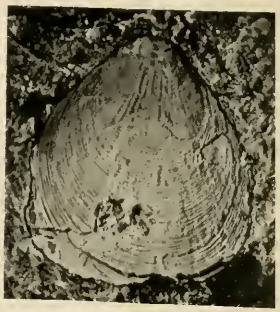

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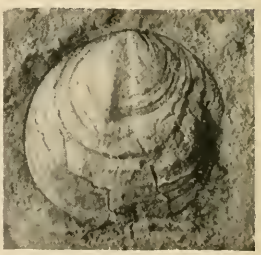
7*a*



8

OBOLUS.

DESCRIPTION OF PLATE 107

PAGE

Obolus myron Walcott 484

FIG. 1. (×6.) Interior of a ventral valve flattened in shaly limestone so as to give it too much width. U. S. Nat. Mus., Cat. No. 69647.

2. (×6.) Dorsal valve associated with the ventral valve fig. 1, widened by compression. U. S. Nat. Mus., Cat. No. 69648.

3. (×6.) Exfoliated dorsal valve in limestone preserving the natural outline. U. S. Nat. Mus., Cat. No. 69649.

The specimens represented by figs. 1-3 are from locality 63x, Upper Cambrian: Ottertail formation; thin-bedded limestone, Wolverine Pass, B. C., Can.

Obolus tetonensis Walcott 484

FIG. 4. (×4.) Partially exfoliated dorsal valve. U. S. Nat. Mus., Cat. No. 69650.

5. (×4.) Exfoliated ventral valve with front margin broken. U. S. Nat. Mus., Cat. No. 69651.

The specimens represented by figs. 4 and 5 are from locality 61q, Ozarkian: Chushina formation, gray limestone, Robson Peak District, B. C., Can.

Obolus teuta Walcott 486

FIG. 6. (×4.) Partially exfoliated ventral valve. U. S. Nat. Mus., Cat. No. 69652.

The specimen represented by fig. 6 is from locality 16r, Ozarkian: Mons formation; Brisco Range, Sinclair Canyon, B. C., Can.

Obolus (Westonia) tertia Walcott 487

FIGS. 7, 7*a*. (×4.) Exterior view of ventral valve and side outline showing convexity. U. S. Nat. Mus., Cat. No. 69653.

8. (×4.) Dorsal valve associated with specimen represented by fig. 7. U. S. Nat. Mus., Cat. No. 69654.

The specimens represented by figs. 7, 7*a*, 8, are from locality 67n, Ordovician: Sarbach formation, in a hard, dirty gray, limestone, northeast slope of Fossil Mountain, Alberta, Can.

DESCRIPTION OF PLATE 108

PAGE

Obolus (Fordinia) nestor Walcott 488

FIG. 1. (×4.) Partially exfoliated dorsal valve in which the visceral area is outlined. U. S. Nat. Mus., Cat. No. 69655.

2. (×6.) A small ventral valve associated with the specimen represented by fig. 1. U. S. Nat. Mus., Cat. No. 69656.

The specimens represented by figs. 1 and 2 are from locality 64w, Upper Cambrian: Lyell formation, Sawback Range, Alberta, Can.

Lingulella cf. *desiderata* Walcott 490

FIG. 3. (×6.) Ventral valve with fine concentric striæ. U. S. Nat. Mus., Cat. No. 69657.

4. (×6.) A small convex dorsal valve. U. S. Nat. Mus., Cat. No. 69658.

The specimens represented by figs. 3 and 4 are from locality 61q, Ozarkian: Chushina formation; gray limestone, Robson Peak, B. C., Can.

Lingulella ibicus Walcott. (See pl. 109, figs. 8, 9) 491

FIG. 5. (×6.) A finely preserved ventral valve. U. S. Nat. Mus., Cat. No. 69659.

6. (×6.) U. S. Nat. Mus., Cat. No. 69817.

7. (×4.) A dorsal valve varying slightly in outline from fig. 8. U. S. Nat. Mus., Cat. No. 69661.

8. (×4.) A dorsal valve associated with the specimen represented by fig. 5. U. S. Nat. Mus., Cat. No. 69662.

The specimens represented by figs. 5-8 are from locality 61q. Same as for figures 3, 4 above.

Lingulella nepos Walcott 493

FIG. 9. (×6.) Partially exfoliated ventral valve. U. S. Nat. Mus., Cat. No. 69663.

10. (×6.) Well preserved dorsal valve. U. S. Nat. Mus., Cat. No. 69664.

11. (×6.) A small ventral valve preserving the outer surface of the test. U. S. Nat. Mus., Cat. No. 69665.

The specimens represented by figs. 9-11 are from locality 16q, Ozarkian: Mons formation, in thin-bedded gray limestone; Brisco Range, Sinclair Canyon, B. C., Can.

Lingulella nechos Walcott 492

FIGS. 12, 12*a*. (×2.) Top view and side outline of a dorsal valve. U. S. Nat. Mus., Cat. No. 69666.

The specimens represented by figs. 12, 12*a*, are from locality 67n, Ordovician: Sarbach formation, in a hard, dirty gray, limestone. Northeast slope of Fossil Mountain, Alberta, Can.

Lingulella nerva Walcott 493

FIGS. 13, 13*a*. (×4.) Top view and side outline of ventral valve. U. S. Nat. Mus., Cat. No. 69667.

14. (×4.) Top view of dorsal valve. U. S. Nat. Mus., Cat. No. 69668.

The specimens represented by figs. 13 and 14 are from locality 16r, Ozarkian: Mons formation; Brisco Range, Sinclair Canyon, B. C., Can.

Lingulella ninus Walcott 494

FIG. 15. (×6.) Ventral valve preserving a little of the exterior surface. U. S. Nat. Mus., Cat. No. 69669.

16. (×4.) Partially exfoliated dorsal valve. U. S. Nat. Mus., Cat. No. 69670.

The specimens represented by figs. 15 and 16 are from locality 61q, as given under figs. 3 and 4 above.

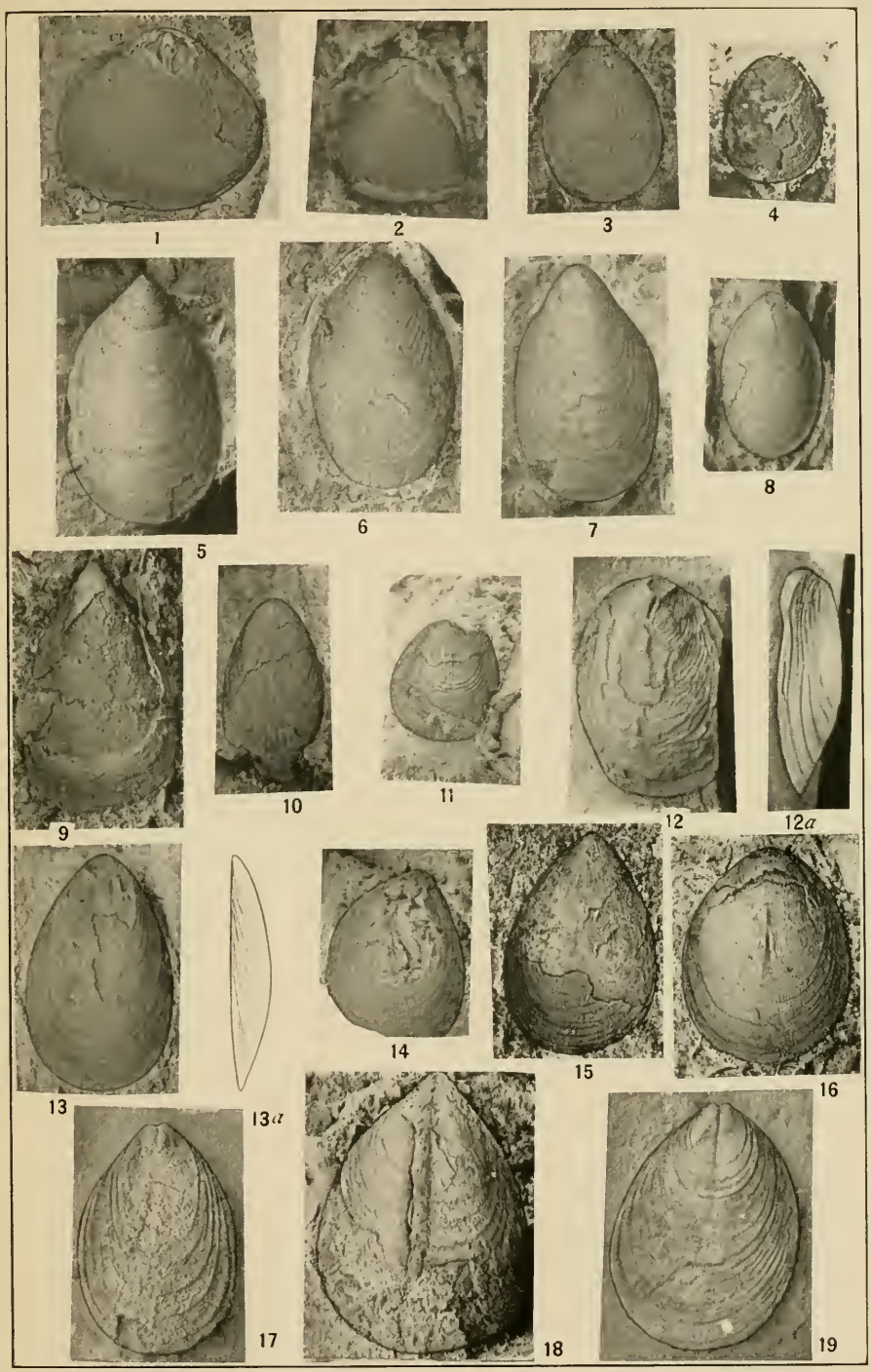
Lingulella siliqua Walcott. (See pl. 109, fig. 1) 495

FIG. 17. (×4.) A ventral ? valve partially flattened on the surface of shaly limestone. U. S. Nat. Mus., Cat. No. 69671.

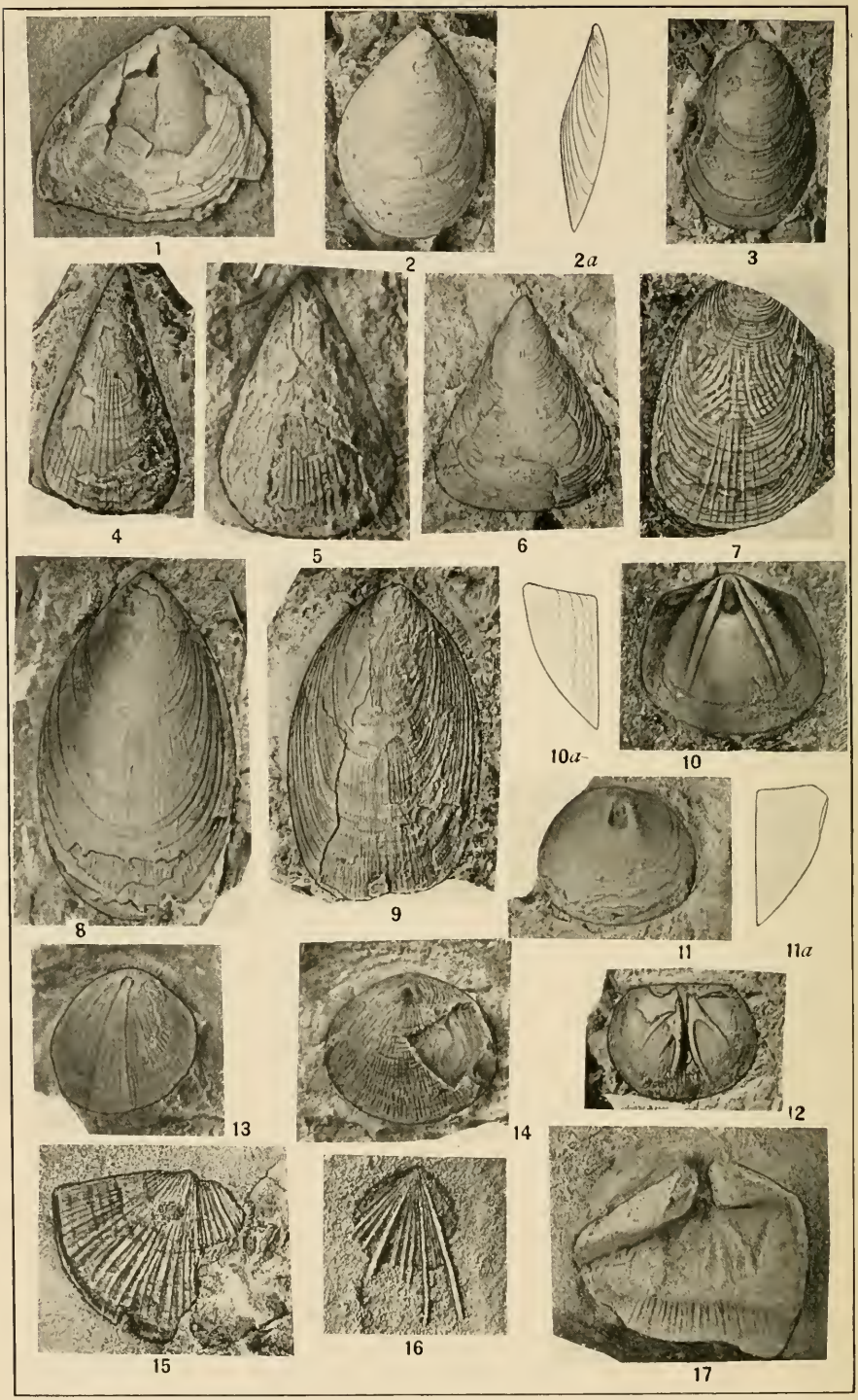
18. (×4.) A small imperfect ventral valve broken out of limestone. U. S. Nat. Mus., Cat. No. 69672.

