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II

No. 9.—NEW YORK POTSDAM-HOYT FAUNA

With Plates 37-49

BY
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INTRODUCTION

When engaged in reconnaissance work in Saratoga County, New York, during the summer of 1878 I found a small group of fossils in a thick-bedded, hard gray siliceous limestone at Hoyts quarry, 4 miles west of Saratoga Springs. The limestone and included fossils were referred to the "Califerous formation"[1] and attention called to the relation of the Hoyt quarry fauna to that of the "Potsdam sandstone of Iowa and Wisconsin." The species described were *Platyceras minutissima, Metoptoma cornutaforme, Conocephalites calciferus, C. hartti,* and *Ptychaspis speciosus.* Subsequently drawings were prepared illustrating the species and a large plate was made up, photographed, and distributed to a few investigators in July, 1885. In 1890 several additional species were described from the Hoyt quarry and illustrated and referred to the Upper Cambrian.[2] These included *Platyceras hoyti, Trochus ? saratogensis,* and *Agraulos saratogensis.* At various times in 1886 and 1888 I made brief visits to different localities about the Adirondack Mountains, New York, where the Potsdam sandstone member of the series was exposed. The results of these observations were included in a summary published in 1891[3] of the Cambrian formations of the Adirondack subprovince, reference being made to the fossils found. In 1903 the name "Saratogian" was proposed[4] for the formations and contained faunas then referred to the Upper Cambrian.

[1] Thirty-second Ann. Rept. New York State Museum, 1879, pp. 129-131.
[2] Proc. U. S. National Museum, Vol. 13, 1890. pp. 268 and 276.
[3] Bull. U. S. Geol. Survey, No. 81, 1891, pp. 341-347.
[4] Journ. Geol., Chicago, Vol. 11, No. 3, 1903, pp. 318, 319.

The "Saratogan" fauna of New York was correlated with the *Dicellocephalus* fauna of the Upper Mississippi Valley in 1879,[1] and in 1891 the list of fossils was corrected by the recognition of the genus *Dicellocephalus*.[2]

In proposing the name "Saratogian" a list of the fauna at the Hoyt quarry was given as follows:[3]

"*Cryptozoa proliferum.*	*Billingsia saratogensis.*
Obolus (*Lingulepis*) *acuminatus.*	*Matthevia variabilis.*
Platyceras minutissimum.	*Dikelocephalus hartti.*
Platyceras hoyti.	*Dikelocephalus speciosus.*
Metoptoma cornutiforme.	*Ptychoparia calcifera.*
Metoptoma simplex.	(*A.*) *saratogensis.*"

In a small drift block of sandstone I found on the road from Trenton to Trenton Falls, Oneida County, New York, in 1867, there is an unusual, apparent association of Upper Cambrian (Hoyt limestone) and Ordovician (Aylmer sandstone, Chazy) fossils. The Hoyt limestone species are *Ptychaspis speciosus* and *Agraulos* cf. *saratogensis*. The Aylmer sandstone species are *Leperditia armata, L.* sp. ?, and *Bathyurus* cf. *angelina* Billings.

When, as a boy, I found the rounded block of sandstone referred to I broke out all the fossils possible, as at the time I was well acquainted with the Trenton limestone fauna, and the fossils in the block were strangers to me, with the exception of *Leperditia armata*. The following winter I endeavored to locate the stratigraphic position of the trilobites, but could not, further than that they were evidently of pre-Trenton age. This study aroused an interest in the American early Paleozoic fossils that gradually led me to take up the Cambrian rocks and faunas as my special field of research.

The block of sandstone was about 3 inches in thickness by 12 in diameter. The impact of the wheel of the wagon in which I was riding split the block open and exposed several cranidia of the trilobite now known as *Ptychaspis speciosus*. Neither this nor *Agraulos* cf. *saratogensis* occurred in direct association with the Chazy *Leperditia* and *Bathyurus*. This now leads me to adopt a suggestion of Dr. E. O. Ulrich that the block of sandstone was part of a bed formed by the overlap of the Aylmer sandstone of the Chazy on a layer of Potsdam sandstone. This would make the line of demarcation between

[1] Walcott. Thirty-second Ann. Rept. New York State Museum, 1879, p. 131.
[2] Bull. U. S. Geol. Survey, No. 81, 1891, p. 346.
[3] Journ. Geol., Chicago, Vol. 11, No. 3, 1903, p. 318.

the Cambrian and Ordovician deposits within the block of sandstone that I found. With this view in mind the Hoyt limestone species are referred to the Upper Cambrian and the Aylmer sandstone species to the Ordovician.

STRATIGRAPHIC POSITION OF FAUNA.

The Potsdam-Hoyt fauna as it occurs about the Adirondack Mountains in New York State is found in the Potsdam sandstone and the superjacent Hoyt limestone. We have represented in the collection of the United States National Museum the following species:

	Upper Cambrian.	
	Potsdam sandstone.	Hoyt limestone.
Protozoa.		
Cryptozoön proliferum Hall	+	..
Annelida.		
Climactichnites	+	..
Scolithus linearis Haldeman ?	+	..
Planolites	+	..
Brachiopoda.		
Lingulella prima (Conrad)	+	..
Lingulella (Lingulepis) acuminata (Conrad)	+	+
Gastropoda.		
Triblidium cornutaforme (Walcott)	..	+
Matherella saratogensis (Walcott)	..	+
Palæacmæa typica Hall and Whitfield	+	..
Eccyliopterus sp	+	..
Ophileta ? sp	+	..
Sinuopea ? sp	+	..
Matthevia variabilis Walcott	..	+
Pteropoda.		
Hyolithes gibbosus Hall and Whitfield	+	..
Hyolithellus papillatus Walcott	+	..
Pelagiella hoyti (Walcott)	..	+
Pelagiella minutissima (Walcott)	..	+
Trilobita.		
Ptychoparia minuta (Bradley)	+	..
Ptychoparia matheri Walcott	+	..
Conocephalina whitehallensis Walcott	+	..
Pagodia seelyi Walcott	+	..
Agraulos saratogensis Walcott	..	+
Lonchocephalus calciferus (Walcott)	..	+
Ptychaspis speciosus Walcott	+	..
Dicellocephalus hartti (Walcott)	..	+
Dicellocephalus tribulis Walcott	..	+
Protichnites logananus Marsh	+	..
Protichnites wilsoni Logan	+	..

The facies of the fauna is essentially Cambrian, with the possible exception of the gastropods *Matherella saratogensis, Eccyliopterus* sp., *Ophileta* ? sp., and *Sinuopea* ? sp. These, however, are all small forms and might well be the Cambrian progenitors of the Ozark gastropod fauna of Missouri. Dr. E. O. Ulrich has recently placed the " Saratogan " fauna far above the top of the Cambrian[1] but with the evidence now known to me from New York and the Appalachian region to the southwest I am inclined tentatively to refer the fauna as found in New York State to the upper limit of the Cambrian. This is subject to investigations now being made in the Upper Mississippi Valley region of Wisconsin and Minnesota that will probably determine more definitely the horizon of some of the upper faunas that have been referred to the " St. Croix sandstone." As now known, the " Saratogan " fauna would be correlated with the fauna of one of the upper horizons of the " St. Croix sandstone " and thus included in the Upper Cambrian.

The most recent expression of opinion on the stratigraphic horizon of the Potsdam sandstone in New York is by Mr. William J. Miller in 1911.[2] He includes it with the Theresa formation and the Little Falls dolomite in the Upper Cambrian and states that the dolomite was everywhere eroded prior to the deposition of the Tribes Hill limestone, a formation which is frequently absent, and that the Black River-Trenton limestone (generally the Lowville) rests upon an eroded surface of the dolomite.

In Dutchess County, New York,[3] the " Saratogan " fauna is represented by *Lingulella prima, Lingulella* (*Lingulepis*) *acuminata, Agraulos saratogensis,* and *Lonchocephalus calciferus.*

Near Blairstown, New Jersey,[4] the fauna in the horizon of the " Kittatinny " limestone there exposed has *Agraulos* cf. *saratogensis* and *Lonchocephalus* cf. *calciferus* of the Hoyt limestone " Saratogan " fauna. The frontal limb of the Saratoga specimen of *Agraulos* is more convex than the one from Blairstown, and the *Lonchocephalus* is identified by a fragment of the occipital segment and median spine. Both identifications are too uncertain to be of value in correlation. The species of *Dicellocephalus, D. newtonensis* Weller, is unlike the Hoyt limestone species *D. hartti* Walcott. It is similar to the *Dicello-*

[1] Bull. Geol. Soc. America, Vol. 22, 1911, No. 3, pl. 27: Table of formations.

[2] Bull. New York State Museum, No. 153, Geology of the Broadalbein Quadrangle, 1911, pp. 25-31.

[3] New York State Museum, Geology of the Poughkeepsie Quadrangle, C. E. Gordon, 1911, p. 49.

[4] Geol. Surv. New Jersey, Rept. on Pal., Vol. 3, 1903, p. 13.

cephalus from the Eminence formation of the Ozark section of Missouri. It is evident from the lists of fossils given by Weller[1] that they belong to more than one faunal horizon. This makes the evidence for correlating the "Saratogan" fauna of New York with that of New Jersey of little value.

Dr. E. O. Ulrich[2] has correlated the Eminence formation of Missouri with that of the Potsdam sandstone and Hoyt limestone of New York; but with the present faunal evidence I think that we should hesitate to accept the correlation as established. The *Dicellocephalus* of the Eminence formation is a later type and the *Agraulos* has little weight because the cranidia of that genus have a close resemblance in specific characters from the Lower Cambrian to basal post-Cambrian strata.

I greatly appreciate the work Dr. Ulrich has done in endeavoring to establish an upper limit to the Cambrian system, and regret that I cannot yet fully agree with him that the "Saratogan" of New York should be classed as post-Cambrian.

USE OF THE TERMS SARATOGAN AND ST. CROIXAN

When I proposed the name "Saratogian" in 1903[3] for the Upper Cambrian group of formations, an examination of several lists of geological formation names failed to show that the name Saratoga had been used by Dr. J. C. Branner[4] for a Cretaceous chalk marl in Arkansas, in his description of "The Cement Materials of Southwest Arkansas."[5] A description of the formation is given, with sections illustrating its stratigraphic position. In 1902 Mr. J. A. Taff used the name Saratoga formation in the same sense as Branner and gave illustrations of sections and contained fossils.[6]

In view of the prior use of the name Saratoga by Branner and Taff, I doubt the advisability of continuing the use of Saratogan as a group name for the Cambrian formations. There is also the fact that the two formations of Saratoga County, New York, that are used as the basis for the name, are not typically of Upper Cambrian age. A present tendency is to include them as passage beds between

[1] Geol. Surv. New Jersey, Rept. on Pal., Vol. 3, 1903, pp. 12 and 13.

[2] Bull. Geol. Soc. America, Vol. 22, No. 3, 1911, pl. 27.

[3] Journ. Geol., Chicago, Vol. 11, 1903, pp. 318-319.

[4] Dr. John M. Clarke recently (May 27, 1912), called my attention to the use of the name Saratoga by Branner, and wrote that he was then discussing the history of the name in a paper in press.

[5] Trans. American Inst. Mining Engineers, Vol. 27, 1898, pp. 52-55.

[6] Twenty-second Ann. Rept. U. S. Geol. Survey, 1902, pp. 714-720.

the Cambrian and the superjacent system of strata, or as belonging to the higher systems.[1] With the evidence now known to me from New York and the Appalachian region to the southwest I am inclined tentatively to refer the fauna as found in New York State to the upper limit of the Cambrian. (See pages 255 and 256 for further discussion of this question.)

My present view is that the use of the name Saratoga should be restricted to the Cretaceous formation, another name adopted for the group of formations included in the Upper Cambrian, and another name for the Potsdam-Hoyt fauna if that fauna is considered as distinct from the Upper Cambrian fauna.

When looking up a name for the Upper Cambrian formations in 1903, I thought of St. Croixan, but as the name St. Croix had become fixed in geological literature for the Cambrian sandstone of the Upper Mississippi Valley[2] I did not use it. In 1911[3] Dr. E. O. Ulrich proposed to use the name St. Croixan for the sea in which the St. Croix sandstones were deposited, and in his table of correlations of formations (pl. 27) and on page 614 of the same work he uses the term as a collective name for his Upper Cambrian formations. If we drop the term "St. Croix" as a formation name for the sandstones of Wisconsin and Minnesota containing the Upper Cambrian fauna, then the term St. Croixan may be used for the assemblage of formations characterized by the Upper Cambrian fauna.

DESCRIPTIONS OF GENERA AND SPECIES

Genus CRYPTOZOÖN Hall

Cryptozoön HALL, 1884, Thirty-sixth Ann. Rept. New York State Mus. Nat. Hist., desc. of pl. 6. (Genus described and discussed as below.)

The original description is as follows:

In the town of Greenfield, Saratoga County, there occurs a bed of limestone which presents a very remarkable appearance, the surface being nearly covered by closely arranged circular or subcircular discs which are made up of concentric laminæ, closely resembling in general aspect the structure of *Stromatopora*. It very often happens that within these larger discs there occur two or more smaller ones, each with its own concentric structure and exterior limitation, and appearing as if budding from the parent mass. A farther examination shows that the entire form of these masses is hemispheric or turbinate, with the broadest face exposed upon the upper surface of the

[1] See Ulrich, Bull. Geol. Soc. America, Vol. 22, No. 3, 1911, pl. 27, and p. 612.

[2] See N. H. Winchell, 1873, Ann. Rept. Board of Regents, University of Minnesota. First Ann. Rept. Geol. and Nat. Hist. Surv. for 1872, pp. 68-80.

[3] Ulrich, Bull. Geol. Soc. America, Vol. 22, No. 3, 1911, p. 613.

limestone layer; that their growth has begun from a point below, and rapidly expanding upwards, has often extended one or two feet in diameter, as now shown upon the exposed surface of the limestone bed. At a single exposure on the farm of Mr. Hoyt, the surface of the limestone is covered by these bodies for many rods in extent. The entire area of the cellar beneath the house of Mr. Hoyt is upon this bed of limestone closely covered by these hemispheric masses with concentric structure. For a distance of one or two miles to the southward the outcrop of this limestone can be traced, and everywhere presenting the same characters in the presence of these masses. Large numbers of specimens of various sizes have been weathered out and lie scattered over the surface. This fossil has also been found at Little Falls, Herkimer County, New York.

