SYNOPSIS OF THE SOLENIDÆ OF NORTH AMERICA AND THE ANTILLES.

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In revising the group for the purpose of monographing the fossil species so many changes in nomenclature and distribution were found to be involved that it was thought the following summary would prove useful to students of the recent forms:

EAST AMERICAN SPECIES.

Genus SOLEN (Linnæus, 1758) Scopoli, 1777.

(*Vagina* Megerle, 1811; + *Hypogæa* and *Hypogæoderma* Poli, 1791-1795; + *Listera*, Leach manuscript, Gray, 1852.) Type, *Solen marginatus* Pulteney.

1. *Solen viridis* Say, 1822; Rhode Island (Totten) to Georgia (Postell).

Section SOLENA Mörch, 1852.

(*Solena* sp. Browne, nonbinomial, 1756; + *Hypogella* Gray, 1854.) Type, *S. obliqua* Spengler = *S. ambiguus* Lamarck.

2. *Solen* (*Solena*) *obliqua* Spengler, 1793; Cuba, Porto Rico, St. Thomas.

S. rudis Sowerby, 1874, not C. B. Adams, 1852; + *philippinarum* Sowerby, 1874, not Hanley, 1843, are synonymous.

Genus ENSIS Schumacher, 1817.

(*Ensatella* Swainson, 1840, + *Solen* Leach, 1852.) Type, *Ensis magnus* Schumacher.

1. *Ensis directus* Conrad, 1843; Labrador to Indian Key, Florida. Pliocene to recent.

E. "*americana* Beck" of H. and A. Adams, 1856, is probably a manuscript name. *Solen siliqua* Chickering, 1855, not Linnæus, 1758, is a synonym. This species was generally confounded with *Solen magnus* of Schumacher, under the name of *Solen ensis* Linnæus, by the earlier American authors.

2. *Ensis minor* Dall; Cape May to Florida and Texas.

This is *Solon ensis* var. *minor* of some of the earlier writers, and bears to *E. directus* the same relation that *Ensis ensis* Linnæus of Europe does to the north European *E. magnus* Schumacher. It differs from the young of *E. directus* in having the valves wider behind than in front and relatively narrower as a whole.

Genus SILIQUA Megerle, 1811.

(*Leguminaria* Schumacher, 1817; + *solecurtus* A Blainville, 1825; + *Aulus* Oken, 1835, not Oken 1815; + *Solecurtoides* Desmoulins, 1832; + *Solenocurtus* Sowerby, 1839; + *Machæra* Gould, 1841.) Type, *Solen radiatus* Linnæus.

1. *Siliqua squama* Blainville, 1824; Grand Banks of Newfoundland and Gulf of St. Lawrence.

This is *Machæra nitida* Gould, 1841, and *Cultellus medius* Sowerby (not Gray), Conch. Icon., 1874.

2. *Siliqua costata* Say, 1822; Gulf of St. Lawrence south to Cape Hatteras, North Carolina, in suitable localities.

The following are synonymous names: *Solecurtoides nahantensis* Desmoulins, 1832; *S. sayi* Gray, 1833; *S. radiatus* Ravenel (not Linnæus), 1834; *Cultellus grayanus* Sowerby (not Dunker?), 1874; *Cultellus subsulcatus* Sowerby, 1874; *Cultellus belcheri* (as of Gray, manuscript) Sowerby, 1874; not *C. costatus* Middendorf, 1847, nor Sowerby, 1874.

Genus PSAMMOSOLEN Risso, 1826.

(= *Psammobia* Risso, 1826, err. typ.; + *Solecurtus* B, Blainville, 1825; + *Macha* Oken, 1835; + *Adasius* Leach, 1852; not *Macha* Philippi, 1853, nor *Psammosolen* Hupé, 1854.) Type, *Solen strigilatus* Linnæus.

1. *Psammosolen sanctæ-marthæ* (Chemnitz) Orbigny, 1853; North Carolina, Bermuda, the Antilles, and south to Rio Janeiro (Dunlap).

2. *Psammosolen cumingianus* Dunker, 1861; North Carolina, to Texas and São Paulo, Brazil.

WEST AMERICAN SPECIES.

Genus SOLEN (Linnæus) Scopoli.

1. *Solen sicarius* Gould, 1850; Vancouver Island to San Pedro, California; Japan, A. Adams (?).

2. *Solen rosaceus* Carpenter, 1863; Santa Barbara, California, south to the Gulf of California; La Paz.

3. *Solen mexicanus* Dall; west coast of Tehuantepec, Mexico.

4. *Solen (Solena) rudis* C. B. Adams, 1852; Panama.

Confounded with *S. obliquus* Spengler of the Antilles by Carpenter and Sowerby.

Genus ENSIS Schumacher.

1. *Ensis californicus* Dall; Monterey, California, south to the Gulf of California; La Paz.

Genus SILIQUA Megerle.

1. *Siliqua lucida* Conrad, 1838; Monterey to San Diego, California. Confounded with the young of *S. nuttallii* by Carpenter, 1863, and Gabb, 1868; also, according to Conrad, with *S. radiata* Linnæus.