19. (×4.) A crushed and somewhat broken dorsal valve on surface of limestone. U. S. Nat. Mus., Cat. No. 69673.

The specimens represented by figs. 17-19 are from locality 63x, Upper Cambrian: Ottertail formation; thin-bedded limestones, Wolverine Pass, B. C., Can.



OBOLUS-LINGULELLA.



LINGULELLA-LINGULEPIS-ACROTRETA-NISUSIA.

DESCRIPTION OF PLATE 109

PAGE

Lingulella siliqua Walcott. (See pl. 108, figs. 17-19) 495

FIG. 1. (×4.) A crushed dorsal valve doubtfully referred to this species. U. S. Nat. Mus., Cat. No. 69674.

For locality, see pl. 108, figs. 17-19.

Lingulella remus Walcott 494

FIGS. 2, 2a. (×4). Ventral valve and side outline. U. S. Nat. Mus., Cat. No. 69675.

3. (×4.) Dorsal valve and side outline. U. S. Nat. Mus., Cat. No. 69676.

The specimens represented by figs. 2, 2a, 3 are from locality 61q, Ozarkian; Chushina formation; gray limestone, Robson Peak District, B. C., Can.

Lingulepis nabis Walcott 489

FIG. 4. (×6.) A small but well preserved ventral valve. U. S. Nat. Mus., Cat. No. 69677.

5. (×6.) Acuminate ventral valve with front margin broken away. U. S. Nat. Mus., Cat. No. 69678.

6. (×6.) A broad ventral valve that may not belong to this species. U. S. Nat. Mus., Cat. No. 69679.

7. (×6.) Partially exfoliated dorsal valve illustrating vascular markings. U. S. Nat. Mus., Cat. No. 69680.

The specimens represented by figs. 4-7 are from locality 16q, Ozarkian: Mons formation, gray limestone; Brisco Range, Sinclair Canyon, B. C., Can.

Lingulella ibicus Walcott. (See pl. 108, figs. 5-8) 491

FIG. 8. (×6.) A ventral valve from the type locality 61q. (See description of figs. 5-8, pl. 108.) U. S. Nat. Mus., Cat. No. 69660.

9. (×6.) A dorsal valve from Sinclair Canyon, locality 16q. (See under description of fig. 7 above). U. S. Nat. Mus., Cat. No. 69681.

Acrotreta atticus Walcott 496

FIG. 10, 10a. (×6.) Top, side and back view of a ventral valve. U. S. Nat. Mus., Cat. No. 61682.

11, 11a. (×6.) Top, side and back view of a ventral valve. U. S. Nat. Mus., Cat. No. 61683.

12. (×6.) Natural cast of interior of dorsal valve. U. S. Nat. Mus., Cat. No. 61684.

The specimens represented by figs. 10-12 are from locality 61q. (See fig. 2, above.)

Acrotreta discoidea Walcott 497

FIG. 13. (×6.) Top view of ventral valve. U. S. Nat. Mus., Cat. No. 69685.

14. (×6.) Exterior of dorsal valve. U. S. Nat. Mus., 69686.

The specimens represented by figs. 13 and 14 are from locality 61q (see fig. 2, above).

Nisusia spinigera Walcott 498

FIG. 15. (×4.) Exterior of a dorsal valve. U. S. Nat. Mus., Cat. No. 69687.

16. (×6.) Spines on surface costæ. U. S. Nat. Mus., Cat. No. 69688.

17. (×4.) Interior of a ventral valve. U. S. Nat. Mus., Cat. No. 69689.

The specimens represented by figs. 15-17 are from locality 63x, Upper Cambrian: Ottertail formation; limestones, Wolverine Pass, B. C., Can.

DESCRIPTION OF PLATE 110

PAGE

Nisusia burgessensis Walcott..... 499

FIG. 1. (×3.) Ventral valve with attached surface spines. U. S. Nat. Mus., Cat. No. 69690.

2. (×2.) Natural cast of exterior of a compressed ventral valve. U. S. Nat. Mus., Cat. No. 69691.

3. (×2.) Interior of a dorsal valve. U. S. Nat. Mus., Cat. No. 69692.

4. (×2.) Outer surface of shell. U. S. Nat. Mus., Cat. No. 69693.

5. (×6.) A small ventral valve enlarged to illustrate outer surface. U. S. Nat. Mus., Cat. No. 69694.

6. (×2.) Interior of a ventral valve. U. S. Nat. Mus., Cat. No. 69695.

7. (×2.) Exterior of a dorsal valve. U. S. Nat. Mus., Cat. No. 69696.

8. (×2.) Top view of natural cast of interior of a dorsal valve. U. S. Nat. Mus., Cat. No. 69697.

The specimens represented by figs. 1-8 are from locality 35k, Middle Cambrian: Burgess shale, B. C., Can.

Nisusia (Jamesella) oriens Walcott..... 500

FIG. 9, 9*a*. (×2.) Top and side views of a ventral valve with prolonged mesial sinus. U. S. Nat. Mus., Cat. No. 69698.

10, 10*a*. (×2.) Top and side views of a ventral valve with a broad mesial sinus. U. S. Nat. Mus., Cat. No. 69699.

11, 11*a*. (×2.) Ventral valve with a small dorsal valve beside it. U. S. Nat. Mus., Cat. No. 69700.

12, 12*a*. (×2.) Top and side view of a ventral valve. U. S. Nat. Mus., Cat. No. 69701.

13, 13*a*. (×2.) Top and side view of a dorsal valve. U. S. Nat. Mus., Cat. No. 69702.

14, 14*a*. (×2.) Top and side view of a depressed dorsal valve. U. S. Nat. Mus., Cat. No. 69703.

The specimens represented by figs. 9-14*a* are from locality 41b, Lower Cambrian: lower beds of Forteau Point, Forteau Bay, north shore of Straits of Belle Isle, Labrador, Canada.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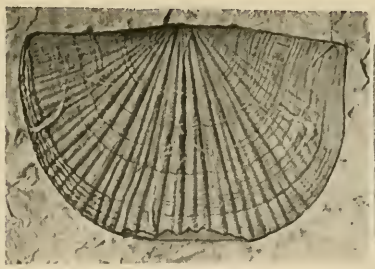
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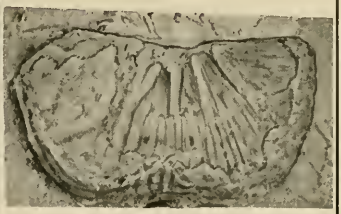
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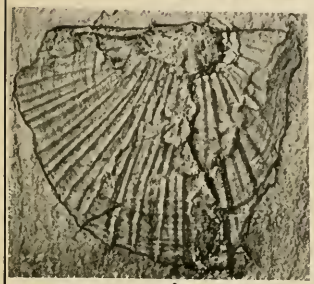
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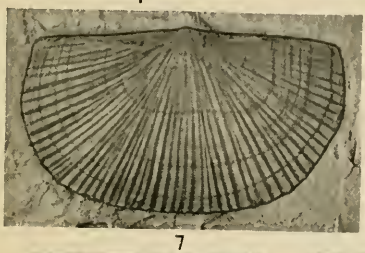
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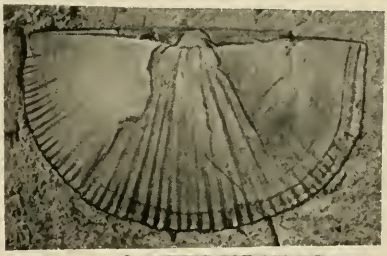
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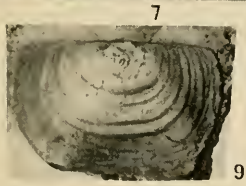
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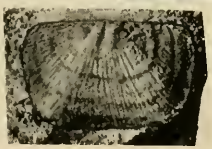
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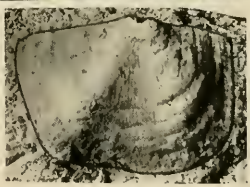
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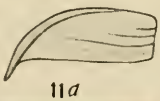
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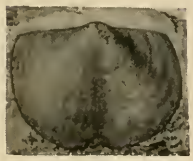
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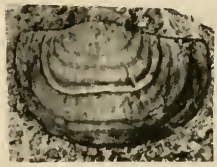
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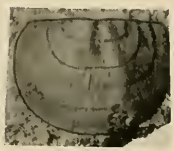
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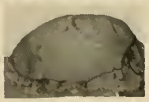
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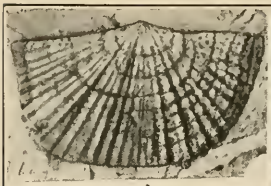
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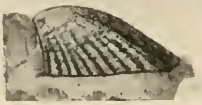
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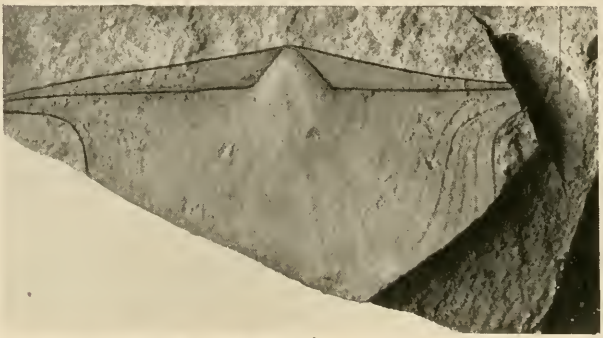
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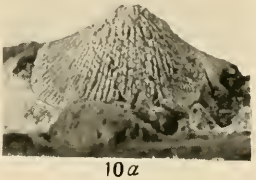
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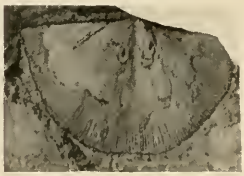
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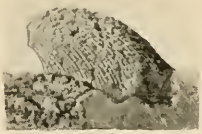
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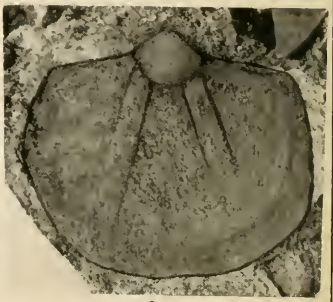
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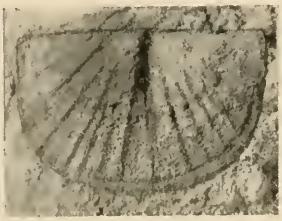
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10

NISUSIA-WIMANELLA-BILLINGSELLA-PROTORTHIS.