These bodies have long been known under the name of *Stromatopora,* from their general resemblance in form and structure to that fossil; but their position in reference to the bedding of the rock is uniformly the reverse of that of Stromatoporæ, which occur in the higher limestones, growing from a broad base which is covered by an epitheca, while these bodies under consideration grow upward and expand from a point below, while the convex surface is on the lower side. A careful examination of the nature of these bodies proves that while having the concentric structure common to *Stromatopora* they have not the regular succession of layers of tubuli characteristic of the species of that genus and cannot properly be included under that term. I, therefore, propose the term *Cryptozoön* as a designation for this peculiar form and mode of growth which will be more fully elucidated in the future.

CRYPTOZOÖN PROLIFERUM Hall

Plate 37, figs. 1-3

Cryptozoön proliferum HALL, 1884, Thirty-sixth Ann. Rept. New York State Mus. Nat. Hist., desc. of pl. 6. (Species defined in description of plate as below, and illustrated by plate 6.)

The original description is as follows:

These bodies are made up of irregular, concentric laminæ of greater or less density and of very unequal thickness. The substance between the concentric lines, in well-preserved specimens, is traversed by numerous, minute, irregular canaliculi which branch and anastomose without regularity. The central portions of the masses are usually filled with crystalline, granular, and oölitic material and many specimens show the intrusion of these extraneous and inorganic substances between the concentric laminæ. That these are intrusions, and not inclusions, is shown from the fact that they can be traced to a vertical fissure or break leading to the exterior of the fossil and which allowed the crystalline matter to enter.

Formation and locality.—Upper Cambrian: (76) Arenaceous Hoyt limestone at Hoyts quarry, 4 miles (6.4 km.) west of Saratoga Springs, Saratoga County, New York.

Genus CLIMACTICHNITES Logan

Plates 38-40

Climactichnites Logan, 1860, Canadian Nat. and Geol., Vol. 5, pp. 279-285, text figs. 1-5. (Describes and illustrates trails. Thinks they may have been made by mollusks.)

Climactichnites Logan, Jones, 1862, The Geologist, London, Vol. 5, pp. 138-139. (Suggests that the trails are infallen gallery-tracks of burrowing crustaceans.)

Climactichnites Logan, Dawson, 1862, Canadian Nat. and Geol., Vol. 7, pp. 274-277. (Suggests that *Climactichnites* may have been made by a crustacean allied to *Limulus*.)

Climactichnites Logan, Chapman, 1864, Exposition of Minerals and Geology of Canada, p. 160. (Brief remarks on genus.)

Climactichnites Logan, Billings, 1870, Quart. Journ. Geol. Soc. London, Vol. 26, p. 485. (Considers that both *Protichnites* and *Climactichnites* trails may have been made by same animal.)

Climactichnites Logan, Chapman, 1877, Canadian Journ. Sci., Lit., and Hist., Vol. 15, pp. 486-490. (Suggests fucoidal origin of *Climactichnites* trails.)

Climactichnites Logan, Todd, 1882, Trans. Wisconsin Acad. Sci., Vol. 5, pp. 276-281. (Describes and illustrates *C. youngi* Chamberlin MS., and concludes that the trails were not made by crustaceans.)

Climactichnites Logan, Dawson, 1890, Quart. Journ. Geol. Soc. London, Vol. 46, pp. 596 and 600. (Same conclusion as in 1862, with a good illustration.)

Climactichnites Logan, Woodworth, 1903, Bull. New York State Mus., No. 69, pp. 956-966. (Describes trails and elongate oval bodies at end of trails, as remains of animal that made trail. Suggests molluscan origin.)

Climactichnites Logan, Clarke, 1905, Bull. New York State Mus., No. 80, pp. 18-20, pl. 3. (General description of the trails described by Woodworth.)

Until after the appearance of Woodworth's description and illustration of the trails found at Mooers, Clinton County, New York,[1] there was very little more than conjecture as to the nature of the animal that made the trails. The discovery of elongate oval bodies at the terminations of each one of a group of trails (pl. 40, fig. 2) immediately suggested a mollusk of some kind that had left a trace of the under side of the foot. Woodworth's conclusions are:[2]

1. The transverse ridges and their lateral extensions running forward to the next transverse ridge were made by the same movement of some organic structure lying transverse to the longitudinal axis of the organism.

2. The unity, identity, and spacing of successive transverse ridges indicate that they were made singly and in succession, that their spacing indicates the forward stride of the organism, and that it went forward by a crawling, hitching movement.

[1] Bull. New York State Museum, No. 69, 1903, pp. 959-966.

[2] Idem, pp. 962, 963-964, and 966.

3. The varying position of the median ridge with reference to the lateral ridges points to the conclusion that the transverse body was at the time characterized by a mesial sinus or upfold, and that the axis of this fold played to the right and left as a fold might in the flexible muscular foot of a crawling mollusk . . . .

4. The pressed sand on the slopes and over the crest of the transverse ridges eliminates from the processes by which the ridges may have been made the backward push of the posterior margin of such an animal as the trilobite or of any transverse gill plate so placed as not to permit, under the condition in which the creature moved, the smoothing down of the successive ridges by some soft, pliable body still further *au derrière.*

. . . . The trail itself, therefore, it seems safe to state, was made by some flexible body like the mesially up-curved posterior margin of the expanded, retractile foot of a large crawling organism.

It remains to note the nature of the terminal impressions associated with many of the trails in the Mooers occurrence. In the first place, the postulate above made that the trails were made progressively toward these oval terminal impressions may now be explained by stating that, where the relation of the oval impressions to the trail can be made out, it is clear that the oval impression has obliterated a portion of the trail which once extended into the area of the oval impression; this is taken to mean that the animal which made the trail reached the end of the track and there, resting on the sandy bottom, left an impression of the outline of some marginally relatively rigid structure of the ventral surface. Had the organism started out from this oval area, it is obvious that the oval would have been partly effaced and merged into the trail. The complete adjustment of the oval terminal impressions to the trails thus becomes of extreme interest; for it must be that in these impressions there is a clue to the outline of the organism which produced *Climactichnites.*

The larger of the terminal impressions measured at Bidwell's crossing gave a length of 16 inches and a breadth of 6 inches.

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The manner in which several of the trails approach in a common direction and end close to each other in sedentary impressions is exactly what takes place in the case of the trails of many gregarious aqueous forms, which crawl up a beach or a partly exposed sand bar and rest on the dry sand.

Among some fine specimens of *Climactichnites youngi* Chamberlin, received from Rev. A. A. Young of New Lisbon, Wisconsin, in 1886, there was one good example (pl. 38) of the outline of a terminal elongate oval body of essentially similar outline to those subsequently found by Woodworth at the ends of the trails at Mooers, New York. I put the specimen aside in the hope that more and better ones would be found so that we would have evidence upon which to base conclusions as to the animal that made the trail.

Woodworth suggests that the animal crawled up from the water at low tide across the ripple-marked and smooth beach sand; that it was

of a gregarious habit, sufficiently heavy to smooth out the ripple marks; and that it disappeared with the incoming tide. His conclusion that it was a mollusk explains some but not all of the facts observed. The impression on the sandstone illustrated by plate 38 shows that the front of the body making the impression was curved forward and that the arching lines extended back to the base of the large oval impression made by the under surface of the animal. So far as known to me, there is no recognized mollusk that would make such forward curving lines, and we do not know of any chiton or mollusk capable of making such an impression. In view of this it occurred to me to inquire into the possibility of the trails having been made by an annelid. Since many annelids have been found in the Middle Cambrian Burgess shale fauna [1] there appears to be no reason why remains and trails of large annelids should not be found in later formations. Among the Burgess shale forms there is a large Chætopod worm (*Pollingeria grandis* [2]), a crushed specimen of which has a length of 13 cm., width 7 cm. The larger scales found in the same layer of shale indicate that some individuals attained near twice that size. Such an annelid would have had sufficient size, weight, and strength to make the *Climactichnites* trails. Among recent annelids species of the Aphroditidæ attain a large size and some have a shallow water habitat and crawl about on the wet sand between tides. We can readily imagine that such an animal made the tracks under consideration. I have not seen any traces of the bristles or stiff setæ that occur on the parapodia of most of the Aphroditidæ, but this is not unexpected in a sandstone formation.

A reproduction of the figure of the specimen described by Woodworth [3] from Clinton County, New York, is made on pl. 40, fig. 2, and on pls. 38 and 39 specimens are illustrated of *C. youngi* from New Lisbon, Wisconsin. Much could be written about the details of these trails, but with the reproductions based on photographs and the descriptions of the figures the student may draw his own conclusions.

Genotype.—*Climactichnites wilsoni* Logan. 1860.

Formation and locality.—Upper Cambrian: (220b) Potsdam sandstone, Rogier's farm just west of town of Beauharnois, Province of Quebec, Canada.

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[1] Smithsonian Misc. Coll., Vol. 57, No. 5, 1911, pp. 110-144, pls. 18-23.

[2] Single scales only are illustrated; Smithsonian Misc. Coll., Vol. 57, No. 5, 1911, pl. 21, figs. 7-9.

[3] Bull. New York State Museum, No. 69, 1903, pp. 956-966.

Upper Cambrian: (99c) "St. Croix sandstone," near banks of Lemon-weir River, 4 miles (6.4 km.) north of New Lisbon, Wisconsin.

LINGULELLA PRIMA (Conrad MS.) (Hall)

Plate 41, figs. 8-11

Lingula prima (Conrad MS.) Hall, 1847, Nat. Hist. New York, Paleontology, Vol. 1, p. 3, pl. 1, fig. 2. (Described and discussed.)

For the synonymy of this species up to 1912, see Monograph 51, U. S. Geol. Survey, p. 526. (In press.)

An extended description and illustration of *Lingulella prima* are given in Monograph 51, pp. 526-527, pl. 27, figs. 1, 1a-c. (In press.)

Formation and locality.—Upper Cambrian: (77)[1] Potsdam sandstone near the water below the falls at the high bridge, and also at several horizons in the section, the highest point being 70 to 75 feet (21 to 23 m.) above the water, in Ausable Chasm; (367f) sandstone at French Creek, 1 mile (1.6 km.) east of Keeseville; (367g) sandstone in the bed of the brook, in the suburbs of Port Henry; (367h) Rosse Bridge, 4 miles (6.4 km.) west of Essex; (136) Potsdam sandstone in bank of stream opposite the first Y on the Port Henry and Maine Railroad out of Port Henry; and (338t) Potsdam sandstone in Ausable Chasm, below Keeseville; all in Essex County, New York.

LINGULELLA (LINGULEPIS) ACUMINATA (Conrad)

Plate 42, figs. 1-7

Lingula acuminata Conrad, 1839, Third Ann. Rept. New York State Surv., p. 64. (Described as a new species.)

For the synonymy of this species up to 1912, see Monograph 51, U. S. Geol. Survey, p. 545. (In press.)

An extended description and discussion of this species are given in Monograph 51, that include its geographic and stratigraphic distribution and a large number of illustrations.

It occurs in the Upper Cambrian, both in the Hoyt limestone (76) and the Potsdam sandstone (76a) in Saratoga County, New York.

Formation and locality.—For these see Monograph 51, pp. 548-550. (In press.)

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[1] 77 is the type locality, though the specimens to which that number is assigned in the United States National Museum were collected later than the type specimens.

Genus TRIBLIDIUM Lindström

TRIBLIDIUM CORNUTAFORME Walcott

Plate 41, figs. 12-14

Metoptoma cornutaforme Walcott, 1879, Thirty-second Ann. Rept. New York State Museum, p. 129. (Original description, as below.)

Oval, subconical; apex incurved, depressed, extending beyond the anterior margin; distance from the posterior margin to the apex twice the width. The most elevated point is about two-thirds the distance from the posterior margin to the apex; from this point the outline curves regularly to the posterior margin and anteriorly to the apex. Outline from the apex to the anterior margin convex. Length, 18 mm.; width, 9 mm.

Surface, with narrow concentric ribs, 1 mm. apart; finely striate vertically.

Formation and locality.—Upper Cambrian: (76) Arenaceous Hoyt limestone at Hoyts quarry, 4 miles (6.4 km.) west of Saratoga Springs, Saratoga County, New York.

Genus MATHERELLA, new genus

Univalve shells, sinistrally coiled; spire composed of round volutions that are more or less elevated; umbilicus open; peristome, so far as known, entire, united with the preceding volution on the inner side and probably not expanded to any considerable extent.

Genotype.—Matherella saratogensis, new species.

Stratigraphic range.—Upper Cambrian Hoyt limestone at Hoyts quarry.

Geographic distribution.—Saratoga County, New York, in the United States. Doubtfully in Shantung, China.

Observations.—This genus was recognized in 1886 and the name *Billingsia* used for it in a list of fossils.[1] As pointed out in the monograph on the Cambrian Brachiopoda [2] this name was previously used by both De Koninch (1876) and Ford (1886).

Comparison may be made between *Matherella* and *Scævogyra* Whitfield.[3] Both shells are sinistrally coiled, with rounded volutions, but *Scævogyra* has a more or less trumpet-shaped peristome, and it has rounded rather than flattened volutions.

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[1] Bull. U. S. Geol. Survey, No. 30, 1886, pp. 5, 21, 60, and 62. Also Bull. U. S. Geol. Survey, No. 81, 1891, p. 346.

[2] Monogr. U. S. Geol. Survey, Vol. 51, 1912, p. 561. (In press.)

[3] Geol. Surv. Wisconsin, Vol. 55, 1878, p. 198, pl. 3, figs. 7-9.

MATHERELLA SARATOGENSIS (Walcott)

Plate 41, figs. 18-21

Billingsia saratogensis WALCOTT, 1886, Bull. U. S. Geol. Surv., No. 30, p. 21. (Name given in list of species, but no description or figure.)

Trochus ? saratogensis WALCOTT, 1890, Proc. U. S. Nat. Mus., Vol. 13, pp. 268-269, pl. 20, fig. 3. (Original description as below.)

Billingsia saratogensis WALCOTT, 1891, Bull. U. S. Geol. Surv., No. 81, p. 346. (Copy of the first reference.)

Shell trochiforme, sinistral, broadly conical with about four slightly convex whorls; base concave; umbilical surface sloping inward from the angle produced by its union with the outer curvature of the body whorl; umbilicus rounded and of medium size; aperture obliquely subelliptical; periphery unknown. Surface marked by a few fine striæ of growth.

This shell is not a true *Trochus,* and in the photographic plate illustrating the Potsdam fauna of Saratoga County, New York, that I prepared in 1885 (page 252), it bears the name *Billingsia saratogensis.* This generic name was used in lists of species in 1886,[1] but no publication of the description of the genus has yet appeared. The name *Billingsia* having been preoccupied (page 263) the species was in 1890 provisionally referred to *Trochus* until further comparisons could be made.

Formation and locality.—Upper Cambrian: (76) Arenaceous Hoyt limestone at Hoyts quarry, 4 miles (6.4 km.) west of Saratoga Springs, Saratoga County, New York.

Genus PALÆACMÆA Hall and Whitfield

Palæacmæa HALL AND WHITFIELD, 1873, Twenty-third Ann. Rept. New York State Mus. Nat. Hist., p. 242. (Description of genus.)

PALÆACMÆA TYPICA Hall and Whitfield

Plate 43, figs. 1 and 2

Palæacmæa typica HALL AND WHITFIELD, 1873, Twenty-third Ann. Rept. New York State Mus. Nat. Hist., p. 242, pl. 2, figs. 4 and 5. (Description of species as below, figures 4 and 5 being reproduced in this paper as figures 1 and 2 of plate 43.)

The original description is as follows:

Shell patelliform, broadly oval in outline, with a depressed conical exterior, and a pointed subcentral apex, situated three-sevenths of the greatest length from one extremity. Surface of the shell marked by several strong folds or undulations parallel to the lines of growth.

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[1] Bull. U. S. Geol. Survey, No. 30, 1886, pp. 5, 21, 60, and 62.

Formation and locality.—Upper Cambrian: (77) Potsdam sandstone near the water below the falls at the high bridge, and also at several horizons in the section, the highest point being 70-75 feet (21.3-22.9 m.) above the water, in Ausable Chasm, Essex County; and in Potsdam sandstone at the north end of the town of Whitehall, Washington County; both in New York.

Genus MATTHEVIA Walcott

Matthevia Walcott, 1885, American Journ. Sci., 3d ser., Vol. 30, p. 17. (Genus described and discussed.)

Matthevia Walcott, 1886, Bull. U. S. Geol. Surv., No. 30, pp. 223-224. (A copy of the previous description.)

MATTHEVIA VARIABILIS Walcott

Plate 42, figs. 1-15

Matthevia variabilis Walcott, 1885, Amer. Journ. Sci., 3d ser., Vol. 30, p. 18, and figs. 1-6, p. 20. (Species described and illustrated.)

Matthevia variabilis Walcott, 1886, Bull. U. S. Geol. Surv., No. 30, pp. 224-225, pl. 32, figs. 1-12, pl. 33, figs. 1, 1a-f. (Described as in 1885, with added illustrations.)

This species is described very fully in Bulletin 30, of the U. S. Geological Survey.

Formation and locality.—Upper Cambrian: (76) Arenaceous Hoyt limestone at Hoyts quarry, 4 miles (6.4 km.) west of Saratoga Springs, Saratoga County, New York.

Genus HYOLITHES Eichwald

HYOLITHES GIBBOSUS Hall and Whitfield

Plate 43, figs. 5 and 6

Hyolithes gibbosus Hall and Whitfield, 1873, Twenty-third Ann. Rept. New York State Cab. Nat. Hist., p. 242, pl. 11, figs. 1-3. (Description of species as below, figures 1 and 2 of plate 11 being reproduced in this paper as figures 5 and 6 of plate 43.)

The original description is as follows:

Shell elongate conical, gradually tapering to an obtuse point, and slightly curving; very depressed, convex on the ventral side, and highly convex and gibbous on the dorsal, the sides being nearly vertical for a short distance from their junction with the ventral margin. Aperture rather more than semicircular; the lip on the ventral portion moderately projecting.

This species resembles *Hyolithes* (*Theca*) *primordialis* Hall, from the Potsdam sandstones of Wisconsin, but differs in being much more convex on the dorsal side, and in the less projecting lip of the ventral side of the aperture. The outlines given in figure 3 show the relative convexity of the two species, the outer dorsal line being that of *H. gibbosus,* and the inner of *T. primordialis.*

Formation and locality.—Upper Cambrian: (77) Potsdam sandstone near the water below the falls at the high bridge, and also at several horizons in the section, the highest point being 70-75 feet (21.3-22.9 m.) above the water, in Ausable Chasm, Essex County, New York.

Genus PELAGIELLA Matthew

Pelagiella Matthew, 1895, Trans. New York Acad. Sci., Vol. 14, p. 131.

PELAGIELLA MINUTISSIMA (Walcott)

Plate 41, figs. 15 and 16

Platyceras minutissimum Walcott, 1879, Thirty-second Ann. Rept. New York State Museum, p. 129. (Original description as below.)

Shell small, subspiral, regularly arcuate from near the aperture to the apex, making nearly three-fourths of one volution; section subelliptical, somewhat carinate upon the dorsum. Two transverse depressions upon the sides give a slight undulation to the body of the shell.

Surface marked by faint longitudinal striæ.

Formation and locality.—Upper Cambrian: (76) Arenaceous Hoyt limestone at Hoyts quarry, 4 miles (6.4 km.) west of Saratoga Springs, Saratoga County, New York.

PELAGIELLA HOYTI (Walcott)

Plate 41, fig. 17

Platyceras hoyti Walcott, 1890, Proc. U. S. Nat. Mus., Vol. 13, p. 268, pl. 20, fig. 8. (Original description as below.)

Shell small, depressed, making about three volutions, the interior below the plane of the outer volution. Volutions contiguous throughout their extent, expanding gradually to the somewhat compressed, more rapidly expanding outer whorl. Aperture unknown.

Outer surface of shell marked by fine concentric striæ and the inner surface by longitudinal striæ.

This species differs from the associated *P. minutissima* in the form of the whorls and surface characters. The longest specimen has a transverse diameter of 4 mm.

Formation and locality.—Upper Cambrian: (76) Arenaceous Hoyt limestone at Hoyts quarry, 4 miles (6.4 km.) west of Saratoga Springs, Saratoga County, New York.

Genus HYOLITHELLUS Billings

Hyolithellus Billings, 1871, Canadian Nat. and Geol., new ser., Vol. 6, p. 240.

HYOLITHELLUS PAPILLATUS, new species

Plate 43, figs. 3 and 4

Long, slender, cylindrical tube with a circular section. The largest specimen in the collection has a length of 12 mm., with a diameter of 2 mm. A difference in diameter in the 12 mm. of length is not perceptible. The surface is thickly studded with minute, rounded, flattened papillæ.

This species differs from described forms in its papillose surface.

Formation and locality.—Upper Cambrian: (111) At the top of the Potsdam sandstone on Marble River, one mile (1.6 km.) south of Chateaugay, Franklin County, New York.

Genus PTYCHOPARIA Corda

PTYCHOPARIA MINUTA (Bradley)

Plate 43, figs. 20-24

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

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

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

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

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

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

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

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

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

The very full description of the characters of the cephalon of this species given by Messrs. Bradley, Billings, and Hall are well represented by figures 20-22 on plate 43. The associated pygidium is shown

by figures 23 and 24. The closely related *Ptychoparia minor* (Shumard)[1] of the "St. Croix sandstone" of Wisconsin occurs at a lower stratigraphic horizon. In Nevada a somewhat similar species, *Ptychoparia? annectans* Walcott[2] occurs in the lower part of the Ordovician Pogonip limestone. So far as known to me the type of trilobite cephalon represented by *P. minuta* occurs in the Upper Cambrian and in higher beds that may now be grouped in the Lower "Ozarkian" of Ulrich.[3]

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

PTYCHOPARIA MATHERI, new species

Plate 44, figs. 15-17

This species is represented by the cranidium, free cheeks, and fragments of an associated pygidium referred to it. It is one of the larger species of the genus and may be compared to *Ptychoparia striata* (Barrande), the type of the genus, and *P. richmondensis* (Walcott).[4] That such a large species of *Ptychoparia* should occur in the Potsdam sandstone is most interesting as the genus reaches its greatest development in the Middle Cambrian.

The largest cranidium has a length of 28 mm. Surface minutely granular.

Formation and locality.—Upper Cambrian: (110) Potsdam sandstone formation, shaly calcareous sandstone resting on massive layers of sandstone in bluff on east side of town of Whitehall, Washington County, New York.

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[1] Well illustrated by Hall, Sixteenth Ann. Rept. New York State Cab. Nat. Hist., 1863, pl. 8, figs. 1-4.

[2] Monogr. U. S. Geol. Survey, Vol. 8, 1884, p. 91, pl. 12, fig. 18.

[3] Bull. Geol. Soc. America, Vol. 22, No. 3, 1911, pl. 27.

[4] Monogr. U. S. Geol. Survey, Vol. 8, 1884, p. 41, pl. 10, fig. 7.

Genus CONOCEPHALINA Brögger

CONOCEPHALINA WHITEHALLENSIS, new species

Plate 44, figs. 9-11a.

Although fragments of this species are abundant they are so broken and abraded that only imperfect specimens of the cranidium, free cheeks, and associated pygidia have been seen.

The elongate-subquadrangular glabella, narrow free cheeks, and long palpebral lobes of the cranidium relate this species to *Conocephalina ornata* Brögger, the type of the genus. The free cheek probably had a short, sharp genal spine. The cranidium illustrated has a length of 7.5 mm.

Formation and locality.—Upper Cambrian: (110a) Potsdam sandstone formation, in sandstone a little above and east of the canal road north end of town of Whitehall, Washington County, New York.

Genus PAGODIA Walcott

Pagodia Walcott, 1905, Proc. U. S. Nat. Mus., Vol. 29, p. 63.

PAGODIA SEELYI, new species

Plate 44, figs. 12-14a.

This very neat species is fairly abundant at one locality of the Potsdam sandstone near Port Henry. It is represented by casts of the cranidium and pygidium and is much like *Pagodia dolon* Walcott[1] from the Upper Cambrian of China. Somewhat similar forms occur in the lower portion of the Pogonip limestone of Nevada.[2]

One of the largest cranidia in the collection has a length of 7 mm.

Formation and locality.—Upper Cambrian: (136a) Potsdam sandstone, on a large brook at a point on the Mineville Railroad at the turning of the first Y near Port Henry, Essex County, New York.

AGRAULOS SARATOGENSIS Walcott

Plate 43, figs. 11-15a.

Bathyurus armatus (Billings), Walcott, 1879, Thirty-second Ann. Rept. New York State Museum, p. 131. (Provisionally identified as *B. armatus.*)

Ptychoparia (*A.*) *saratogensis* Walcott, 1886, Bull. U. S. Geol. Surv., No. 30, p. 21. (Name used in list.)

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

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[1] Proc. U. S. National Museum, Vol. 29, 1905, p. 66.

[2] Monogr. U. S. Geol. Survey, Vol. 8, 1884, pl. 12, fig. 5.

Ptychoparia (A.) saratogensis Walcott, Lesley, 1889, Geol. Surv. Pennsylvania Rept. P 4, Dictionary of Fossils, Vol. 2, p. 834, 4 text figures only. (Reproduces 4 drawings sent him by Walcott.)

Agraulos saratogensis Walcott, 1890, Proc. U. S. Nat. Mus., Vol. 13, p. 276, pl. 21, fig. 14. (Description of species.)

Agraulos saratogensis (Walcott), Weller, 1903, Geol. Surv. New Jersey, Report on Paleontology, Vol. 3, The Paleozoic Faunas, pp. 118-119, pl. 1, figs. 7-9. (Describes and illustrates specimens from New Jersey.)

Nothing has been added to our information about this species since its description in 1890, except that the outer surface of the test is finely granulated and the species occurs in other localities.

The cranidia of the Hoyt quarry specimens have an average length of about 10 mm., and a few large ones reach 15 mm., and one from near Poughkeepsie has a length of 20 mm.

The specimens from Newton, New Jersey, are smaller, but appear to be similar so far as can be determined by comparing the cranidia.

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

Doubtfully in lower portion of Kittatinny limestone: (11c) Hardyston quartzite [Weller, 1900, pp. 10 and 12], O'Connell and McManniman's quarry, Newton, Sussex County, New Jersey.

Specimens of similar cranidia occur in a block of drift sandstone, found near Trenton Falls, Oneida County, New York, supposed to have been derived from the Potsdam sandstone somewhere west of the Adirondack Mountains, New York.

Genus LONCHOCEPHALUS Owen

LONCHOCEPHALUS CALCIFERUS (Walcott)

Plate 43, figs. 7-10a

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

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

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

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

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

Head semicircular, convex. Glabella truncato-conical, moderately convex; width at the base nearly equal to the length; anterior margin straight, abruptly rounded at the angles; sides straight and regularly converging; the posterior and middle glabellar furrows oblique and well marked, the anterior furrow indicated by a smooth line upon the granulose outer shell, and a slight depression when the outer shell is removed. Occipital furrow broad and well impressed. Occipital ring narrow at the sides, widening at the center to form the base of a strong, slightly curved spine, which extends obliquely backward; the length of the spine in large individuals equals the length of the head. The glabella in very young individuals is more convex, the glabellar furrows more strongly impressed, and the spine projecting from the occipital ring shorter and less obliquely inclined backward. Dorsal furrows equally impressed at the sides and front of the glabella. Facial suture, curving slightly outward from the frontal margin, passes directly to the anterior angles of the palpebral lobe opposite the anterior glabellar furrow, thence curving to the posterior angle of the palpebral lobe, it extends obliquely outward to the lateral margin of the posterior limb.

Fixed cheeks narrow; frontal limb extending a distance equal to one-half the length of the glabella, sloping somewhat abruptly to a comparatively broad, thickened margin; posterior limb narrow, elongate, with a strongly defined furrow along the center. Palpebral lobe separated from the fixed cheeks by a sigmoid groove, which unites anteriorly with the dorsal furrow. Surface of glabella and fixed cheeks granulose; on the frontal limb the granules are so arranged as to give the appearance of lines running from the dorsal furrow to the broad margin, which has lamellose striæ subparallel to the margin. The largest head of this species obtained is nearly 25 mm. in length, with a spine of equal length projecting from the occipital ring.

Observations.—This species is closely related to *Lonchocephalus wisconsinensis* (Owen). It differs in having a relatively shorter frontal limb and longer palpebral lobes and it occurs at a somewhat higher horizon.

The fragment provisionally referred to *L. calciferus* by Dr. Stuart Weller may possibly belong to it, but it is too doubtful to base any conclusion on.

Some of the specimens of *L. calciferus* from south of Poughkeepsie are larger than those from Hoyts quarry. One cranidium is over 21 mm. in length, exclusive of the occipital spine.

Formation and locality.—Upper Cambrian, Hoyt limestone: (76) Arenaceous limestone at Hoyts quarry, 4 miles (6.4 km.) west of

Saratoga Springs, Saratoga County.; (76a) in a railroad quarry, 1 mile (1.6 km.) north of Saratoga Springs, Saratoga County; and in arenaceous limestone, 2 miles (3.2 km.) south of Poughkeepsie, Dutchess County; all in New York.

Genus PTYCHASPIS Hall

PTYCHASPIS SPECIOSUS Walcott

Plate 43, figs. 16-19

Ptychaspis speciosus Walcott, 1879, Thirty-second Ann. Rept. New York State Museum, p. 131. (Species described as below.)