DESCRIPTION OF PLATE 111

PAGE

Nisusia alberta Walcott 499

FIGS. 1, 1*a*. (×2.) Top and side view. U. S. Nat. Mus., Cat. No. 69704.

The specimens represented by figs. 1 and 1*a* are from locality 14s, Middle Cambrian: Stephen formation; Mount Stephen, above Field, B. C., Can.

Wimanella borealis Walcott 501

FIG. 2. (×4.) Portion of an exfoliated ventral valve with faint vascular sinuses. U. S. Nat. Mus., Cat. No. 69705.

3. (×4.) A small ventral valve with acute cardinal angles. U. S. Nat. Mus., Cat. No. 69706.

4. (×4.) Exfoliated dorsal valve with acute cardinal angle. U. S. Nat. Mus., Cat. No. 69707.

The specimens represented by figs. 2-4 are from locality 61v, Middle Cambrian: Titkana formation; gray shaly limestone, Robson Peak District, Alberta, Can.

Wimanella occidens Walcott 501

FIG. 5. (×4.) Natural casts of interior of ventral valves. U. S. Nat. Mus., Cat. No. 69708.

6. (×4.) Natural cast of interior of a dorsal valve. U. S. Nat. Mus., Cat. No. 69709.

7. (×4.) Partially exfoliated dorsal valve somewhat doubtfully referred to this species. U. S. Nat. Mus., Cat. No. 69710.

The specimens represented by figs. 5-7 are from locality 64l, Upper Cambrian: Lyell formation; gray limestone, Glacier Lake Canyon, Alberta, Can.

Billingsella olen Walcott 502

FIG. 8. (×4.) Exterior of dorsal valve. U. S. Nat. Mus., Cat. No. 69711.

9. (×4.) Partially exfoliated ventral valve showing main sinuses. U. S. Nat. Mus., Cat. No. 69712.

The specimens represented by figs. 8 and 9 are from locality 21j, Ozarkian: Mons formation, hard gray limestone, east of Golden, B. C., Can.

Protorthis porcias Walcott 504

FIGS. 10, 10*a*, 10*b*. (×4.) Top, side and back view of a small ventral valve. U. S. Nat. Mus., Cat. No. 69713.

11. (×2.) Partially exfoliated dorsal valve. U. S. Nat. Mus., Cat. No. 69714.

The specimens represented by figs. 10, 10*a*, 10*b*, and 11 are from locality 65w, Ozarkian: Mons formation, Clearwater Canyon, Alberta, Can.

DESCRIPTION OF PLATE 112

PAGE

Billingsella archias Walcott 501

FIG. 1. (×4.) Exterior of a ventral valve. U. S. Nat. Mus., Cat. No. 69715.

2. (×4.) Natural cast of interior of a ventral valve. U. S. Nat. Mus., Cat. No. 69716.

3. (×4.) Natural cast of interior of a broken ventral valve. U. S. Nat. Mus., Cat. No. 69717.

4. (×4.) Natural cast of interior of a dorsal valve. U. S. Nat. Mus., Cat. No. 69718.

5. (×4.) Natural cast of an interior of a ventral valve. U. S. Nat. Mus., Cat. No. 69719.

The specimens represented by figs. 1-5 are from locality 61q, Ozarkian: Chushina formation, Robson Peak District, B. C., Can.

Eoorthis vicina Walcott 512

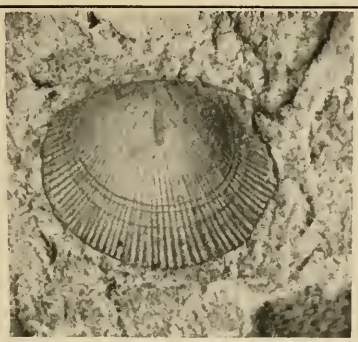
FIG. 6. (×3.) Exterior of ventral valve. U. S. Nat. Mus., Cat. No. 69720.

7. (×3.) Exterior of dorsal valve. U. S. Nat. Mus., Cat. No. 69721.

8. (×3.) Exterior of ventral valve. U. S. Nat. Mus., Cat. No. 69722.

9. (×3.) Partial cast of interior of ventral valve. U. S. Nat. Mus., Cat. No. 69723.

The specimens represented by figs. 6-9 are from locality 65x, Ozarkian: Mons formation, Clearwater Canyon, Alberta, Can.



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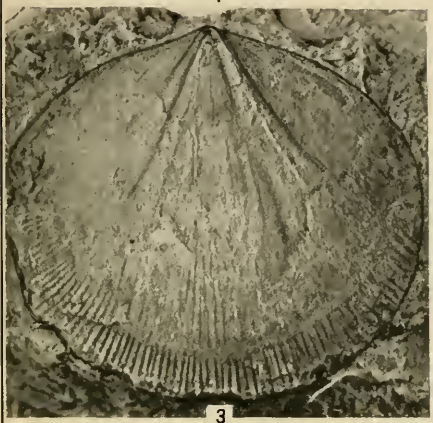

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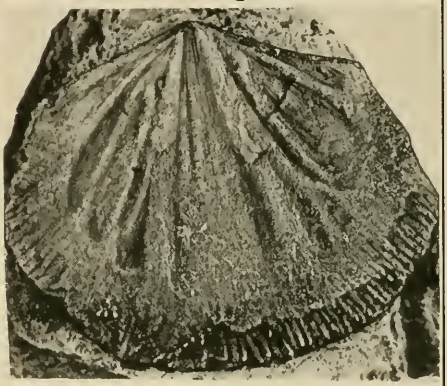

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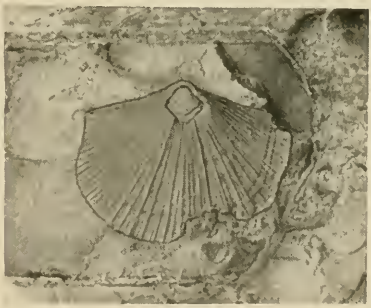

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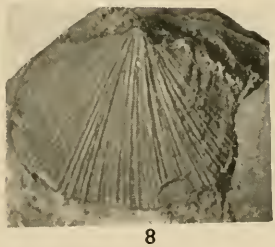

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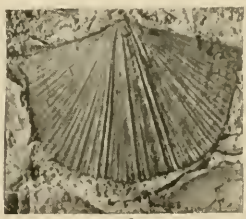

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BILLINGSELLA-EOORTHIS.


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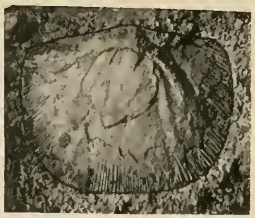
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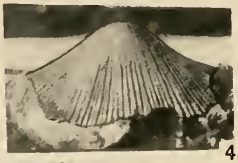
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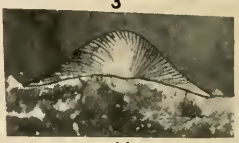
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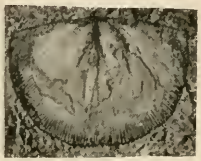
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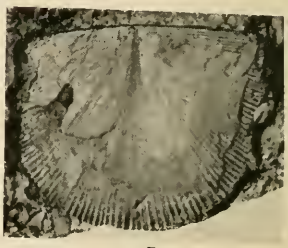
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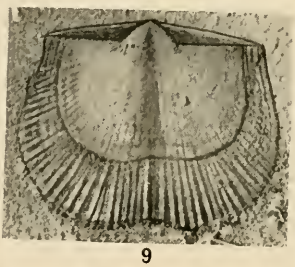
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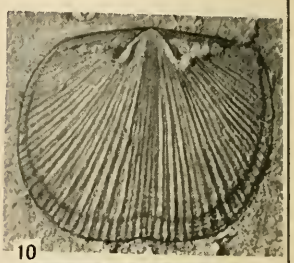
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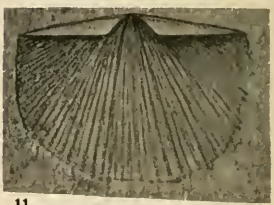
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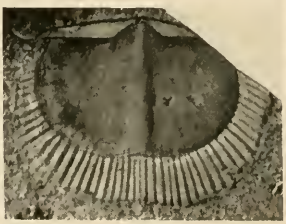
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14

PROTORTHIS-EOORTHIS.

DESCRIPTION OF PLATE 113

PAGE

Protorthis iones Walcott 503

FIG. 1. (×2.) Partially exfoliated ventral valve. U. S. Nat. Mus., Cat. No. 69724.

2. (×2.) Natural cast of interior of a ventral valve. U. S. Nat. Mus., Cat. No. 69725.

3. (×2.) Natural cast of interior of a ventral valve. U. S. Nat. Mus., Cat. No. 69726.

4, 4*a*, 4*b*. (×4.) Top, side and back view of a small ventral valve. U. S. Nat. Mus., Cat. No. 69727.

5. (×2.) Partially exfoliated dorsal valve. U. S. Nat. Mus., Cat. No. 69728.

6. (×4.) Outer surface of a dorsal valve. U. S. Nat. Mus., Cat. No. 69729.

7. (×2.) Partially exfoliated dorsal valve. U. S. Nat. Mus., Cat. No. 69730.

The specimens represented by figs. 1-7 are from locality 65w, Ozarkian: Mons formation, Clearwater Canyon, Alberta, Can.

Eoorthis bellicostata Walcott 505

FIG. 8. (×3.) Ventral and dorsal valves on surface of shale. U. S. Nat. Mus., Cat. No. 69731.

9. (×3.) Natural cast of interior of a ventral valve. U. S. Nat. Mus., Cat. No. 69732.

10. (×3.) Exterior of a compressed ventral valve. U. S. Nat. Mus., Cat. No. 69733.

11. (×3.) Interior of a dorsal valve. U. S. Nat. Mus., Cat. No. 69734.

12. (×3.) Dorsal valve. U. S. Nat. Mus., Cat. No. 69735.

13 and 14. (×3.) Interior of dorsal valves. U. S. Nat. Mus., Cat. Nos. 69736, 69737.

The specimens represented by figs. 8-14 are from locality 35k, Middle Cambrian: Burgess shale, above Field, B. C., Can.

DESCRIPTION OF PLATE 114

PAGE

Eoorthis iophon Walcott (see pl. 119, fig. 14) 508

FIG. 1. (×4.) Small ventral valve. U. S. Nat. Mus., Cat. No. 69738.

2. (×4.) Ventral valve showing outline of visceral cavity beneath umbo. U. S. Nat. Mus., Cat. No. 69739.

3. (×2.) Dorsal valve with acute cardinal angles. U. S. Nat. Mus., Cat. No. 69740.

4. (×2.) Dorsal valve with broad mesial sinus. U. S. Nat. Mus., Cat. No. 69741.

5. (×2.) Exterior of dorsal valve. U. S. Nat. Mus., Cat. No. 69742.

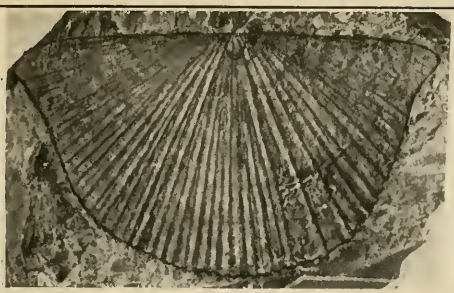
The specimens represented by figs. 1-5 are from locality 65e, with the exception of fig. 3 which is from locality 67w. All are from Ozarkian: Mons formation, Sawback Range, Alberta, Can.

Eoorthis putillus Walcott (see pl. 115, fig. 9) 510

FIG. 6. (×4.) Ventral and dorsal valves in limestone. U. S. Nat. Mus., Cat. No. 69743.

7. (×4.) Another group of shells on broken surface of limestone. U. S. Nat. Mus., Cat. No. 69744.

The specimens represented by figs. 6 and 7 are from locality 61q, Ozarkian: Chushina formation; gray limestone, Robson Peak District, B. C., Can.