Ptychaspis speciosus Walcott, Lesley, 1889, Geol. Surv. Pennsylvania, Rept. P 4, Dictionary of Fossils, Vol. 2, p. 830. (Text figure reproduced from a drawing sent him by Walcott.)

Glabella large, very convex, almost subcylindrical, width a little less than the length, nearly straight in front, the lateral angles rounded, sides straight and nearly parallel; posterior glabellar furrow extending deeply and obliquely about one-third across the glabella and connected by a straight transverse furrow; the middle glabellar furrow is less deeply impressed and extends across the glabella subparallel to the posterior furrow; the anterior furrow is indicated by a very obscure line opposite the anterior angle of the palpebral lobe. The occipital furrow is deeply impressed throughout its length. The occipital ring is strong and prominent, but not elevated above the general surface of the glabella. Dorsal furrow deeply excavated at the sides and well defined in front.

The facial suture, cutting the frontal margin on a line with the outer edge of the palpebral lobe, curves slightly outward, and passes directly to the anterior angle of the palpebral lobe; curving around this it passes obliquely outward to the margin of the posterior limb.

Fixed cheeks of medium width; the frontal limb is impressed with a groove midway between the dorsal furrow and its anterior margin; the posterior limb is subtriangular, with a furrow extending from the dorsal furrow to its lateral margin; the palpebral lobe is large and separated from the fixed cheeks by a deep sigmoid furrow. Surface granulose with waving striæ on the central portion of the fixed cheeks opposite the palpebral lobes.

This species is referred to the genus *Ptychaspis* from its strongly furrowed subcylindrical glabella and the direction of the facial suture. The largest specimen obtained of the head has a length of 12.5 mm., with a breadth of 13.7 mm. at the palpebral lobes.

Observations.—This very striking form is represented by numerous specimens of the cranidium with a few free cheeks and pygidia referred to it. The most nearly related species is *Ptychaspis granulosa* (Owen), which differs in having a proportionately shorter, more convex cranidium and smaller palpebral lobes. The pygidium (fig. 18) is very doubtfully referred to the species. The generic reference is somewhat doubtful as the large palpebral lobes and broadly rounded anterior margin of the glabella suggest *Dicellocephalus lodensis* (Whitfield).

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

A form apparently identical with *P. speciosus* was found in a drift block of sandstone, near Trenton Falls, Oneida County, New York, supposed to have been derived from the Potsdam sandstone west of the Adirondack Mountains.

Genus DICELLOCEPHALUS Owen

DICELLOCEPHALUS HARTTI (Walcott)

Plate 44, figs. 1-7a.

Conocephalites hartti Walcott, 1879, Thirty-second Ann. Rept. New York State Museum, p. 130. (Original description of species.)

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

Dicellocephalus hartti (Walcott), Lesley, 1889, Geol. Surv. Pennsylvania, Rept. P 4, Dictionary of Fossils, Vol. 1, p. 199. (Text figure reproduced from drawing sent him by Walcott.)

Glabella truncato-conical, moderately convex; width at base, excluding occipital segment, equal to the length; slightly rounded in front, with anterior lateral angles abruptly rounded; posterior glabellar furrow extends obliquely in about one-third the distance across the glabella from each side, where it is united by a transverse furrow; middle furrow extends obliquely in from each side, but is not united at the center; anterior furrow obscurely defined opposite the anterior angle of the palpebral lobe. Occipital furrow broad and not deeply impressed. Occipital ring broad and slightly convex. Dorsal furrow well defined at the sides and front.

The facial suture curves slightly outward from the frontal margin, thence curving in to the anterior angle of the palpebral lobe, passes to the posterior angle of the palpebral lobe, and thence obliquely outward to the margin of the posterior limb.

Fixed cheeks comparatively broad; frontal limb about one-fifth the length of the head, curving gently from the dorsal furrow to the anterior margin; posterior limb elongate, with a strong furrow from the dorsal furrow to its extremity. Palpebral lobe elongate, separated from the fixed cheeks by a groove within the margin; surface covered with fine lamellose striæ.

This species is much larger than *Lonchocephalus calciferus*. The largest cranidium in the collection has a length of 30 mm., and a large pygidium has a length of 37 mm. with a width of 60 mm.

The surface is finely punctate and marked by very fine, irregular imbricating lines.

Observations.—This species differs from *Dicellocephalus minnesotensis* in details, but it appears to come within the limits of the genus.

In the larger specimens the frontal rim is broad and slightly convex and in some specimens merged directly into the frontal limb. In the small specimens the frontal rim is more rounded and a distinct broad groove separates it from the narrow frontal limb. Comparing specimens of the cranidium 8 to 10 mm. in length with specimens 30 mm. in length two species would appear to be indicated, but there is a gradual transition by the widening out and flattening of the frontal limb so that the two extremes are united by forms that grade from the narrow rounded frontal limb to the broad flattened rim.

A somewhat similar gradation exists between small pygidia and large pygidia. In the small pygidia the median lobe extends back nearly to the posterior margin. The space between the margin and the end of the lobe increases in size until in the large forms, 37 millimeters in length, the flattened border is nearly one-third the length of the pygidium.

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

DICELLOCEPHALUS TRIBULIS, new species

Plate 44, figs. 8 and 8a.

A second well-marked species of *Dicellocephalus* occurs in association with *D. hartti*. It is closely allied to *D. misa* Hall of the "St. Croix sandstone" of Wisconsin. It differs in having slightly wider fixed cheeks, a more rounded frontal rim, and granulated surface.

The pygidium provisionally referred to this species also varies considerably from the pygidium referred to *D. misa*.

The largest specimen of a cranidium in the collection has a length of 16 mm.

Formation and locality.—Upper Cambrian, Hoyt limestone: (76) Arenaceous limestone at Hoyts quarry, 4 miles (6.4 km.) west of Saratoga Springs, Saratoga County, New York.

Genus PROTICHNITES Owen

Protichnites OWEN, 1852, Quart. Journ. Geol. Soc. London, Vol. 8, p. 214. (Describes *Protichnites septem-notatus* and thus uses generic name.)

Protichnites Owen, BILLINGS, 1857, Canadian Nat. and Geol., Vol. 1, pp. 35-39. (General remarks and quotations from Owen's paper of 1852.)

Protichnites Owen, DAWSON, 1862, Idem, Vol. 7, pp. 271-277. (Discusses relations of *Protichnites* to the tracks of *Limulus*.)

Protichnites Owen, CHAPMAN, 1864, Exposition of the Minerals and Geology of Canada, pp. 159-160. (General remarks.)

Protichnites Owen, BILLINGS, 1870, Quart. Journ. Geol. Soc. London, Vol. 26, pp. 484-485. (Discusses Dawson's views and concludes that the tracks were made by trilobites.)

Protichnites Owen, CHAPMAN, 1877, Canadian Journ. Sci., Lit., and Hist., new ser., Vol. 15, pp. 486-490. (Discusses tracks and concludes that the so-called tracks of *Protichnites* and *Climactichnites* are of fucoidal origin.)

Protichnites Owen, DAWSON, 1890, Quart. Journ. Geol. Soc. London, Vol. 46, pp. 599-601, figs. 4 and 5a. (States that *Protichnites* are indubitable tracks of crustaceans.)

Protichnites Owen, PACKARD, 1900, Proc. American Acad. Arts and Sci., Boston, Vol. 36, pp. 63-71. (Restricts use of *Protichnites* to tracks with individual footprints.)

The first notice of the tracks subsequently named *Protichnites* appeared in the Montreal Gazette in 1847. They were referred to as the tracks of a tortoise. The editor, Mr. Abraham, called Mr. William E. Logan's attention to them and the latter subsequently made a geological study of the region where they occurred in Beauharnois County, Ontario, Canada. He[1] identified the sandstone as the Potsdam formation of the New York state geologists and took great pains to have casts made of the first tracks for Prof. Richard Owen, who at first thought that the tracks might be those of a tortoise.[2] Later, with more material, he described the tracks under the generic name *Protichnites*.[3] He described and illustrated six species, *Protichnites septem-notatus, P. octo-natatus, P. latus, P. multinotatus,*

[1] Quart. Journ. Geol. Soc. London, Vol. 7, 1851, pp. 247-250.

[2] Idem, pp. 250-252.

[3] Idem, Vol. 8, 1852, p. 214.

P. lineatus, and *P. alternans.*[1] Professor Owen concludes[2] that a crustacean like *Limulus* was nearest to his idea of the kind of animal which left the impressions on the Potsdam sandstone.

In 1857[3] Mr. E. Billings wrote a general paper on the fossils of the Potsdam sandstone, but did not add any observations of importance.

Dr. J. W. Dawson, in order to test Professor Owen's view that an animal like *Limulus* may have made the *Protichnites* tracks experimented with a living *Limulus* at the seashore, causing it to creep about on the sand under various conditions. Summarized, his conclusions are:[4]

1. The conjecture of Owen that they may have been made by a creature somewhat resembling *Limulus,* is verified by the impressions made by that animal.

2. The further view of Owen that the grouping of the impressions depended on multifid limbs, and that the number of impressions in a group might indicate specific diversity, is also vindicated by the facts, with this limitation, anticipated by Professor Owen, that tracks like *P. lineatus,* might have been made by any of the animals which made the other impressions, and that if like *Limulus* they possessed one large pair of feet making the principal marks, and smaller ones occasionally used, the numbers of marks may have somewhat differed in different circumstances . . . .

3. The animal or animals producing the *Protichnites* probably resembled *Limulus* in general form, and in the possession of a strong caudal spine. They probably differed from *Limulus* in the less breadth or depth of the cephalothorax, and in the greater complexity and comparative size of the feet.

4. Some at least of the *Protichnites* were probably produced by animals creeping on wet sand; but *P. lineatus* and the *Climactichnites,* if the work of a similar animal, were formed under water . . . .

5. The suppositions above stated would account for the absence or rarity of remains of the animals which produced the *Protichnites* . . . .

6. If we enquire what animals, known to palæontologists, have produced the *Protichnites,* it would seem that no others fulfil the necessary conditions in any particular, except the larger trilobites, for instance those of the genus *Paradoxides* . . . . On the whole we may safely conclude that if any of the larger primordial trilobites were provided with walking and swimming feet of the type of those of *Limulus,* but differing in details of structure, they may have produced both the *Protichnites* and the *Climactichnites.* On the other hand, it is quite possible that these impressions have been formed by crustaceans yet undiscovered, and approaching in some respects more nearly to *Limulus* than any of the known trilobites. In this last case I should suppose that the animal in question had a flatter or more shallow cephalo-thorax than

[1] Quart. Journ. Geol. Soc. London, Vol. 8, 1852, pp. 214-225.

[2] Idem, p. 224.

[3] Canadian Nat. and Geol., Vol. 1, 1857, pp. 35-39.

[4] Idem, Vol. 7, 1862, pp. 276 and 277.

that of *Limulus,* proportionately stronger and perhaps more divided feet, and a stouter caudal spine.

Mr. E. Billings in 1870[1] concluded that:

1. The tracks could have been made either by a *Limulus* or by a trilobite.
2. No fossils of the order (Ziphosura) to which *Limulus* belongs have been found so low down as the Potsdam sandstone.
3. Large trilobites occur there in abundance.

The weight of evidence, therefore, favors the opinion that the tracks in question are those of trilobites.

Prof. E. J. Chapman in 1877[2] broached the view that the tracks named *Protichnites* and *Climactichnites* were of fucoidal origin. I will refer to this view again under *Climactichnites* (see p. 278).

In a very fine paper on burrows and tracks Sir J. William Dawson in 1890[3] stated that the *Protichnites* of the Potsdam sandstone are indubitable tracks of crustaceans, and that both *Protichnites* and *Climactichnites* may have been made by the same animal.

My own interest in the tracks began in 1886 when I first met with them north of the Adirondack Mountains in Beauharnois, Canada, and on the eastern side of the mountains in Essex County, New York. At the Beauharnois locality, west of the town, on Rogier's farm I obtained fine specimens of the *Protichnites* tracks, showing that many of the impressions were trifid (pls. 46 and 47) and made by a crustacean having legs terminating in a joint that had three strong, narrow, terminal spines. It was this trifid aspect of the tracks that probably led the first observers to consider that the tracks might have been made by a three-toed vertebrate similar to the tortoise. For twenty-six years I have had the specimens, or photographs of them, in my laboratory, waiting for something to turn up that would explain more satisfactorily not only the complicated and varied series of tracks described by Owen, but also the trifid impressions illustrated on plates 46 and 47 of this paper. The explanation came with the discovery in 1911 of the series of appendages of the trilobite *Neolenus serratus* (Rominger). On plate 45, figure 1, is shown a series of the legs on the left side of the trilobite extending far beyond the margin of the dorsal shield. In figure 2, the terminal joints of several of the legs have three terminable, movable, slightly curved spines. The cephalic legs of figure 3 project forward from the side of the cephalon, and figure 4 shows the trifid arrangement of the short, strong spines of the terminal joint of the cephalic legs.

[1] Quart. Journ. Geol. Soc. London, Vol. 26, 1870, pp. 484-485.
[2] Canadian Journ. Sci., Lit., and Hist., new ser., Vol. 15, 1877, p. 490.
[3] Quart. Journ. Geol. Soc. London, Vol. 46, 1890, p. 599.

If we picture in our imagination a trilobite with a series of twelve pairs of legs posterior to the cephalon (figs. 1 and 2), and five pairs of cephalic legs, walking on the smooth or rippled surface of fine wet sand exposed at low tide, I think we can readily explain the *Protichnites* tracks on the Potsdam sandstone. Such a series of feet would make varied and complex series of tracks that would differ in depth, definition, and details of grouping with the varying degree of consistency and hardness of the surface over which the animal was traveling and its method of moving. I have fine trilobite trails made on the surface of sandy mud that show the imprint of a considerable portion of the legs. On a hard surface the animal touched only the extremities of the legs, but on a muddy surface the terminal joint would sink in and other joints would leave an impression.

The particular trilobites that left the tracks on the beaches of Potsdam sandstone time were undoubtedly species of the genus *Dicellocephalus*. Individuals of this genus attained a large size, and *Dicellocephalus hartti* occurs in the Potsdam sandstone both north and south of the Adirondack Mountain area of New York.

With our present information of the structure of the trilobites I do not think that we can consider *Climactichnites* as the trail of a trilobite. This has been referred to under discussion of that genus (pp. 259-261).

Summary.—The *Protichnites* tracks found on the surface of layers of Potsdam sandstone were made by trilobites of the genus *Dicellocephalus*.

The trifid imprint resulted from the impress of the end of the terminal joint of the trilobite's leg with its three movable spines.