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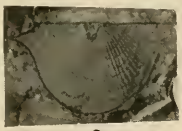

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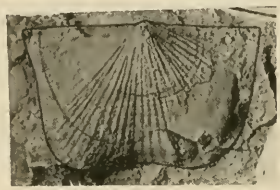

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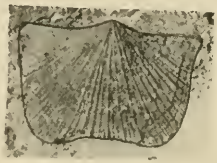

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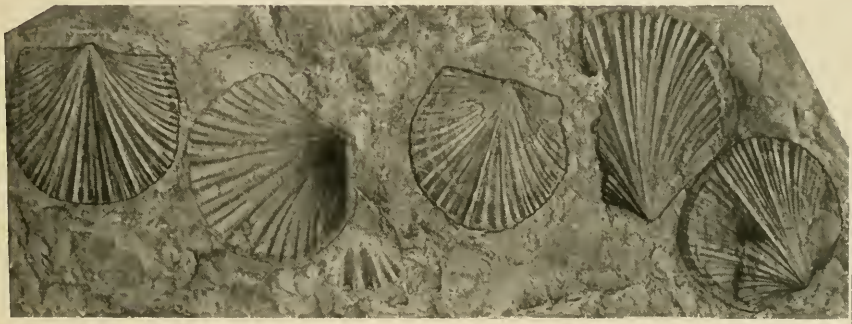

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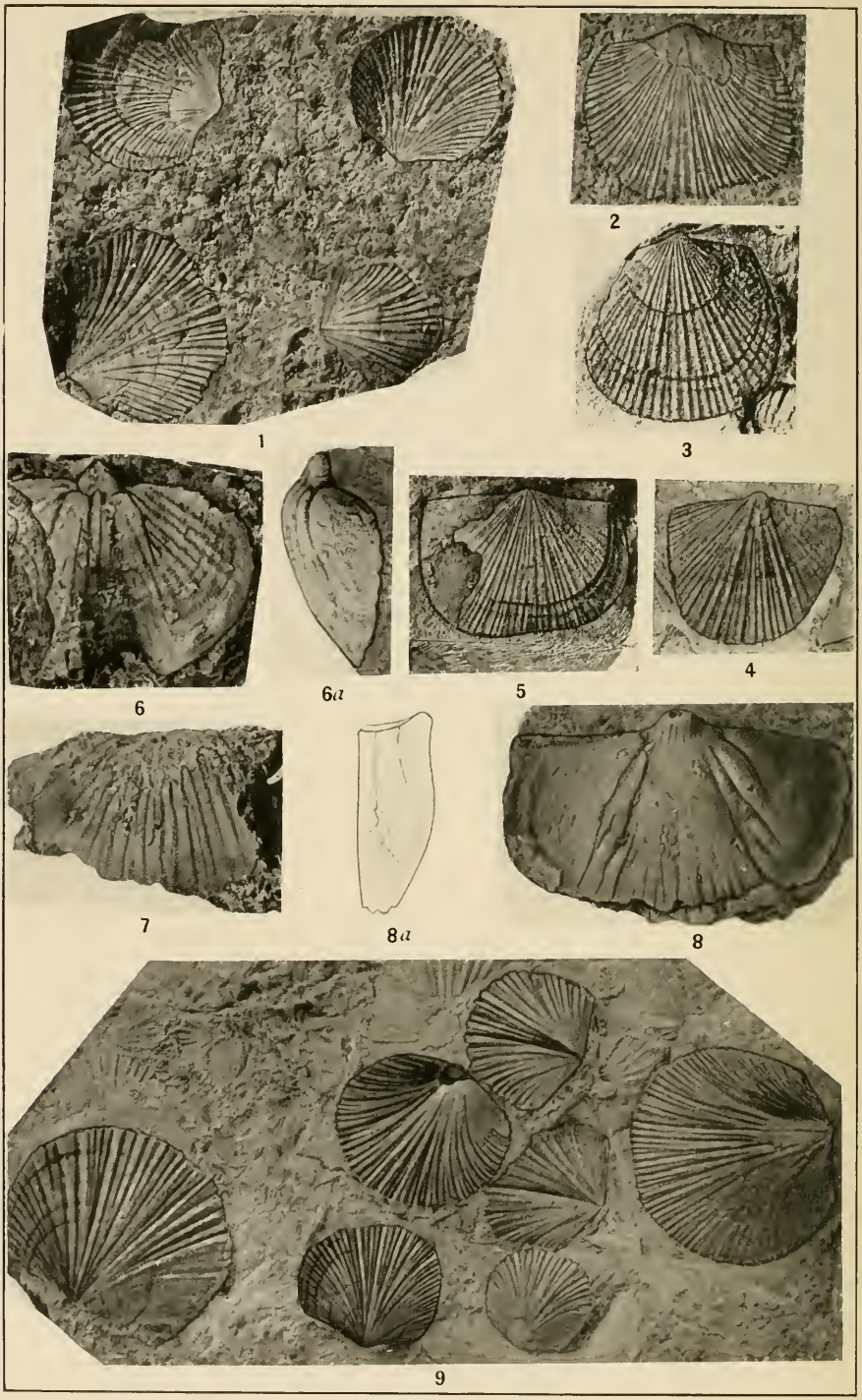


EOORTHIS-FINKELNBURGIA.

DESCRIPTION OF PLATE 115

PAGE

Eoorthis putillus laeviuscula Walcott 511

FIG. 1. (×4.) Ventral valves. U. S. Nat. Mus., Cat. No. 69745.

2. (×4.) Dorsal valve associated with specimens shown in fig. 1. U. S. Nat. Mus., Cat. No. 69746.

The specimens represented by figs. 1 and 2 are from locality 67q, Ozarkian: Mons formation; gray limestone, Douglas Lake Canyon Valley, Alberta, Can.

Eoorthis lineocosta Walcott 508

FIGS. 3 and 4. (×2.) Casts of exterior of ventral valves. U. S. Nat. Mus., Cat. Nos. 69747, 69748.

5. (×2.) Exterior of a broken dorsal valve. U. S. Nat. Mus., Cat. No. 69749.

The specimens represented by figs. 3-5 are from locality 360a, Ozarkian: Manitou formation; red silicious limestone, Beyer Park, El Paso County, Colorado.

Finkelnburgia noblei Walcott 514

FIGS. 6, 6*a*. (×3.) Top and side view of a cast of the interior of a broken ventral valve. U. S. Nat. Mus., Cat. Nos. 69750.

7. (×3.) Portion of the radially striated surface of the interior of the shell. U. S. Nat. Mus., Cat. No. 69751.

8, 8*a*. (×3.) Top and side views of a cast of a ventral valve. U. S. Nat. Mus., Cat. No. 69752.

The specimens represented by figs. 6-8*a* are from locality 73c, Upper Cambrian: Muav formation; Hermit Creek, Grand Canyon of the Colorado River, Arizona.

Eoorthis putillus Walcott (see pl. 114, figs. 6, 7) 510

FIG. 9. (×3.) Group of shells in shaly limestone [from a locality ? miles (? km.) distant from locality 61q at Mount Robson]. U. S. Nat. Mus., Cat. No. 69753.

The specimen represented by fig. 9 is from locality 67w, Ozarkian: Mons formation; Sawback Range, Alberta, Can.

DESCRIPTION OF PLATE 116

FIG. 1. (×4.) Exterior of ventral valve. U. S. Nat. Mus., Cat. No. 69754.

2. (×4.) Partially exfoliated ventral valve. U. S. Nat. Mus., Cat. No. 69755.

3. (×4.) Interior of a ventral valve showing strong vascular sinuses. U. S. Nat. Mus., Cat. No. 69758.

4. (×4.) Exfoliated ventral valve doubtfully referred to this species. U. S. Nat. Mus., Cat. No. 69759.

5. (×4.) Dorsal valve. U. S. Nat. Mus., Cat. No. 69760.

6. (×4.) Ventral valve on same surface of limestone as fig. 5. U. S. Nat. Mus., Cat. No. 69761.

7. (×4.) Exterior of a dorsal valve. U. S. Nat. Mus., Cat. No. 69762.

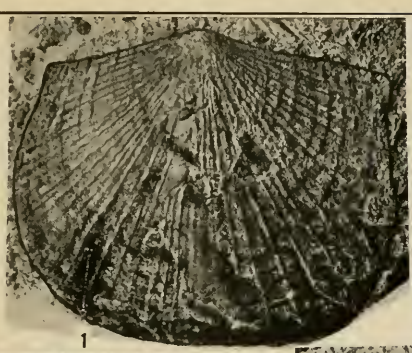
8. (×4.) A partially exfoliated dorsal valve. U. S. Nat. Mus., Cat. No. 69756.

9. (×4.) Outer surface of a dorsal valve. U. S. Nat. Mus., Cat. No. 69757.

10. (×8.) Enlargement of surface to show main ribs intercalated finer ribs or elevated striæ, and concentric lines and striæ of growth. U. S. Nat. Mus., Cat. No. 69763.

The specimens represented by figs. 1, 2, 8 and 9 are from locality 64l, Upper Cambrian: Lyell formation. Head of Glacier Lake Canyon, Alberta, Canada.