The trails named *Climactichnites* were not formed by trilobites and have a quite different origin from the *Protichnites* tracks.

PROTICHNITES SEPTEMNOTATUS Owen

Plates 46 and 47

Protichnites septem-notatus OWEN, 1852, Quart. Journ. Geol. Soc. London, Vol. 8, pp. 214-217, pl. 9. (Description of species.)

I shall not attempt to insert the synonymy of this species. The principal papers treating of the genus have been mentioned. In a future paper on the trilobite I may consider in detail the various series of tracks to which Owen gave specific names. At present I am inclined to consider that all the Beauharnois tracks were made by one species of *Dicellocephalus* and the Keeseville, Essex County, New York, tracks by another species. The latter tracks are on a finer-

grained, smoother surface than those at Beauharnois, and the individual impressions of the feet are more numerous and crowded along the main lines of tracks.

Formation and locality.—Cambrian (Upper ?), Potsdam sandstone: (220b) Rogier's farm just west of Beauharnois, Province of Quebec, Canada.

PROTICHNITES LOGANANUS Marsh

Plates 48 and 49

Protichnites logananus MARSH, 1869, American Journ. Sci., 2d ser., Vol. 48, pp. 46-49. (General description, discussion, and illustration.)

Protichnites logananus MARSH, 1869, Proc. American Assoc. Adv. Sci., Vol. 17, pp. 322-324. (Same as preceding reference, except that the plate is omitted; also the footnote regarding Doctor Dawson's view.)

The tracks are described as having been made by a smaller animal than the one that made the Beauharnois *Protichnites* tracks; also that there was no medial trail or tail mark as in the latter tracks.

I collected from near the type locality several slabs of the sandstone with many tracks on them. Some of these have a median trail or furrow that indicates two terminal spines on the pygidium, or, which I think is the more correct view, the furrow with deep sides was formed by the dragging of the anterior portion of the caudal furca of the trilobite on the sand. That some series of tracks are without the median trail indicates that the animal that made the tracks kept well up from the sand, while others that may have been heavier or weaker touched and dragged some portion of the median dorsal surface or the caudal furca along on the sand.

Formation and locality.—Upper Cambrian, Potsdam sandstone: (77) Sandstone near the water below the falls at the high bridge, and also at several horizons in the canyon, the highest point being 70-75 feet (21-22 m.) above the water, in Ausable Chasm, Essex County, New York.

DESCRIPTION OF PLATE 37

PAGE

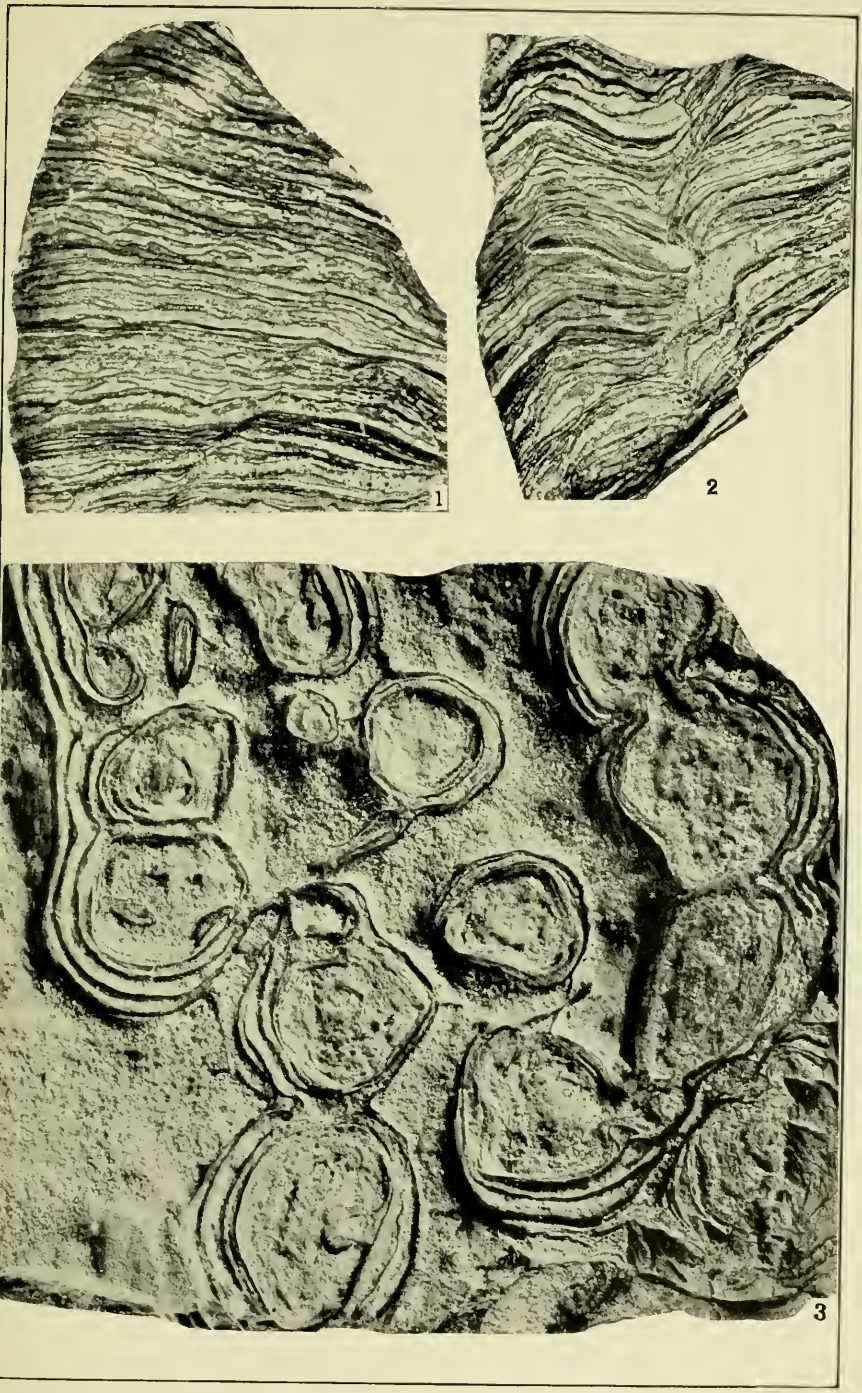
Cryptozoön proliferum (Hall) 258

FIG. 1. (Natural size.) View, by transmitted light, of a thin transverse section, showing the lamellæ. U. S. National Museum, Catalogue No. 58541.

2. (Natural size.) View, by transmitted light, of a thin section, showing the lamellæ where there was a slight dislocation, caused by irregularity of growth. U. S. National Museum, Catalogue No. 58542.

3. (Natural size.) View of the weathered surface of limestone, showing several specimens. U. S. National Museum, Catalogue No. 58543.

The specimens represented by figs. 1-3 are from locality (110) Upper Cambrian, shaly calcareous sandstone resting on massive layers of Potsdam sandstone, east side of the town of Whitehall, Washington County, New York.



CRYPTOZOÖN PROLIFERUM HALL

DESCRIPTION OF PLATE 38

PAGE

Climactichnites youngi (Chamberlin). (See pl. 39)..... 259

FIG. 1. (Reduced one-sixth.) Impression on beach sand by the lower surface of the animal making the *Climactichnites* trails. A portion of the trail is shown, also the forward arching lines on the transverse ridges made by the backward push of the animal in creeping forward. These are well shown by fig. 2, pl. 39. U. S. National Museum, Catalogue No. 58544.

The specimen represented is from locality (99c) Upper Cambrian, near New Lisbon, Wisconsin.

TRAIL OF ANNELID

DESCRIPTION OF PLATE 39

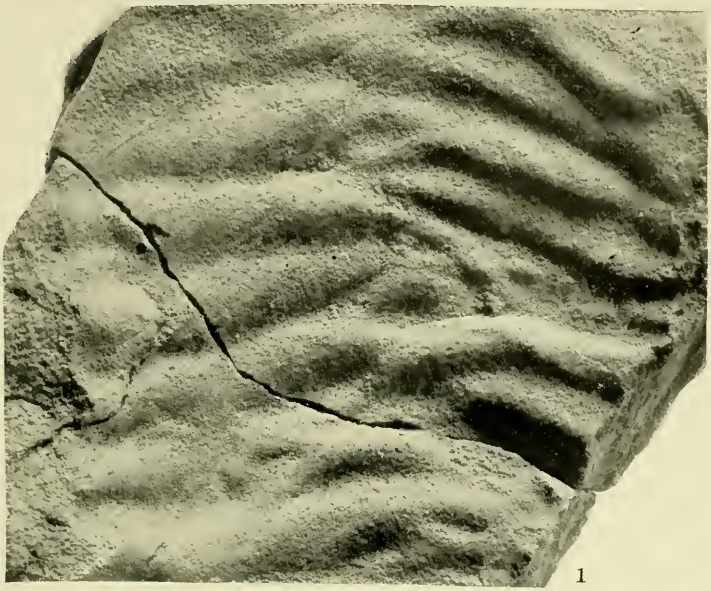
PAGE

Climactichnites youngi (Chamberlin). (See pl. 38) 259

FIG. 1. (Natural size.) Portion of a trail where the animal made a very irregular track and thus recorded the fact of its having a very flexible under surface. U. S. National Museum, Catalogue No. 58546.

2. (Reduced about one-seventh.) Portion of a very regular trail, showing forward-curving transverse furrows made by pressing the beach sand backward in creeping, also curved lines made by the impression of the very fine, forward-arching transverse ridges on the ventral surface of the animal. U. S. National Museum, Catalogue No. 58545.

Both specimens represented are from locality (99c) Upper Cambrian, near New Lisbon, Wisconsin.



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TRAIL OF ANNELID

DESCRIPTION OF PLATE 40

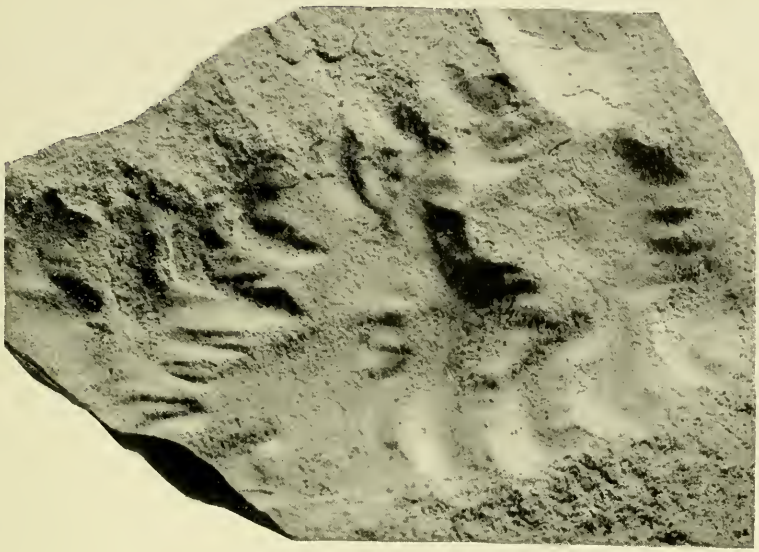
PAGE

Climactichnites wilsoni (Logan) 259

FIG. 1. (Reduced to about one-half natural size.) Trail showing longitudinal furrows very much like those on fig. 1, pl. 39. This specimen strongly suggests the action of water in forming the longitudinal furrows. U. S. National Museum, Catalogue No. 58547.

The specimen represented is from locality (99c) Upper Cambrian, near New Lisbon, Wisconsin.

2. (One-twenty-fifth of natural size.) Copy of portion of plate illustrating a series of trails discovered at Mooers, Clinton County, New York. [Bull. New York State Museum, No. 80, 1905, pl. 3.] The specimen represented is now in the New York State Museum, Albany, New York.



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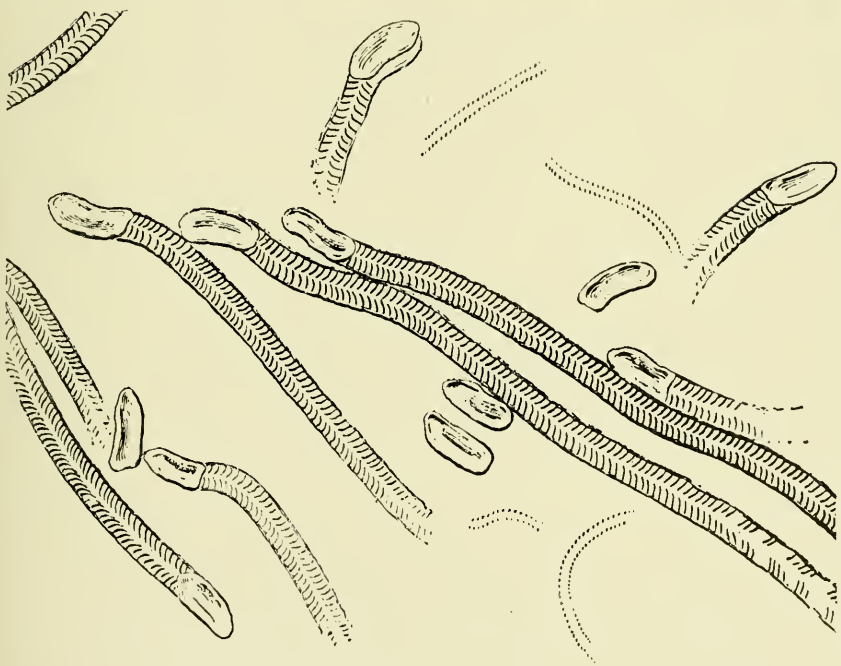


2

TRAILS OF ANNELID

DESCRIPTION OF PLATE 41

PAGE

Lingulella (*Lingulepis*) *acuminata* (Conrad) 262

FIGS. 1-4. Varying forms of the ventral valve. Fig. 4 is much like that of the type specimen of "*Lingulella pinnaformis* Owen."

5-7. Varying forms of the dorsal valve.

Figs. 1-7 are copied from the figures illustrating this species on Plate XL, figs. 1h-n, respectively, of Monogr. 51 U. S. Geol. Survey, 1912 (in press). The specimen represented by figure 1h is in the U. S. National Museum, Catalogue No. 52469a; the specimens represented by figures 1i-n are in the U. S. National Museum, Catalogue Nos. 51878a-f, respectively.

Lingulella prima (Conrad MS.) Hall 262

FIG. 8. Fragment of a ventral valve, showing the cast of the area, the divided umbonal muscle scar (g), and the pedicle scar (m). U. S. National Museum, Catalogue No. 27435c.

9. Exterior of a ventral valve, showing rather strong undulations of growth. U. S. National Museum, Catalogue No. 27435b.

10. Cast of the interior of a ventral valve, showing the pestle-shaped ridge that filled the median groove of the interior of the shell. U. S. National Museum, Catalogue No. 27435a.

11. Partly exfoliated dorsal valve. U. S. National Museum, Catalogue No. 27435d.

The specimens represented are all from locality (77), Upper Cambrian sandstone, Ausable Chasm, Essex County, New York.

Figs. 8-11 are copied from the figures illustrating this species on Plate XXVII, figs. 1b, 1a, 1, and 1c, respectively, of Monogr. 51, U. S. Geol. Survey, 1912 (in press).

Triblidium cornutaforme (Walcott) 263

FIG. 12. (×3.) Side view of a small, rather depressed specimen, showing the profile. U. S. National Museum, Catalogue No. 58548.

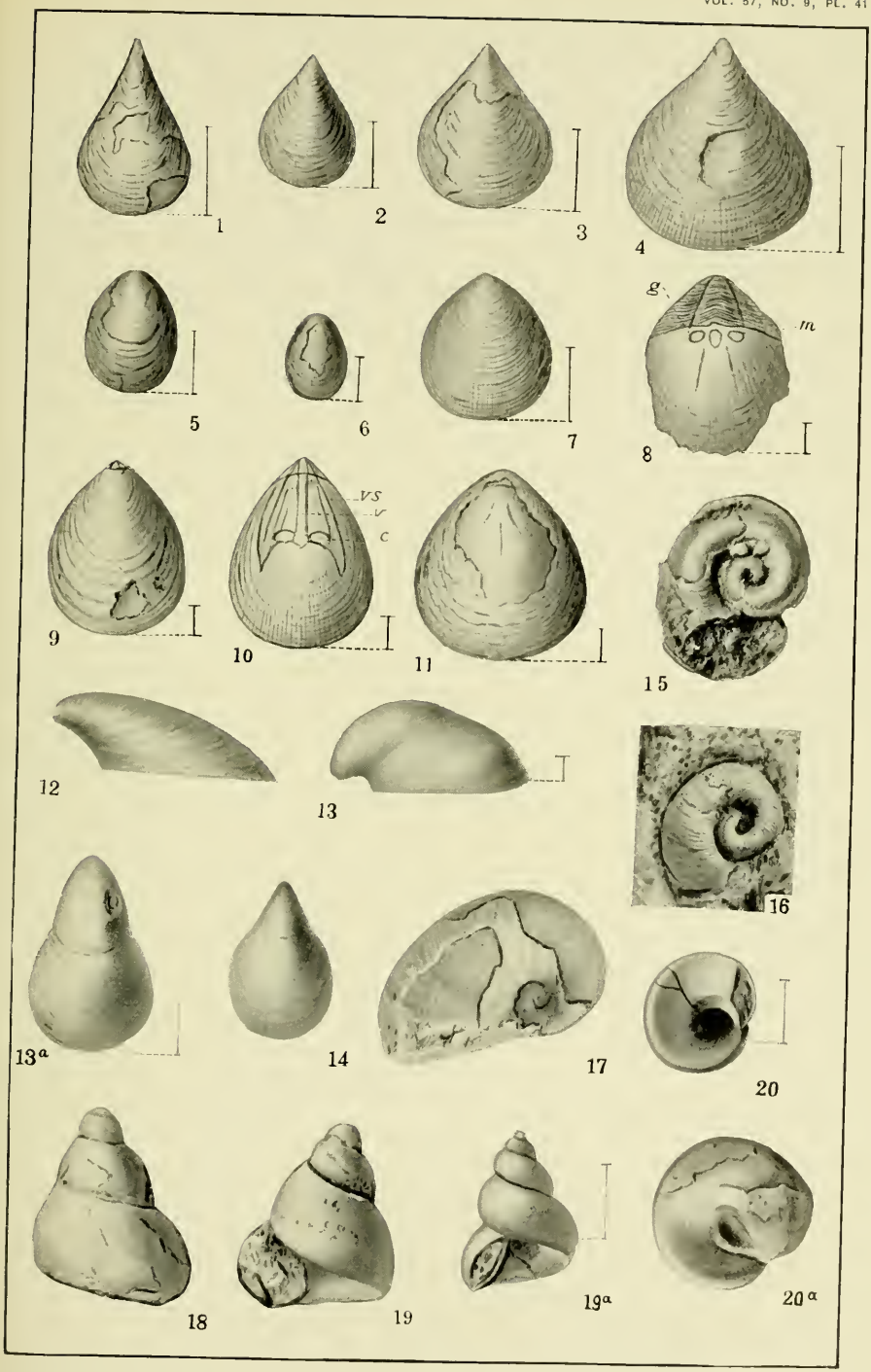
13 and 13a. (×5.) Side and top view of a small specimen having an irregular growth. U. S. National Museum, Catalogue No. 58549.

14. (×1.5.) Top view. U. S. National Museum, Catalogue No. 58550.

Pelagiella minutissima (Walcott) 266

FIG. 15. (×6.) Side view of a partly exfoliated specimen. U. S. National Museum, Catalogue No. 58551.

16. (×6.) Side view of a specimen preserving the striated outer surface. U. S. National Museum, Catalogue No. 58552.



POTSDAM–HOYT FAUNA

DESCRIPTION OF PLATE 41 (Continued)

PAGE

Pelagiella hoyti (Walcott) 266

FIG. 17. (×6.) Side view of the type specimen. U. S. National Museum Catalogue No. 23846.

Matherella saratogensis (Walcott).....

FIGS. 18 and 19. (×2.) Anterior and posterior sides of the same shell. U. S. National Museum, Catalogue No. 23847.

20. (×2.) Umbilical view of the shell illustrated by figs. 18 and 19.

21. (×2.) Anterior view of two whorls of a shell attached to the matrix. U. S. National Museum, Catalogue No. 23847.

All the specimens illustrated on this plate, with the exception of figs. 1 and 8-11, are from locality (76), Upper Cambrian, Hoyt limestone, Potsdam horizon, Hoyt's quarry, 4 miles (6.4 km.) west of Saratoga Springs, New York.

The specimen represented by figure 1 is from locality (76a), Upper Cambrian, 1 mile (1.6 km.) north of Saratoga Springs, New York.

DESCRIPTION OF PLATE 42

PAGE

Matthevia variabilis Walcott 265

FIGS. 1, 1a-b. (×2.5.) End, summit, and side views of one of the most characteristic forms of the species.

2. (×2.) A more conical form than the specimen represented by fig. 1b.

3. (×3.) Associated operculum with portions of the shell broken away.

4. (×3.) Natural cast of the interior of an operculum.

5, 5a-b. (×3.) Side, end, and summit views of a conical specimen, having a deeply sinuous margin.

6. (Natural size.) Cast of the interior of the chamber of habitation and inner chambers. The septa are seen at s, s'. The outline of the shell about the chambers is traced.

7. (Natural size.) Cast of the chambers of a more conical specimen than that represented by fig. 6.

8. (Natural size.) Cast of the chambers of a shorter specimen than those represented by figs. 6 and 7.

9. (×6.) Natural transverse section of a specimen on a line of the septa separating the chamber of habitation and the inner chambers.

10. (×6.) Transverse septum separating one of the inner chambers and the chamber of habitation.

11. (×5.) Enlarged transverse section of a portion of a shell, illustrating the peculiar vesiculose structure of the shell.

12. Enlargement of the interior surface of a part of a chamber of habitation, as seen on the specimen represented by fig. 7.

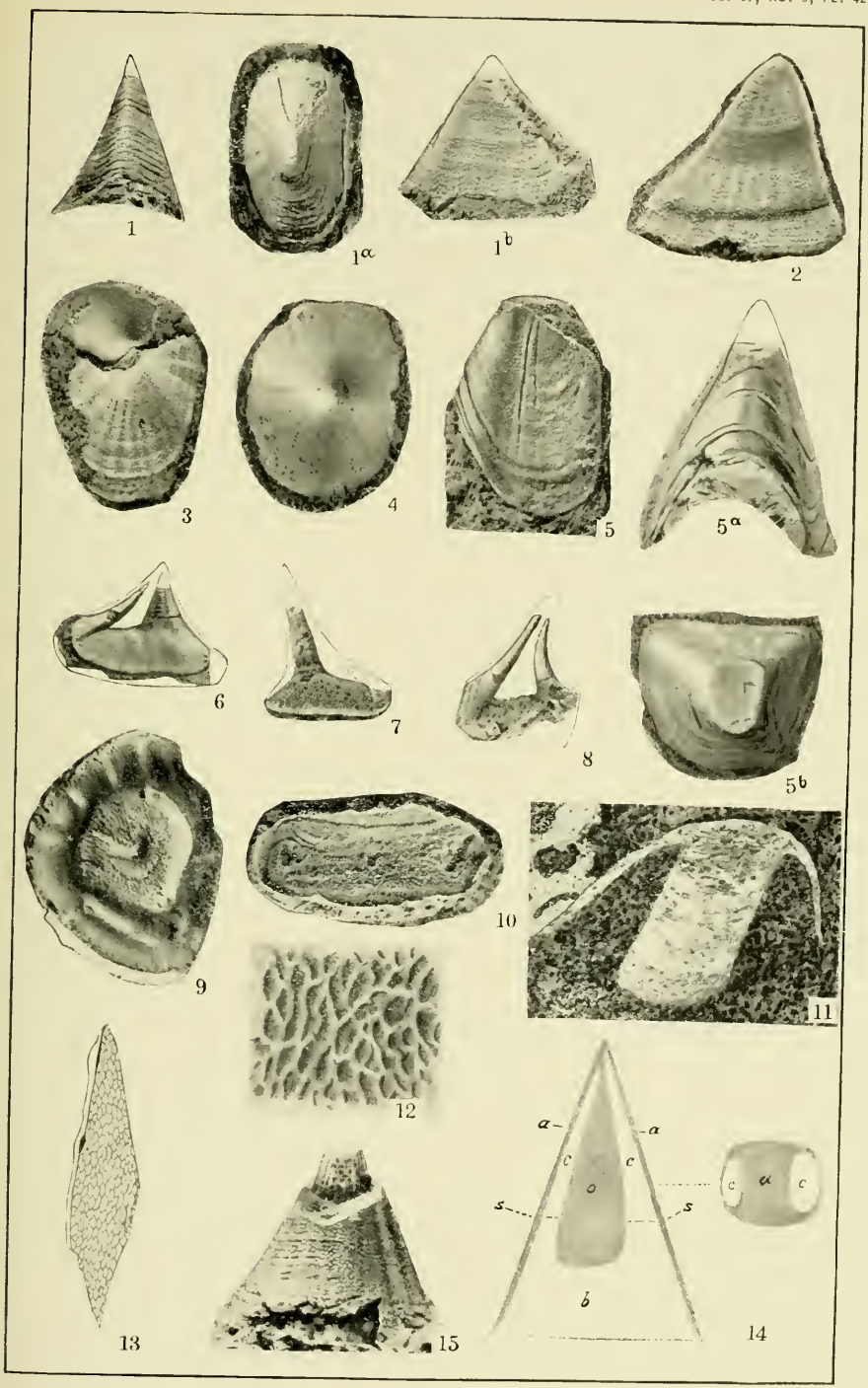
13. (×4.) Thin section of a portion of a shell, showing the vesiculose structure of the shell.

14. Diagrammatic vertical section to illustrate a shell (a, a); inner chambers (c, c); chamber of habitation (d), and septa (s, s) between the chamber of habitation and the inner chambers.

On the left side the transverse section of a shell (a), and the inner chambers (c, c).

15. (×3.) End view of a conical specimen, showing the cast of one of the inner chambers, the thickness of the outer shell, and the papillose character of the outer surface.

All the specimens illustrated on this plate are included under one number, U. S. National Museum, Catalogue No. 24598. From locality (76), Upper Cambrian, Hoyt limestone, Hoyts quarry, 4 miles (6.4 km.) west of Saratoga Springs, Saratoga County, New York.



POTSDAM-HOYT FAUNA

DESCRIPTION OF PLATE 43

PAGE

Palæacmæa typica Hall and Whitfield 264

FIG. 1. (Natural size.) View of the upper side of a large specimen.

2. Profile view, showing the convex side and curvature of the shell represented by fig. 1.

These figures are reproduced from illustrations by Hall and Whitfield (Twenty-third Ann. Rept. New York State Cab. Nat. Hist., 1873, pl. 11, figs. 4 and 5). The specimens represented by figs. 1 and 2 are from the Potsdam sandstone, Keeseville, New York.

Hyolithellus papillatus Walcott 267

FIG. 3. (Natural size.) Portion of a rather large tube. U. S. National Museum, Catalogue No. 58553.

4. (×4.) Enlargement of a portion of the specimen illustrated by fig. 3, to illustrate the surface characters.

The specimens represented by figs. 3 and 4 are from locality (111), Upper Cambrian, at the top of the Potsdam sandstone on Marble River, one mile (1.6 km.) south of Chateaugay, Franklin County, New York.

Hyolithes gibbosus Hall and Whitfield..... 265

FIG. 5. (Natural size.) View of the ventral, rounded side, showing the form of the shell.

6. (Natural size.) Profile view, showing the convex side and curvature of the shell.

These figures are reproduced from illustrations by Hall and Whitfield (Twenty-third Ann. Rept. New York State Cab. Nat. Hist., 1873, pl. 11, figs. 1 and 2). The specimens represented by figs. 5 and 6 are from the Potsdam sandstone, Keeseville, New York.