Figs. 3-7 and 10 are from locality 64t, Lyell formation, Sawback Range, Alberta, Can.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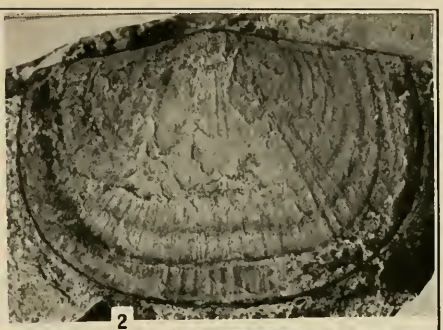
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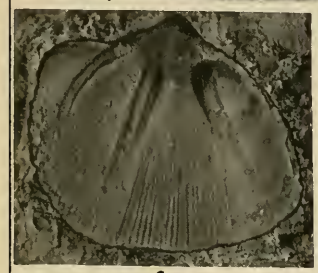
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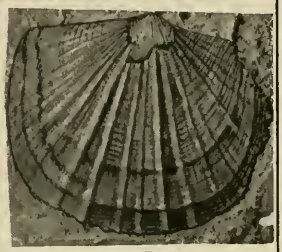
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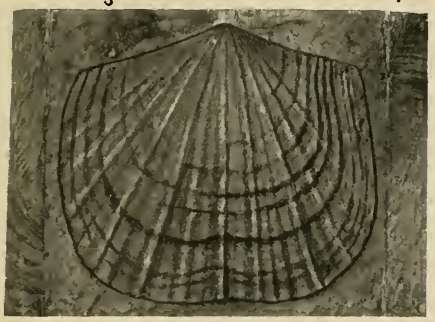
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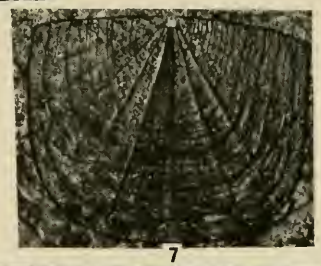
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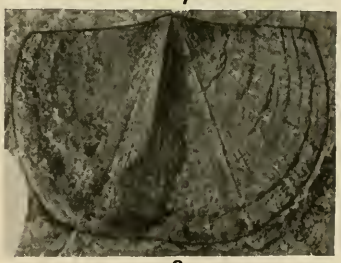
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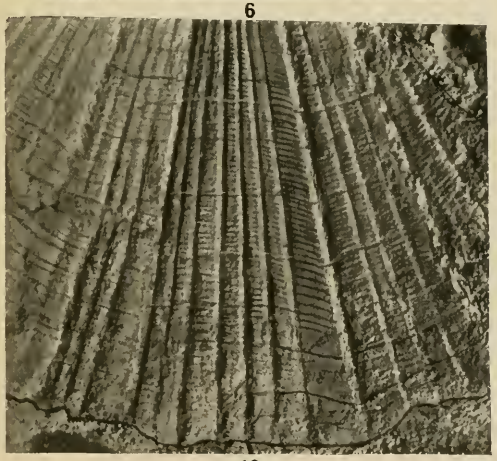
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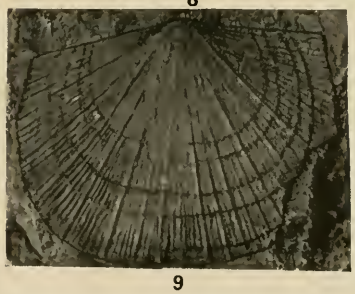
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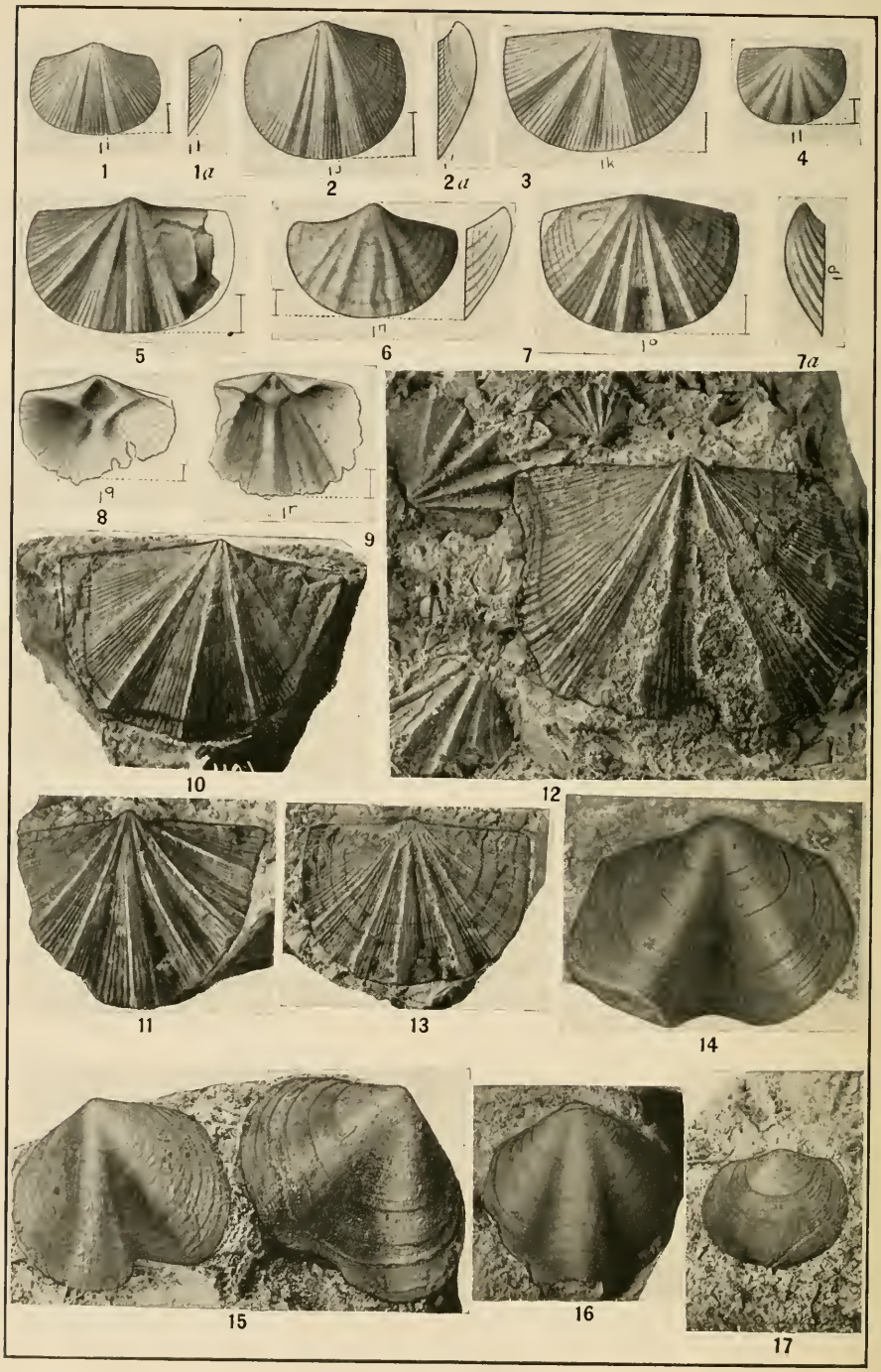

EOORTHIS-SYNTROPHIA.

DESCRIPTION OF PLATE 117

PAGE

Eoorthis fascigera Walcott 507

FIGS. 1, *1a*, and 2, *2a*. Top and side views of ventral valves from locality 14k, Upper Cambrian limestone on Wolf Creek, 15 miles (24.2 km.) west-southwest of Sheridan, Sheridan County, Wyoming. U. S. Nat. Mus., Cat. Nos. 52320a and 52320b, respectively.

3 and 4. Exterior of dorsal valves associated with the dorsal valves represented by figures 1 and 2. U. S. Nat. Mus., Cat. Nos. 52320c and 52320d, respectively.

5 and 6. Exterior of small ventral valves. U. S. Nat. Mus., Cat. Nos. 52319a and 52319b, respectively.

7. Exterior and side view of a ventral valve. U. S. Nat. Mus., Cat. No. 52319c.

7a. Side view of a young, convex shell. U. S. Nat. Mus., Cat. No. 52319d.

8. Posterior portion of the interior of an abraded ventral valve. U. S. Nat. Mus., Cat. No. 52319e.

9. Interior of an abraded dorsal valve. U. S. Nat. Mus., Cat. No. 52319f.

The specimens represented by figures 5-9 are from locality 168, Middle Cambrian limestones, Tepee Creek, Bighorn Mountains, Wyoming.

Figs. 1 to 9, inclusive, are the same as figs. *1i* to *1r*, pl. 96, of Mong. 51, U. S. Geological Survey, 1912.

Eoorthis ochus Walcott 509

FIGS. 10 and 11. (×3.) Ventral valves with very regular radiating elevated lines and fine strong ribs. U. S. Nat. Mus., Cat. Nos. 69764, 69765.

12. (×3.) A large dorsal valve with the main radiation ribs broken off. The smaller associated shells have very strong radiating ribs. U. S. Nat. Mus., Cat. No. 69766.

13. (×3.) A ventral valve with the apex broken down. U. S. Nat. Mus., Cat. No. 69767.

The specimens represented by figs. 10-13 are from locality 16u, Ozarkian: Mons formation, Sinclair Canyon, B. C., Can.

Syntrophia isis Walcott 517

FIG. 14. (×4.) A ventral valve with a strong mesial sinus. U. S. Nat. Mus., Cat. No. 69768.

15. (×4.) Two ventral valves that vary slightly in outline. U. S. Nat. Mus., Cat. No. 69769.

16. (×4.) Dorsal valve. U. S. Nat. Mus., Cat. No. 69770.

17. (×4.) A young shell with a very slight mesial fold. U. S. Nat. Mus., Cat. No. 69770.

The specimens represented by figs. 15-17 are from locality 65f, Ozarkian: Mons formation, Glacier Lake, Alberta, Can.

DESCRIPTION OF PLATE 118

PAGE

Syntrophia perilla Walcott 519

FIG. 1. (×4.) Ventral valve with traces of radiating lines on the inner layers of the shell. U. S. Nat. Mus., Cat. No. 69773.

2. (×4.) A larger, more transverse ventral valve with shell partly exfoliated. U. S. Nat. Mus., Cat. No. 69772.

3. (×4.) A large dorsal valve. U. S. Nat. Mus., Cat. No. 69774.

4. (×4.) An elongate dorsal valve. U. S. Nat. Mus., Cat. No. 69775.

5. (×4.) Dorsal valve. U. S. Nat. Mus., Cat. No. 69776.

6. (×4.) Ventral valve, U. S. Nat. Mus., Cat. No. 69777.

7. (×4.) A small dorsal valve. U. S. Nat. Mus., Cat. No. 69778.

The specimens represented by figs. 1-7, with the exception of fig. 2, are from locality 65x, Ozarkian: Mons formation, Clearwater Canyon, Alberta, Can.

Fig. 2 is from Fossil Mountain, Alberta, Can.

Huenella simon Walcott 521

FIG. 8. (×4.) A ventral valve with a broad shallow mesial sinus. U. S. Nat. Mus., Cat. No. 69779.

9. (×8.) Enlargement of surface ribs of fig. 8.

The specimen represented by figs. 8 and 9 is from locality 64z, Ozarkian: Mons formation; Sawback Range, Alberta, Can.

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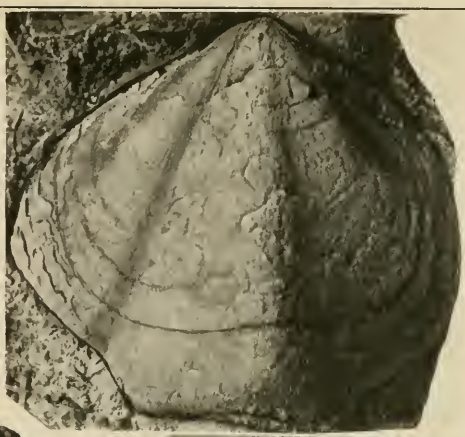

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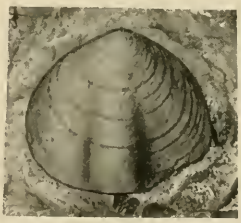

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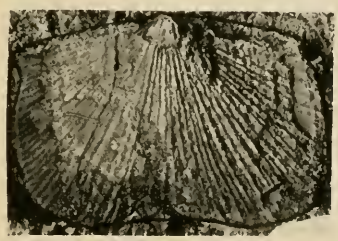

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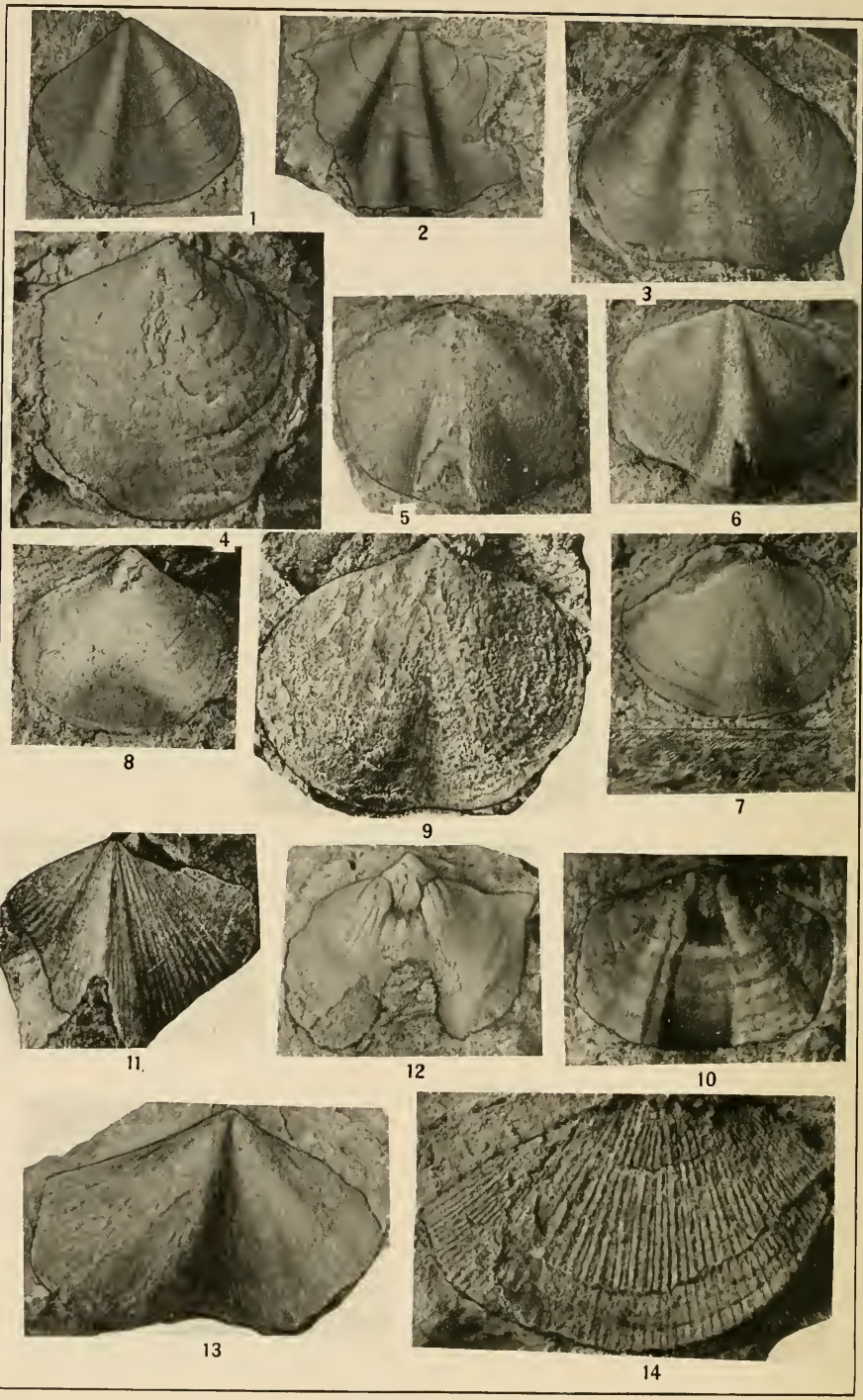
SYNTROPHIA-HUENELLA.



SYNTROPHIA-HUENELLA.

DESCRIPTION OF PLATE 119

PAGE

Syntrophia nisis Walcott 517

FIG. 1. (×4.) Ventral valve with strong ridge on sides of mesial fold. U. S. Nat. Mus., Cat. No. 69780.

2. (×4.) Dorsal valve with furrow on mesial fold. U. S. Nat. Mus., Cat. No. 69781.

3. (×4.) Dorsal valve with faint furrow on mesial fold. U. S. Nat. Mus., Cat. No. 69782.

The specimens represented by figs. 1-3 are from locality 66 o, Ozarkian: Mons formation; Fossil Mountain, Alberta, Can.

Syntrophia nonus Walcott 518

FIG. 4. (×4.) Ventral valve with a slight mesial sinus. U. S. Nat. Mus., Cat. No. 69783.

5. (×4.) Dorsal valve with broad mesial fold. U. S. Nat. Mus., Cat. No. 69784.

6. (×4.) Dorsal valve with a more sharply elevated mesial fold. U. S. Nat. Mus., Cat. No. 69785.

7. (×4.) Dorsal valve with a few faint radiating ribs. U. S. Nat. Mus., Cat. No. 69786.

8. (×4.) Ventral valve. U. S. Nat. Mus., Cat. No. 69787.

9. (×4.) A large exfoliated ventral valve preserving traces of the vascular sinuses. U. S. Nat. Mus., Cat. No. 69788.

The specimens represented by figs. 4-7 are from locality 66 o, given under *S. nisis* above. Figs. 8 and 9 are from the same locality, but a little lower in the section (66n).

Huenella hera Walcott 520

FIG. 10. (×4.) Interior of a ventral valve showing cast of pseudospondilium. U. S. Nat. Mus., Cat. No. 69789.

The specimen represented by fig. 10 is from locality 64w, Upper Cambrian: Lyell formation; Sawback Range, Alberta, Can.

Huenella juba Walcott 521

FIG. 11. (×4.) Exterior of a broken dorsal valve. U. S. Nat. Mus., Cat. No. 69790.

12. (×4.) Cast of interior of a ventral valve showing cast of pseudospondilium. U. S. Nat. Mus., Cat. No. 69791.

13. (×4.) Ventral valve with a broad mesial sinus. U. S. Nat. Mus., Cat. No. 69792.

Eoorthis iophon Walcott (see pl. 114, figs. 1-5) 508

FIG. 14. (×4.) Enlargement of surface to show strong, fine radiating ribs. U. S. Nat. Mus., Cat. No. 69793.

The specimens represented by figs. 11-14 are from locality 65e, Ozarkian: Mons formation; Sawback Range, Alberta, Can.

DESCRIPTION OF PLATE 120

PAGE

Huenella icetas Walcott 520

FIG. 1. (×4.) Ventral valve. U. S. Nat. Mus., Cat. No. 69794.

2. (×4.) Exterior surface of a small ventral valve. U. S. Nat. Mus., Cat. No. 69795.

3. (×4.) A dorsal valve associated with fig. 1. U. S. Nat. Mus., Cat. No. 69796.

The specimens represented by figs. 1-3 are from locality 65e, Ozarkian: Mons formation: Sawback Range, Alberta, Can.

Huenella texana Walcott 522

FIG. 4. (×4.) A ventral valve partially concealed by the mesial sinus of another specimen.

6. (×4.) Interior of a ventral valve that occurs on the same weather surface as 4 and 8.

7. (×4.) Dorsal valve associated with *Huenella weedi* Walcott.

8. (×4.) Part of a small piece of a thin layer of limestone on which the fossils weather out in relief. Both *H. texana* and *H. weedi* occur scattered irregularly over the surface.

U. S. Nat. Mus., Cat. No. 69797.

Huenella weedi Walcott 522

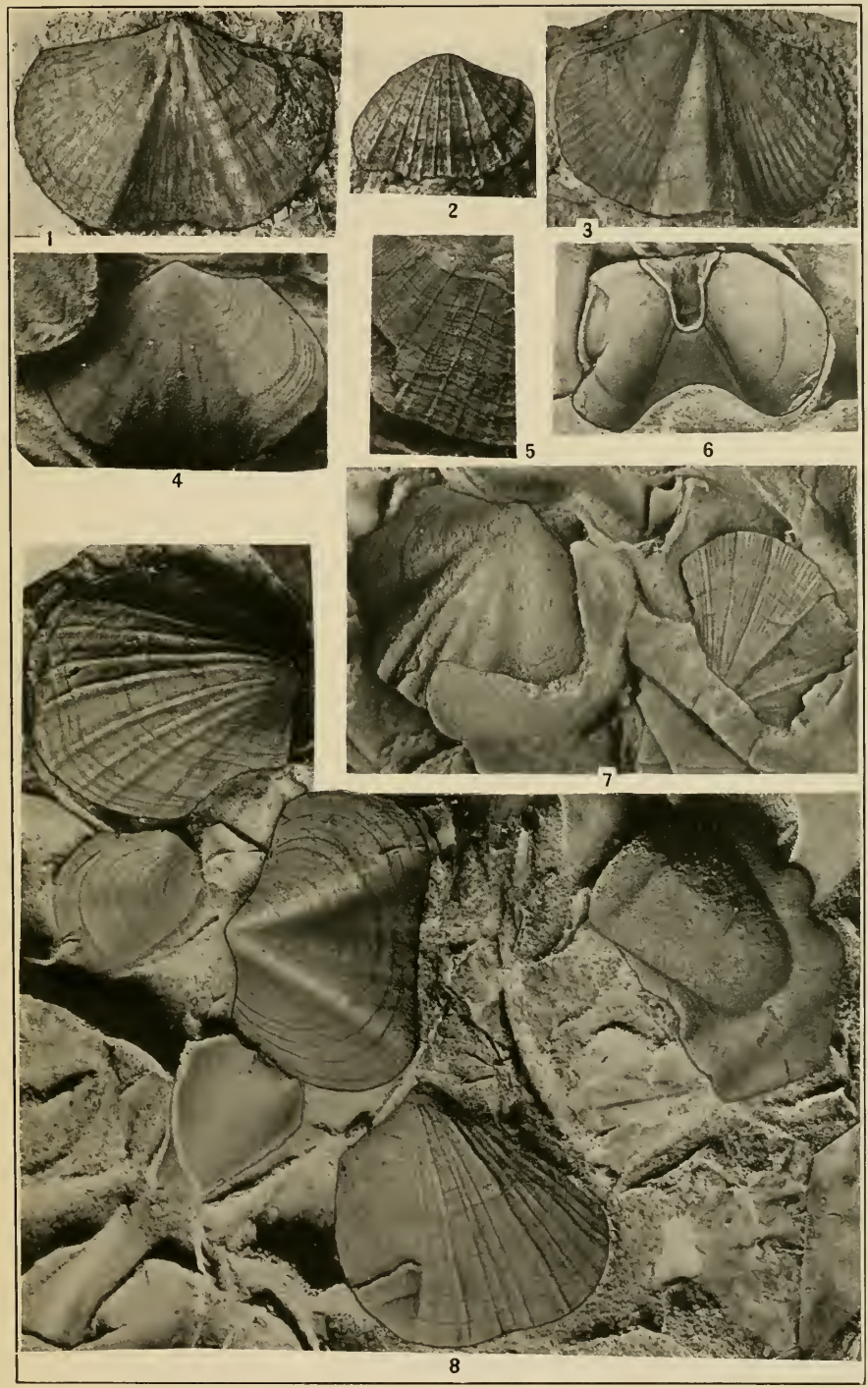
FIG. 5. (×4.) A small portion of the outer surface of the shell.

7. (×4.) Dorsal valve.

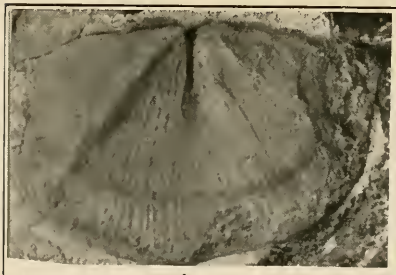
8. (×4.) Ventral valve associated with *H. texana* Walcott.

U. S. Nat. Mus., Cat. No. 69798.

The specimens represented by figs. 4-8 are from locality 302g, Upper Cambrian; Crowfoot Ridge, Yellowstone National Park, Wyoming.



HUENELLA.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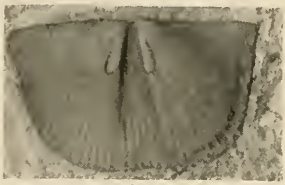
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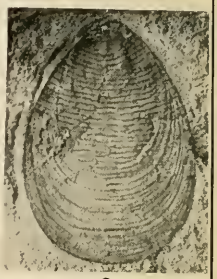
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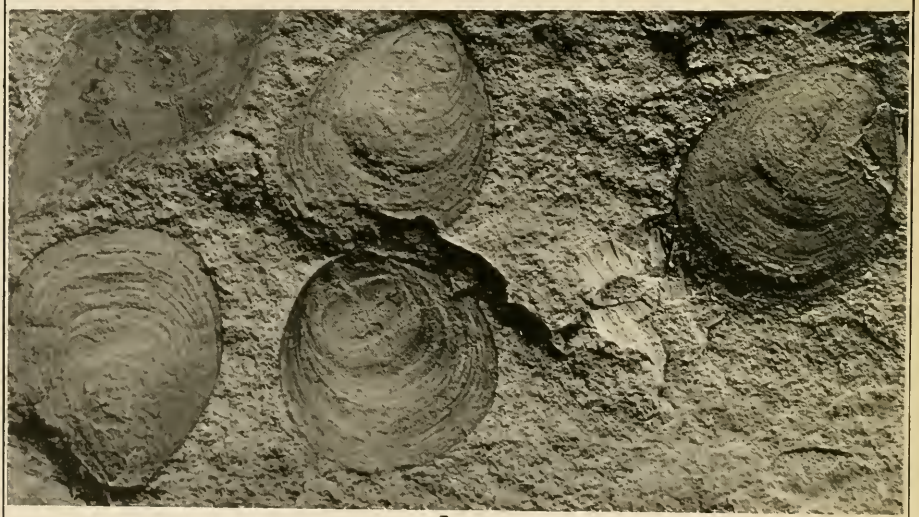
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BILLINGSELLA-OBOLUS.

DESCRIPTION OF PLATE 121

PAGE

Billingsella origen Walcott 503

FIG. 1. (×4.) Exfoliated dorsal valve. U. S. Nat. Mus., Cat. No. 19809.

2. (×4.) An exfoliated dorsal valve showing traces of muscle scars. U. S. Nat. Mus., Cat. No. 69807.

3. (×4.) Natural cast of interior of ventral valve showing visceral area and main vascular sinuses. U. S. Nat. Mus., Cat. No. 69808.

The specimens represented by figs. 1-3 are from locality 17t, Ozarkian: Mons formation, Sabine Mountain, B. C., Can.

Obolus whymperi Walcott 487

FIG. 4. (×3.) A small well preserved dorsal valve. U. S. Nat. Mus., Cat. No. 69810.