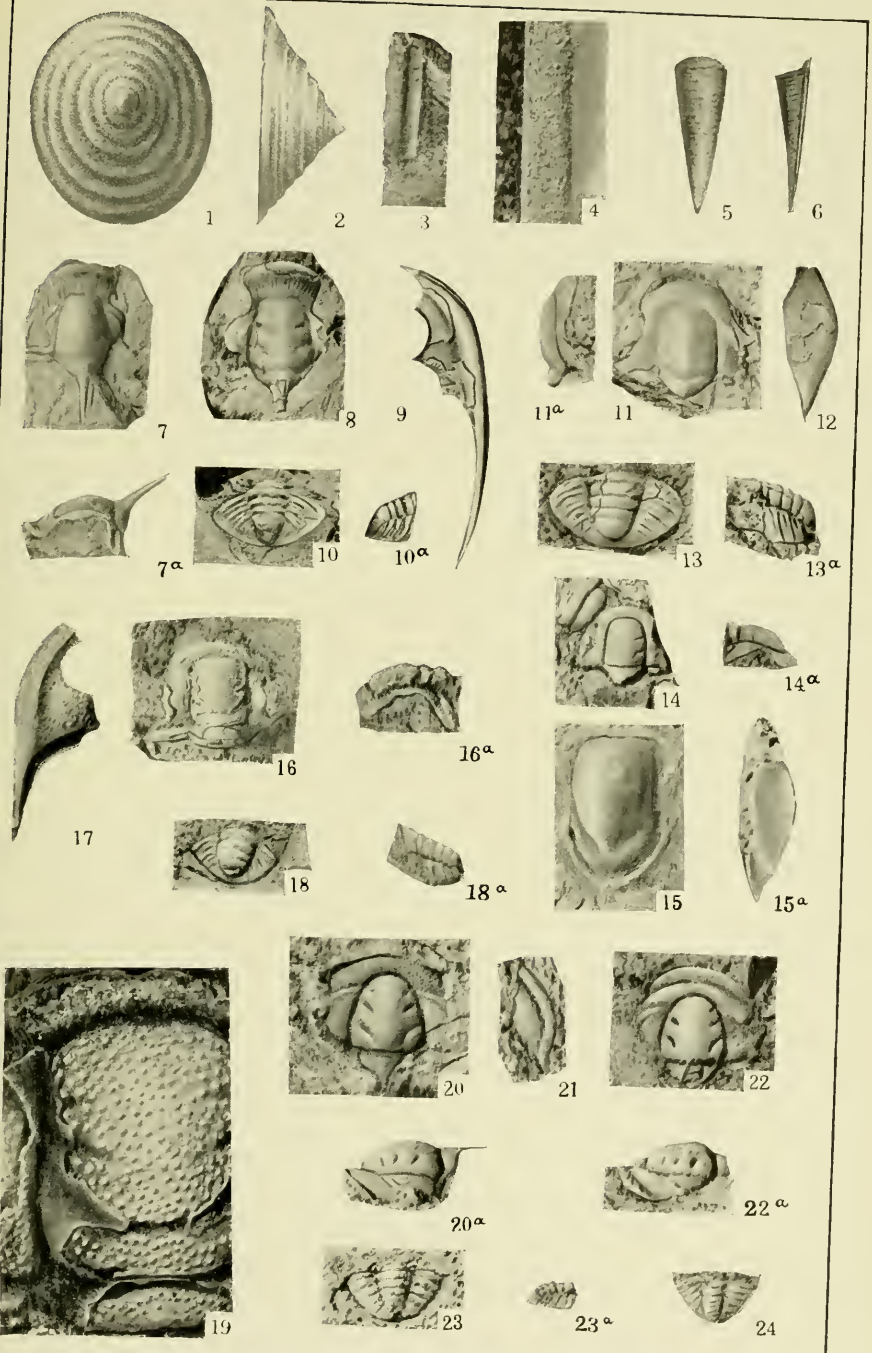
Lonchocephalus calciferus (Walcott) 270

FIGS. 7 and 7a. (Natural size.) Dorsal and side views of an imperfect cranidium. U. S. National Museum, Catalogue No. 58554.

8. (Natural size.) Dorsal view of a cranidium, showing the characters of the glabella. U. S. National Museum, Catalogue No. 58555.

9. (Natural size.) Free cheek. U. S. National Museum, Catalogue No. 58556.

10 and 10a. (×2.) Dorsal view and side outline of pygidium associated with this species. U. S. National Museum, Catalogue No. 58557.



POTSDAM–HOYT FAUNA

DESCRIPTION OF PLATE 43 (Continued) PAGE

Agraulos saratogensis Walcott 269

FIGS. 11 and 11a. (Natural size.) Dorsal and side views of an imperfect cranidium. U. S. National Museum, Catalogue No. 58558.

12. (Natural size.) A large free cheek associated with this species. U. S. National Museum, Catalogue No. 58559.

13 and 13a. (× 2.) Dorsal and side views of associated pygidium. U. S. National Museum, Catalogue No. 58560.

14 and 14a. (× 2.) Dorsal and side views of a nearly entire cranidium. U. S. National Museum, Catalogue No. 58561.

15 and 15a. (× 3.) Ventral and side views of an hypostoma associated with this species. U. S. National Museum, Catalogue No. 58562.

Ptychaspis speciosus Walcott 272

FIGS. 16 and 16a. (Natural size.) Dorsal and side views of an imperfect cranidium. U. S. National Museum, Catalogue No. 58563.

17. (× 2.) Associated free cheek referred to this species. U. S. National Museum, Catalogue No. 58564.

18 and 18a. (× 2.) Dorsal and side views of associated pygidium referred to this species. U. S. National Museum, Catalogue No. 58565.

19. (× 4.) Enlargement of the central portions of the cranidium of the specimen represented by fig. 16, showing the coarse tubercles on the glabella and fine tubercles on the anterior margin. U. S. National Museum, Catalogue No. 58563.

The specimens represented by figs. 7-19 are from locality (76), Upper Cambrian, Hoyt limestone, Hoyts quarry, 4 miles (6.4 km.) west of Saratoga Springs, Saratoga County, New York.

Ptychoparia minuta (Bradley) 267

FIGS. 20 and 20a. (× 3.) Dorsal and side views of a convex cranidium. U. S. National Museum, Catalogue No. 58566.

21. (× 3.) Associated free cheek. U. S. National Museum, Catalogue No. 58567.

22 and 22a. (× 3.) Dorsal and side views of a cranidium preserving the anterior rim and border. U. S. National Museum, Catalogue No. 58568.

23 and 23a. (× 3.) Dorsal and side views of a pygidium from which the test has been exfoliated. U. S. National Museum, Catalogue No. 58569.

24. (× 3.) Dorsal view of a pygidium preserving the test. U. S. National Museum, Catalogue No. 58570.

The specimens represented by figs. 20-24 are from locality (77), Upper Cambrian, Potsdam horizon, sandstone near the water below the falls at the high bridge, and also at several horizons in the section, the highest point being 70-75 feet (21.3-22.9 m.) above the water in Ausable Chasm, Essex County, New York.

DESCRIPTION OF PLATE 44

PAGE

Dicellocephalus hartti (Walcott) 273

FIGS. 1 and 1a. (Natural size.) Dorsal and side views of a large, imperfect cranidium. U. S. National Museum, Catalogue No. 58571.

2. (Natural size.) Free cheek. U. S. National Museum, Catalogue No. 58572.

3 and 3a. (Natural size.) Dorsal and side views of a smaller cranidium than that illustrated by fig. 2. U. S. National Museum, Catalogue No. 58573.

4. (Natural size.) Hypostoma with outline restored. U. S. National Museum, Catalogue No. 58574.

5. (Natural size.) Portion of thoracic segment. U. S. National Museum, Catalogue No. 58575.

6 and 6a. (Natural size.) Dorsal and side views of a large pygidium, illustrating the increase in width of the border as compared with the specimen represented by fig. 7. U. S. National Museum, Catalogue No. 58576.

7 and 7a. (Natural size.) Dorsal and side views of a smaller pygidium. U. S. National Museum, Catalogue No. 58577.

Dicellocephalus tribulis Walcott 274

FIGS. 8 and 8a. (× 2.) Dorsal and side views of the type specimen of cranidium. U. S. National Museum, Catalogue No. 58578.

The specimens represented by figs. 1-8a are from locality (76), Upper Cambrian, Hoyt limestone, Hoyts quarry, 4 miles (6.4 km.) west of Saratoga Springs, Saratoga County, New York.

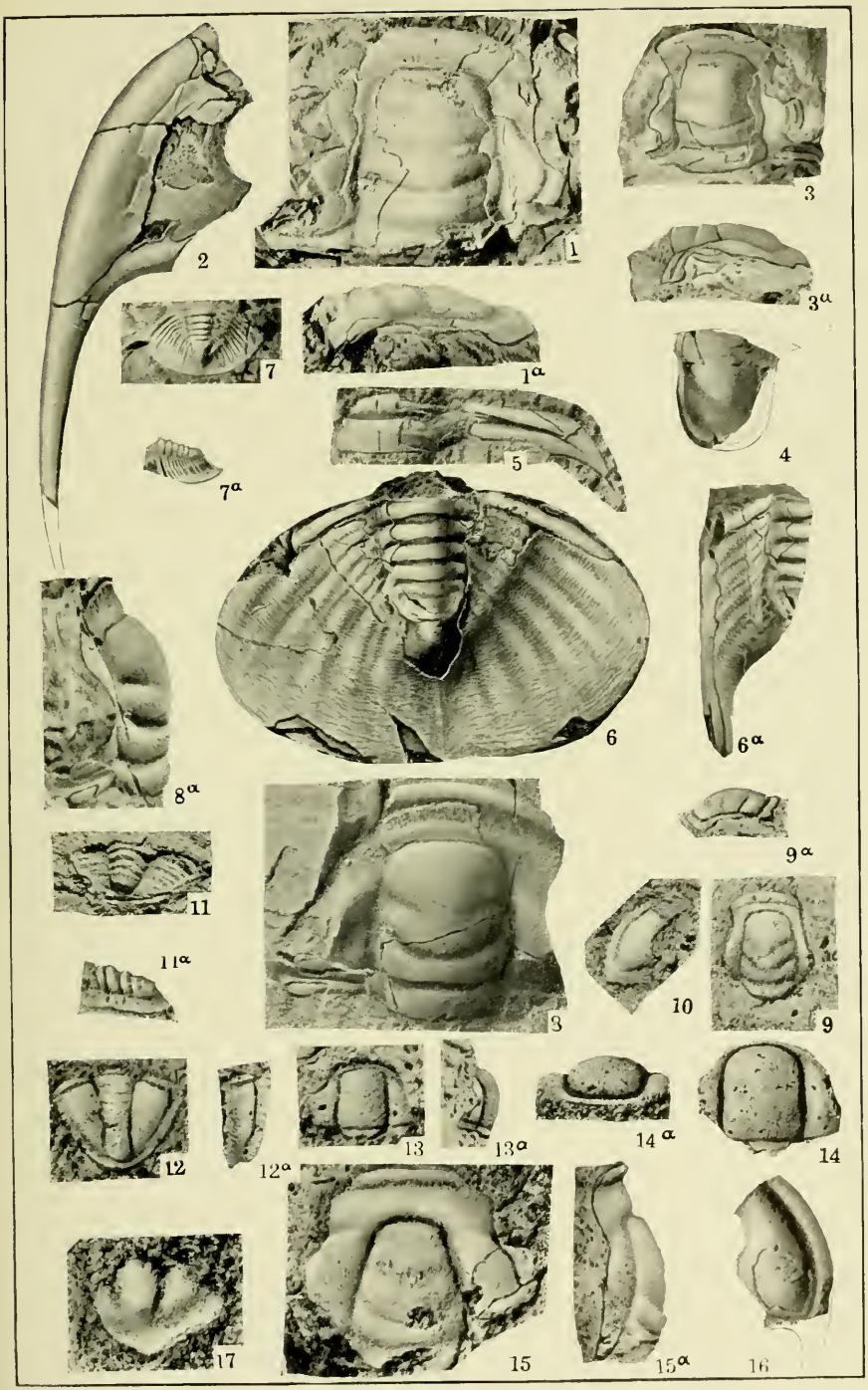
Conocephalina whitehallensis Walcott 269

FIGS. 9 and 9a. (× 2.) Dorsal and side views of the type specimen of the cranidium. U. S. National Museum, Catalogue No. 58579.

10. (× 3.) Free cheek associated with the specimen represented by fig. 8. U. S. National Museum, Catalogue No. 58580.

11 and 11a. (× 2.) Dorsal and side views of an associated pygidium referred to this species. U. S. National Museum, Catalogue No. 58581.

The specimens represented by figs. 9-11a are from locality (110a) (just above 110), Upper Cambrian, sandstone on the east side of the town of Whitehall, Washington County, New York.



POTSDAM–HOYT FAUNA

DESCRIPTION OF PLATE 44 (Continued)

PAGE

Pagodia seelyi Walcott 269

FIGS. 12 and 12a. (× 2.) Dorsal and side views of pygidium. U. S. National Museum, Catalogue No. 58582.

13 and 13a. (× 3.) Dorsal and side views of a small cranidium. U. S. National Museum, Catalogue No. 58583.

14 and 14a. (× 2.) Dorsal and front views of a larger cranidium. U. S. National Museum, Catalogue No. 58584.

The specimens represented by figs. 12-14a are from locality (77), Upper Cambrian, Potsdam sandstone near the water below the falls at the high bridge, and also at several horizons in the section, the highest point being 70-75 feet (21.3-22.9 m.) above the water in Ausable Chasm, Essex County, New York.

Ptychoparia matheri Walcott 268

FIGS. 15 and 15a. (Natural size.) Dorsal and side views of an imperfect cranidium. U. S. National Museum, Catalogue No. 58585.

16. (Natural size.) Associated free cheek. U. S. National Museum, Catalogue No. 58586.

17. (× 2.) Fragment of the interior cast of the posterior portion of a pygidium associated with this species. U. S. National Museum, Catalogue No. 58587.

The specimens represented by figs. 15-17 are from locality (110), Upper Cambrian, shaly calcareous sandstone resting on massive layers of Potsdam sandstone, east side of the town of Whitehall, Washington County, New York.

DESCRIPTION OF PLATE 45

PAGE

Neolenus serratus (Rominger) 277

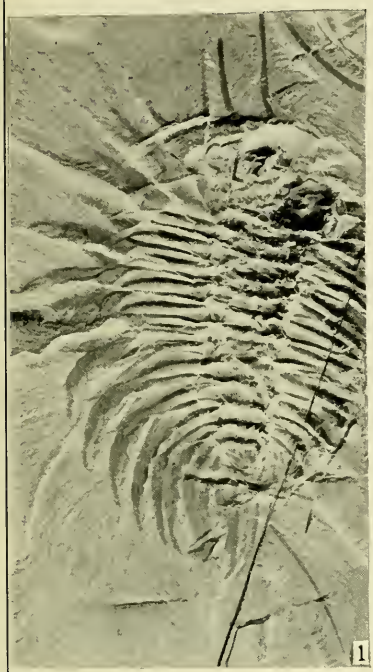
FIG. 1. (Natural size.) A specimen showing on the left side 12 thoracic abdominal legs and portions of three imperfect cephalic legs, also antennæ and one of the caudal furca. U. S. National Museum, Catalogue No. 58588.