5. (×3.) A partially exfoliated ventral valve. U. S. Nat. Mus., Cat. No. 69812.

6. (×3.) A ventral valve with some of the inner layers of the shell preserved. U. S. Nat. Mus., Cat. No. 69811.

7. (×3.) Three dorsal valves and a broken ventral valve as they occur on the surface of shaly limestone. U. S. Nat. Mus., Cat. No. 69813.

The specimens represented by figs. 4-7 are from locality 68c, Lower Cambrian: Mt. Whyte formation, Mount Whymper, B. C., Can.

Obolus (Westonia) ollius Walcott 487

FIG. 8. (×3.) A flattened ventral valve with the apex broken off. U. S. Nat. Mus., Cat. No. 69814.

9. (×3.) A flattened, slightly distorted dorsal valve showing the elevated transverse lines. U. S. Nat. Mus., Cat. No. 69815.

10. (×3.) A partially exfoliated dorsal valve. U. S. Nat. Mus., Cat. No. 69816.

The specimens represented by figs. 8-10 are from locality 11c, Upper Cambrian: Hardystone Quartzite, Newton, New Jersey.

DESCRIPTION OF PLATE 122

PAGE

Lingulella miltoni Walcott 492

FIG. 1. (×4.) Broad form of ventral valve. U. S. Nat. Mus., Cat. No. 69818.

2. (×4.) An elongate dorsal valve. U. S. Nat. Mus., Cat. No. 69819.

3. (×4.) Narrow elongate form of ventral valve. U. S. Nat. Mus., Cat. No. 69820.

4. (×4.) Broad form of dorsal valve. U. S. Nat. Mus., Cat. No. 69821.

The specimens represented by figs. 1-4 are from locality 61u, Ozarkian: Chushina formation, Mount Robson, B. C., Can.

Lingulella waptaensis Walcott 496

FIG. 5. (×6.) Dorsal valve with a flattened ventral valve turned sideways beneath it. U. S. Nat. Mus., Cat. No. 69822.

6. (×6.) An uncompressed ventral valve. U. S. Nat. Mus., Cat. No. 69823.

7. (×6.) A group of ventral and dorsal valves on a piece of hard silicious shale. U. S. Nat. Mus., Cat. No. 69824.

8. (×6.) Ventral valves on the same piece of shale as those represented by fig. 7. U. S. Nat. Mus., Cat. No. 69824.

The specimens represented by figs. 5-8 are from locality 35k, Middle Cambrian: Burgess shale. Ridge between Mount Wapta and Mount Field, B. C., Can.

Acrothyra gregaria Walcott 498

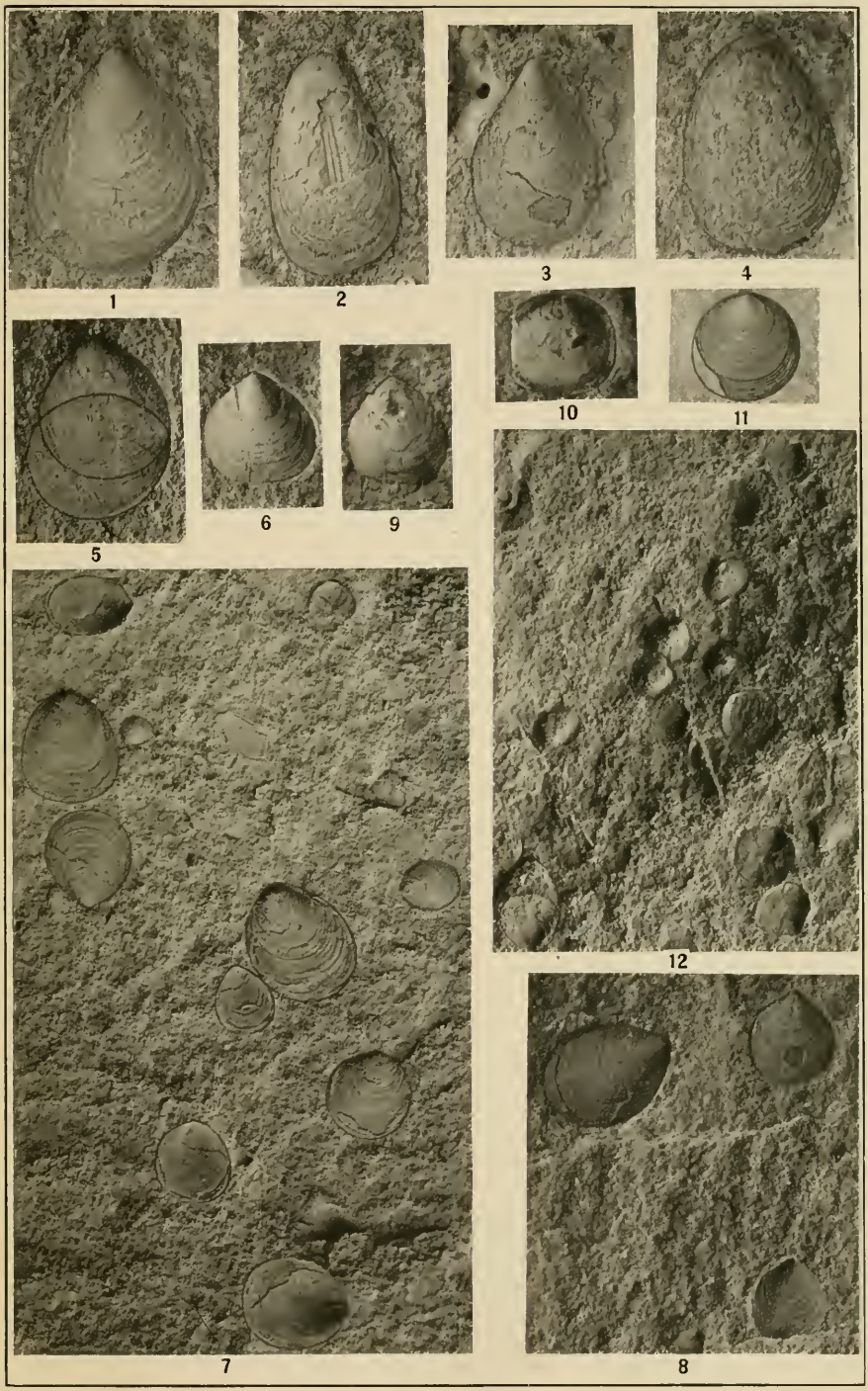
FIG. 9. (×8.) Partially exfoliated ventral valve showing cast of apical callosity and main vascular sinuses. U. S. Nat. Mus., Cat. No. 69825.

10. (×8.) Partially exfoliated dorsal valve showing trace of median septum. U. S. Nat. Mus., Cat. No. 69826.

11. (×8.) Exterior of a dorsal valve. U. S. Nat. Mus., Cat. No. 69827.

12. (×8.) A group of shells on a piece of hard silicious shale. U. S. Nat. Mus., Cat. No. 69828.

The specimens represented by figs. 9-12 are from locality 35k as above.



LINGULELLA-ACROTHYRA.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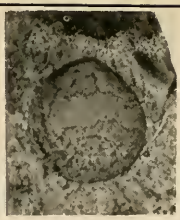
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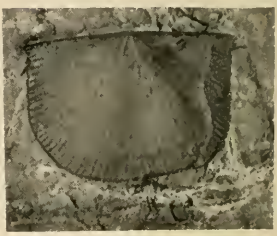
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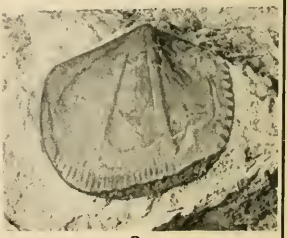
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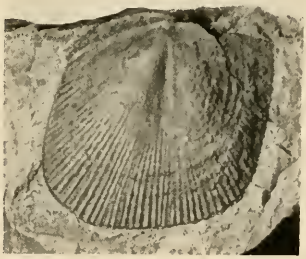
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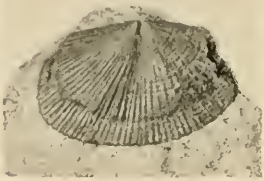
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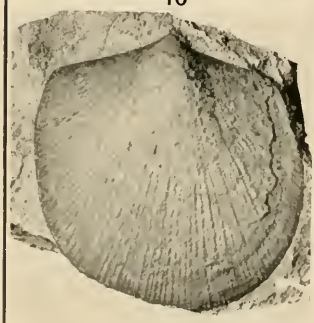
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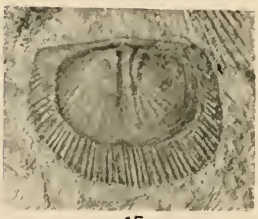
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16

LINGULELLA-BILLINGSELLA.
Novaya Zemlaya Brachiopods.

DESCRIPTION OF PLATE 123

PAGE

Lingulella arctica Walcott 524

FIG. 1. (×3.) An exfoliated ventral valve.

2. (×3.) A partially exfoliated dorsal valve.

Lingulella cf. *desiderata* Walcott 524

FIGS. 3 and 4. (×6.) Dorsal valves.

5. (×6.) Ventral valve.

Billingsella holtedahli Walcott 525

FIG. 6. (×2.) View of a partially exfoliated ventral valve, preserving part of main vascular sinuses and inner markings of shell.

7. (×2.) Partial interior of a dorsal valve. See fig. 15.

8. (×2.) Partly exfoliated dorsal valve.

9. (×2.) Partly exfoliated ventral valve.

10. (×2.) Dorsal valve with a shallow median furrow.

11. (×2.) Dorsal valve with outer surface layer exfoliated.

12. (×3.) Top view of a small ventral valve.

13. (×2.) Dorsal valve with outer surface preserved.

14. (×2.) Exterior of ventral valve with outer surface layer more or less exfoliated.

15. (×2.) Partially exfoliated dorsal valve. See fig. 7.

16. (×4.) Partialy exfoliated ventral valve showing cast of vascular sinuses and umbonal cavity.

The specimens represented by figs. 1, 2, 6-16, are from locality 67y, Island of Novaya Zemlya, Russia, west coast of southern island, Gribovii Fjord.

Figs. 3, 4, 5 are from locality 68a, west coast of southern island in mountains 7 km. northwest of the head of Bessimyanni Fjord.

DESCRIPTION OF PLATE 124

PAGE

Billingsella ? oppius Walcott..... 525

FIG. 1. (×2.) Exterior of dorsal valve.

2. (×2.) Exterior of ventral valve with shell crushed into umbonal cavity.

3. (×4.) Exterior of a small dorsal valve that may belong with this species.

4 and 6. (×2.) Casts of interior of ventral valves.

5. (×2.) Exfoliated ventral valve doubtfully referred to this species.

7. (×2.) Exterior surface of dorsal valve.

8. (×2.) Top and side view of exterior of a ventral valve.

The specimens represented by figs. 1-8 are from locality 67y, Island of Novaya Zemlya, Russia, west coast of southern island, Gribovii Fjord.

Eoorthis sabus Walcott..... 526

FIG. 9. (×4.) Cast of interior of a small ventral valve.

10. (×3.) Top view of exterior of a ventral valve.

11. (×3.) Natural cast of the interior of a dorsal valve.

12. (×2.) View of the cast of a ventral valve.

13. (×3.) Partly exfoliated dorsal valve having a shallow mesial sinus.

14. (×3.) One of a small group of shells in an arenaceous matrix.

15. (×4.) Fragment of a cast of the exterior surface.

The specimens represented by figs. 9-14 are from locality 68a, west coast of southern island, mountains 7 km. northwest of the head of Bessimyanni Fjord. Fig. 15 is from locality 67y, west coast of southern island, Gribovii Fjord, Island of Novaya Zemlya, Russia.


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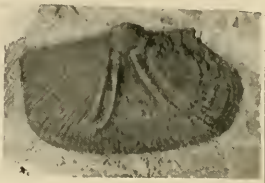
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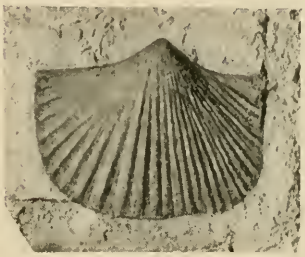
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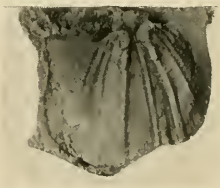
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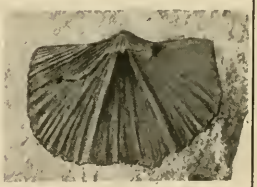
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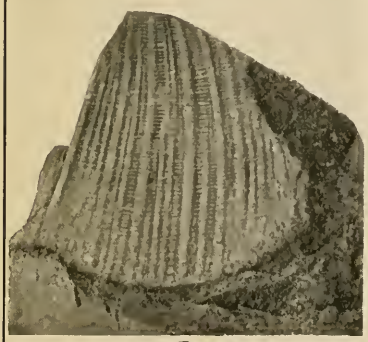
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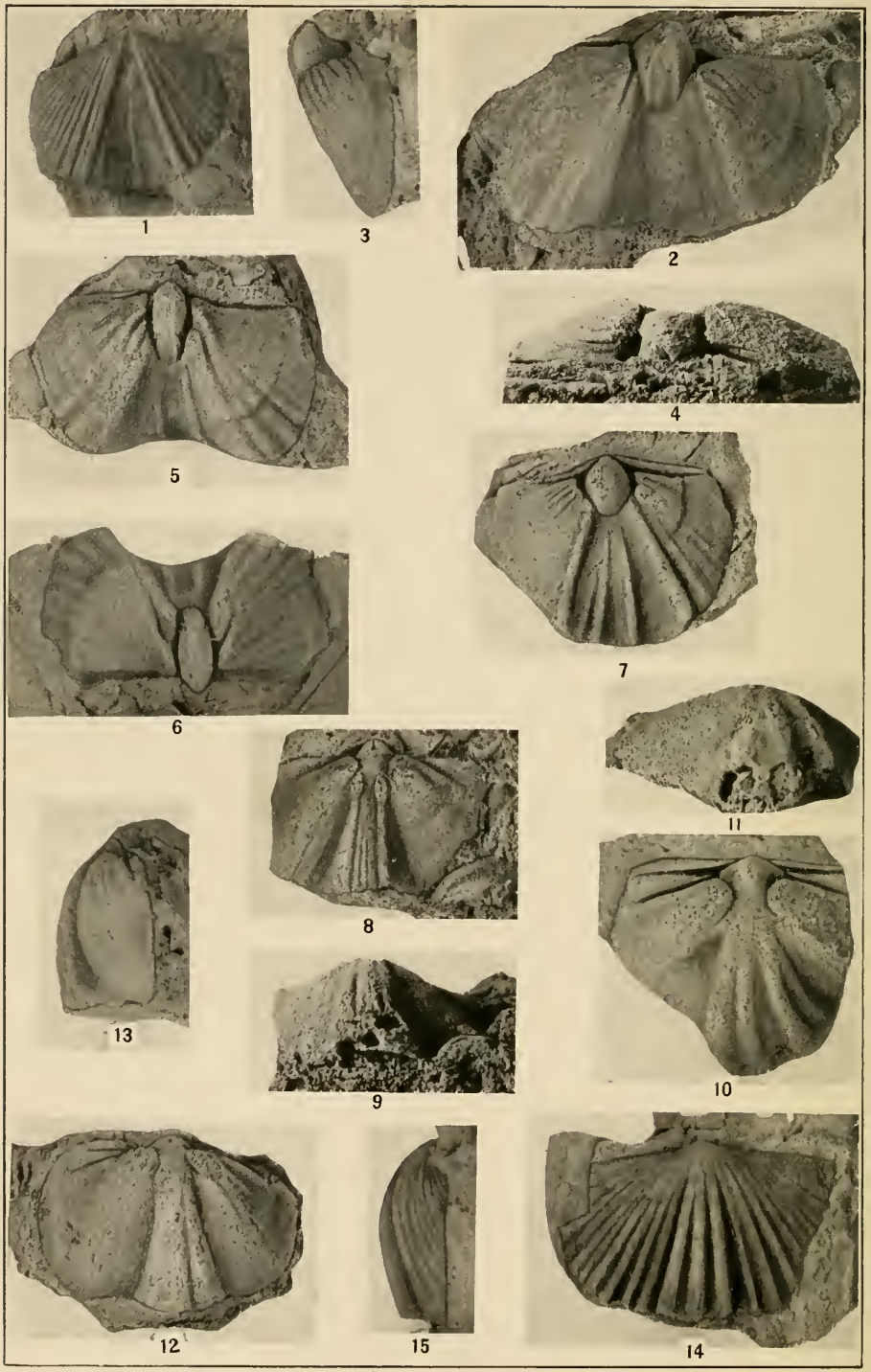
14

BILLINGSELLA-EOORTHIS.
Novaya Zemlaya Brachiopods.



HUENELLA.
Novaya Zemlaya Brachiopods.

DESCRIPTION OF PLATE 125

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Huenella triplicata Walcott 526

FIG. 1. (× 3.) Exterior of a ventral valve with one well defined mesial plication in furrow.

2, 3, 4. (× 3.) Top, side and back views of cast of the interior of a ventral valve showing pseudospondilium of medium length, short slight sinuses extending out into the cardinal slopes.

5, 6. (× 3.) Top and half back view of cast of interior of ventral valve with a narrow, long pseudospondilium, base of short vascular sinuses, and two plications in mesial sinus.

7. (× 3.) Cast of the interior of a ventral valve with two strong and one faint plications in mesial furrow, and a relatively short pseudospondilium.

8, 9. (× 3.) Top and front views of a cast of interior of a dorsal valve showing imprint of adductor muscle scars, small pseudospondilium and a minute cardinal process.

10, 11, 12, 13. (× 3.) Top, front and side views of casts of interior of dorsal valves varying somewhat from figs. 8, 9.

14, 15. (× 3.) Top and side view of exterior of dorsal valve with three plications on a rather mesial fold.

The specimens represented by figs. 1-15 are from locality 68a, mountains 7 km. northwest of the head of Bessimyanni Fjord, island of Novaya Zemlya, Russia.

DESCRIPTION OF PLATE 126

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Ozomia lucan Walcott 531

FIG. 1. (×3.) Natural cast of the interior of one side of the carapace of a large specimen. U. S. Nat. Mus., Cat. No. 69799.

2. (×3.) Natural cast of a smaller carapace. U. S. Nat. Mus., Cat. No. 69800.

3, 3*a*. (×3.) Side and anterior view of a cast preserving the impression of both sides of the carapace. U. S. Nat. Mus., Cat. No. 69801.

The specimens represented by figs. 1-3, and 3*a*, are from locality 66n, Ozarkian: Mons formation, Fossil Mountain, Alberta, Can.

Endoceras (?) monsensis Walcott 529

FIG. 4. (×4.) View of the deeper side of the conch in which the annulations and the lines of the cameræ are clearly defined. U. S. Nat. Mus., Cat. No. 69802.

4*a*. (×4.) Dorsal or ventral view of fig. 4 specimen.

4*b*. (×4.) Section of fig. 4 specimen, showing the oval dorso-ventral section.

The specimens represented by figs. 4, 4*a*, 4*b*, are from locality 54p, Ozarkian: Mons formation, Glacier Lake Canyon Valley, Alberta, Can.

Ellesmerocceras robsonensis Walcott 527

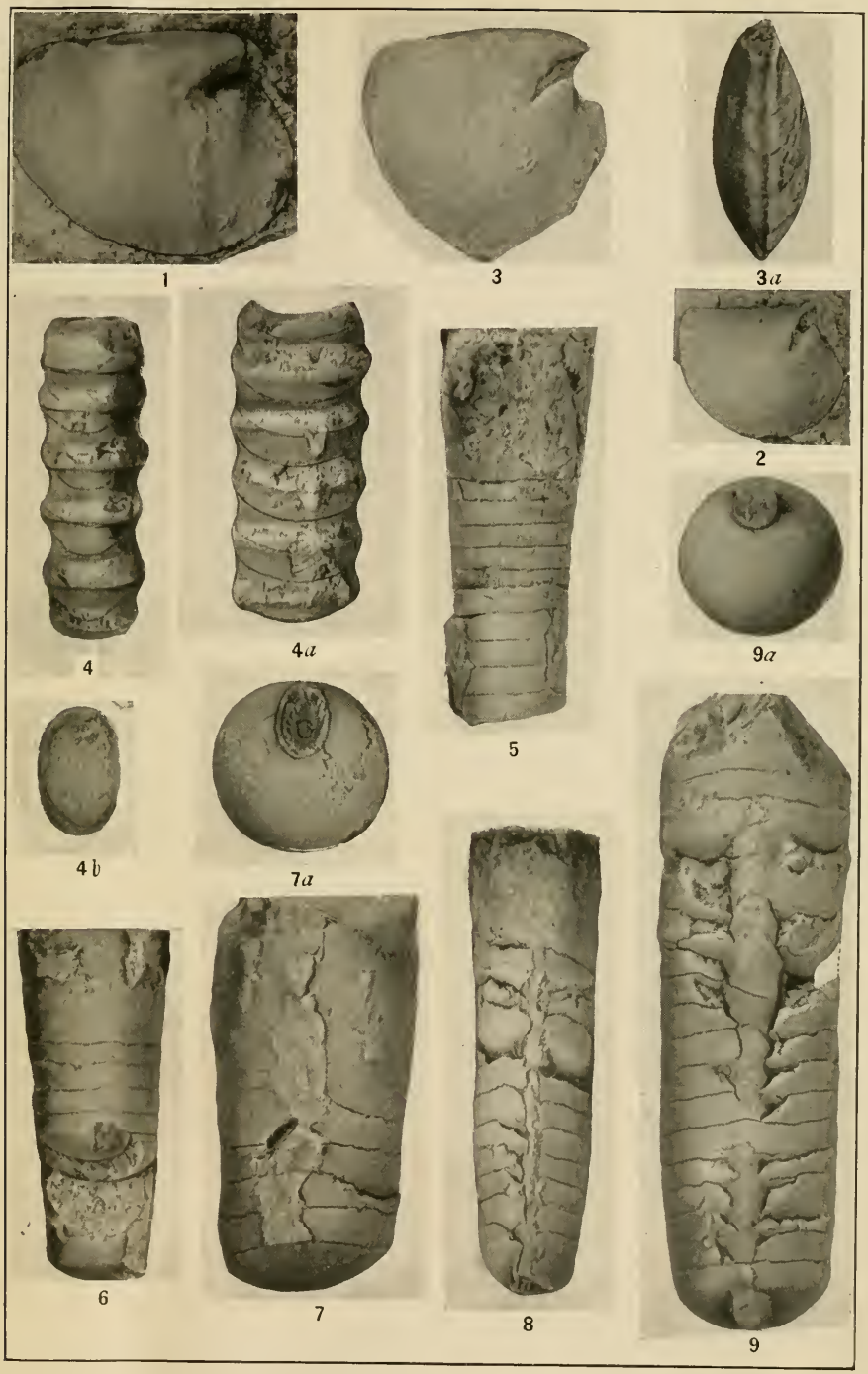
FIGS. 5 and 6. (×4.) Two views of a fragment of a conch preserving a portion of the living chamber and a number of the sutures separating the septa. U. S. Nat. Mus., Cat. No. 69803.

7, 7*a*. (×4.) A fragment of a conch preserving a portion of the living chamber, a few septa, and at the end one of the camera with a section of the siphuncle. U. S. Nat. Mus., Cat. No. 69804.

8. (×4.) Ventral side of a broken conch preserving the living chamber, septa and sutures; the siphuncle shows fairly well. U. S. Nat. Mus., Cat. No. 69805.

9, 9*a*. (×4.) A finely dissected specimen of the septate middle section of a conch showing the septa of the siphuncle with slightly elevated margin on the sutures, the cameræ, and sutures. Fig. 9*a* illustrates the position of the siphuncle. U. S. Nat. Mus., Cat. No. 69806.

The specimens represented by figs. 5-9*a* are from locality 61q, Ozarkian: Chushina formation, Billings Butte, Mount Robson District, B. C., Can.



OZOMIA-ENDOCERAS-ELLESMEROCERAS.