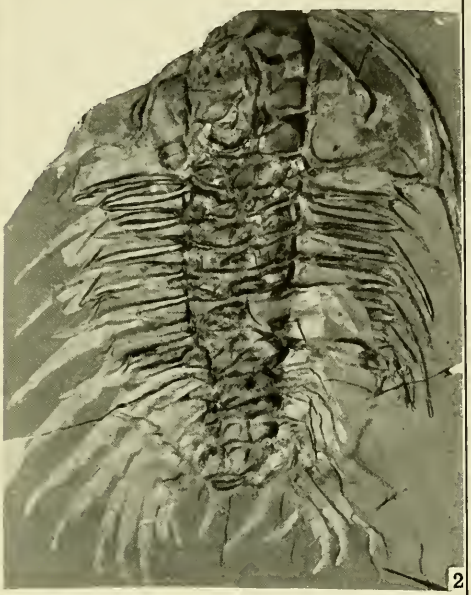
2. (Natural size.) A specimen showing thoracic-abdominal legs and how they vary in length beneath the pygidium. This variation would necessarily make the imprints of the terminal joint occur at varying distances from the median line as represented by the base of the caudal furca. The posterior legs on the left side have three short spines attached to the distal end of the terminal joint. U. S. National Museum, Catalogue No. 58589.

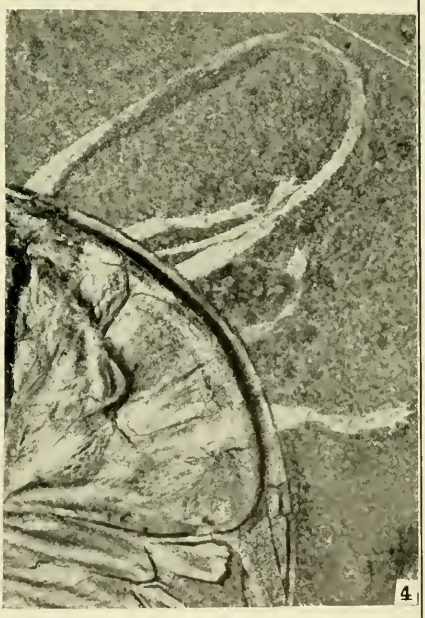
3. (× 2.) Cephalic legs projecting forward. U. S. National Museum, Catalogue No. 58590.

4. (× 2.) Legs showing terminal joint with trifid termination. Such legs would make an imprint similar to the trifid tracks on plates 48 and 49. U. S. National Museum, Catalogue No. 58591.

The specimens represented by figs. 1-4 are from locality (35k), Middle Cambrian, Burgess shale member of the Stephen formation, on the west slope of the ridge between Mount Field and Wapta Peak, one mile (1.6 km.) northeast of Burgess Pass, above Field, British Columbia.







LEGS OF TRILOBITES

DESCRIPTION OF PLATE 46

PAGE

Protichnites septemnotatus Owen. (See pl. 47) 278

FIG. 1. (Natural size.) Broad track showing trifid imprint and furrow made by dragging of ventrum or more probably base of caudal furca in the sand. U. S. National Museum, Catalogue No. 58592.

The specimen represented is from locality (220b), Upper Cambrian, Potsdam sandstone, near Beauharnois, Province of Quebec, Canada.

TRACKS OF TRILOBITES

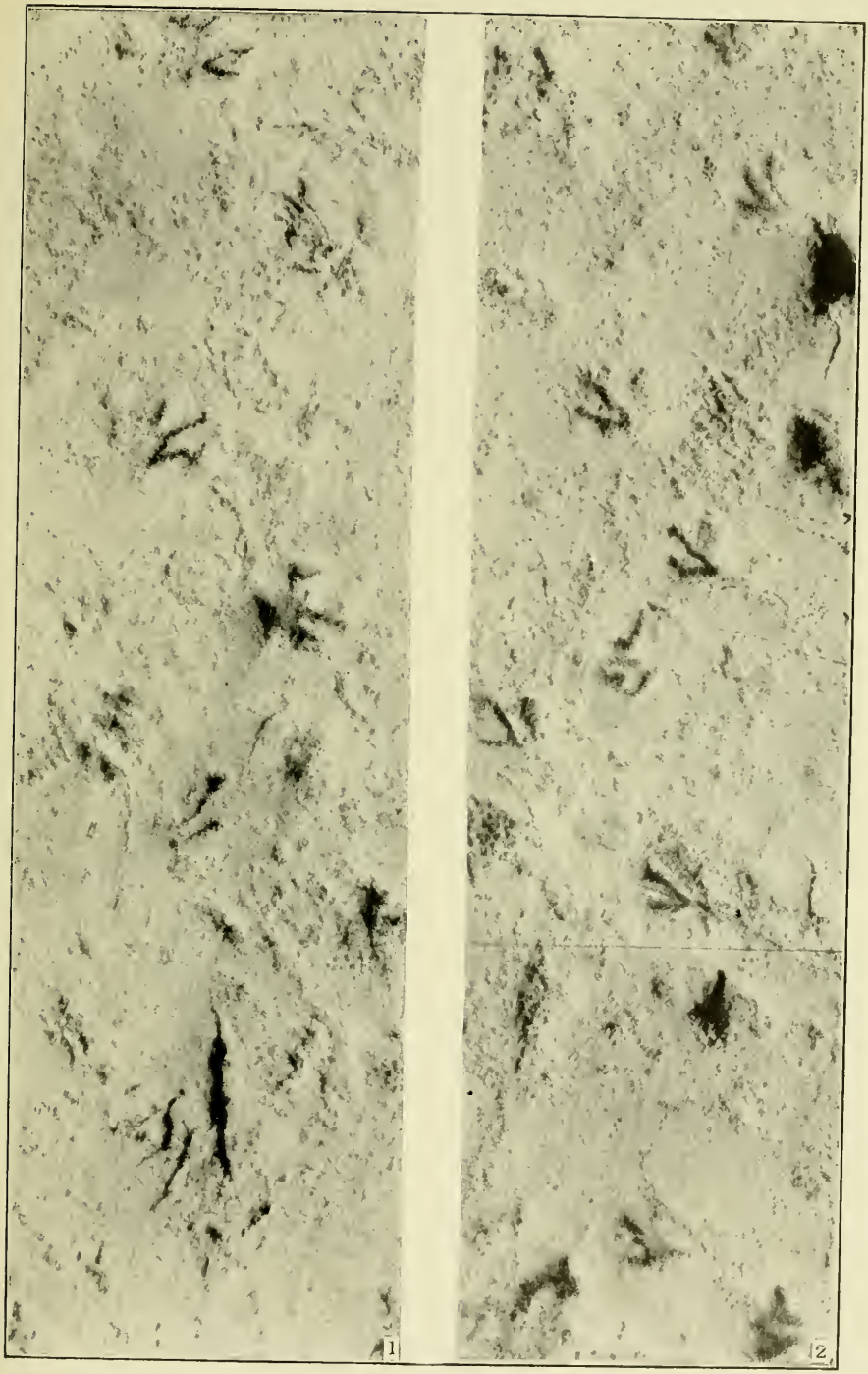
DESCRIPTION OF PLATE 47

PAGE

Protichnites septemnotatus Owen. (See pl. 46) 278

FIGS. 1 and 2. (Natural size.) Right and left side of broad track 13-15 cm., showing the trifid tracks. The central portion of the track has been cut out in order to bring the imprints of the two sides within the limits of the plate. U. S. National Museum, Catalogue No. 58593.

The specimen represented is from locality (220b), Upper Cambrian, Potsdam sandstone, near Beauharnois, Province of Quebec, Canada.



TRACKS OF TRILOBITES

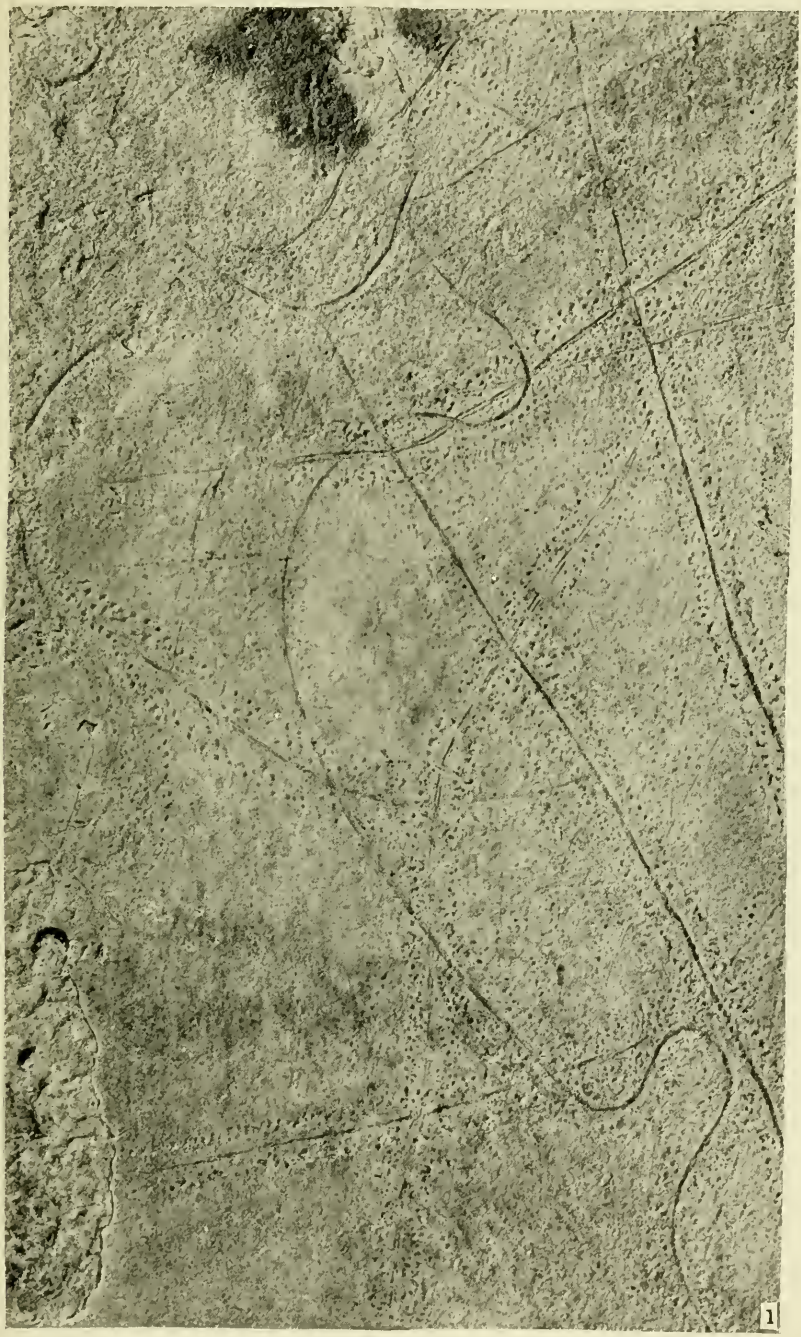
DESCRIPTION OF PLATE 48

PAGE

Protichnites logananus Marsh. (See pl. 49) 279

FIG. 1. Photograph of slab 4 ft. 10 in. x 2 ft. 11 in., reduced to about one-eighth natural size. This slab has numerous series of tracks on its smooth surface. These trails are quite unlike the trails of *Climatichnites* and evidently were not made by the same kind of animal. U. S. National Museum, Catalogue No. 58402.

The specimen represented is from locality (77), Upper Cambrian, Potsdam sandstone in Ausable Chasm, Essex County, New York.



TRACKS OF TRILOBITES

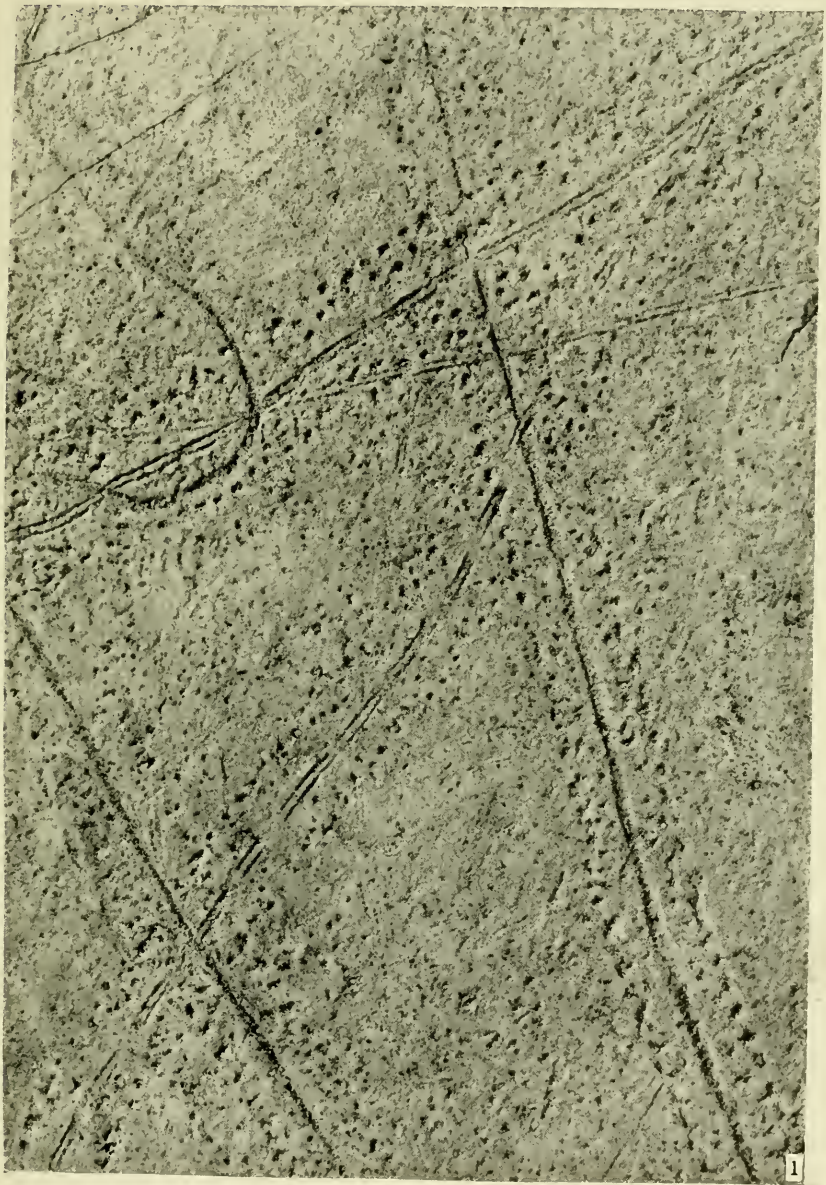
DESCRIPTION OF PLATE 49

PAGE

Protichnites loganannus Marsh. (See pl. 48) 279

FIG. 1. (Reduced to about one-fifth natural size.) Part of the trail shown in the upper part of plate 48. In the central trail, crossing diagonally from the left lower to upper right corner, the imprint made by the caudal furca shows that the animal partly lifted its body from the sand as it moved along. U. S. National Museum, Catalogue No. 58402.

The specimen represented is from locality (77), Upper Cambrian, Potsdam sandstone in Ausable Chasm, Essex County, New York.



TRACKS OF TRILOBITES