2. *Siliqua media* Gray, 1839; Okhotsk and Bering seas and northward to the Arctic Ocean at Cape Lisburne.

Machæra costata Middendorf, 1851, not Say, 1822; + *S. borealis* Conrad, 1867, not *Cultellus medius* Sowerby, Conch. Icon., 1874, = *S. squama* Blainville.

3. *Siliqua patula* Dixon, 1788, Okhotsk Sea; the southern border of Bering Sea, and the Gulf of Alaska to Sitka.

Described from Cooks Inlet, Alaska. The following names are synonyms: *Solen maximus* Wood, 1815, not Gmelin, 1792; *S. gigas* Dillwyn, 1817; *S. grandis* (Hinds Manuscript as of Gmelin) Dunker, 1861, and Carpenter, 1863; *S. splendens* Chenu, 1845 and 1862. Large; with submedian beaks and straight rib. The following are discriminable varieties, but apparently connected by gradations with the typical *S. patula*.

4. *Siliqua* (*patula* var.) *alta* Broderip and Sowerby, 1829; Bering Sea and Strait.

This is figured under the name of *Cultellus costatus* by Sowerby, Conch. Icon., 1874, but is not the *costatus* of Say. It is short and broad with very anterior beaks and straight rib.

5. *Siliqua* (*patula* var.) *nuttallii* Conrad, 1838, Lituya Bay, Alaska, south to Oregon, and California as far as Monterey.

S. americana Chenu, 1845, may be the same, but I do not know it; *S. californica* Conrad, 1868, and *S. nuttali* Sowerby, 1874, are synonymous. The shell is very straight, brilliantly polished, narrower than the typical *S. patula* and with a much more oblique rib. The beaks are less anterior than in *S. alta*.

NOTES.

Solen tenuis Broderip and Sowerby, 1829, is unidentifiable, from the absence of a figure and the excessive brevity of the description. It is not the *S. tenuis* Gray, in Griffith's Cuvier, 1833. It was collected by Belcher, whose shells came mostly from northwest America.

Solen "lineatus Spengler," appears in Mörch's Catalogue of Poulsen's West India shells. It is probably intended for *S. linearis* Spengler (in Chemnitz) and may have been based on a misidentified specimen of *Ensis minor*.

Solen niveus Hanley is listed by Guppy in his Paria fauna, 1877, and was perhaps based on a young specimen of *S. obliquus* Spengler, or the following species:

Solen lappeanus Dunker, Moll. Marina, 1858, is said to be from the Antilles, but has not been reported from that region by anyone else. Externally it is not unlike *S. viridis* Say.

Aulus (=*Siliqua*) *rostratus* Dunker, 1861, figured by Sowerby, Conch. Icon., 1874, is said to be from the Arctic Ocean, but this is certainly erroneous. *Solen radiatus* Linnæus, appears in Pfeiffer's list of Cuban shells,[1] but the shell intended was very likely *Tagelus divisus* Spengler. No species of *Siliqua* is known from Cuba.

Krebs cites *Machœra lucida* "Gould," from Mörch's Yoldi catalogue, as Central American; but this is doubtless *M. lucida* of Conrad, from the Pacific coast of Central America.

There is no large species of *Ensis* on the west coast of America corresponding to the *E. magnus* and *E. directus* of the northern Atlantic, though the *E. californicus* is the exact analogue of the European *E. ensis* and the east American *E. minor*. Among the Siliquas on the two sides of the continent *S. alta* and *S. squama*, *S. media* and *S. costata*, are respectively analogous, while *S. lucida* finds its counterpart in the *S. pulchra* of Japan.

SOLEN MEXICANUS, new species.

Shell small, straight, parallel-sided, with anterior beaks, the anterior end obliquely truncate; the posterior end squarely truncate with the corners slightly rounded off; hinge with the teeth normal, the ligament unusually long in a very narrow groove; shell white, covered with a polished olivaceous epidermis, longitudinally striate near the ventral edges of the valves. Length of shell, 60 mm.; of ligament, 11 mm.; width of valves, 8.5 mm.; diameter, 5.5 mm.

Type.—No. 120634, U.S.N.M. Specimen from the Gulf of Tehuantepec.

This species recalls the *Solen linearis* of Chemnitz, which, however, is considerably longer in proportion to its width.

ENSIS CALIFORNICUS, new species.

Shell small, slender, arcuate, the sides nearly parallel, the valves being slightly attenuated toward the ends, beaks anterior, the anterior truncation bluntly rounded, the posterior similar; color white with livid pink streaks concentrically disposed; epidermis olivaceous brilliantly polished; hinge with small and very delicate cardinals (usually broken off), one in the right and two in the left valve, the dorsal ridge comparatively strong and elevated, shorter than the ligament. Length of shell, 60 mm.; of dorsal tooth or ridge, 5.2 mm.; of ligament, 9 mm.; width of shell, 7 mm.; perpendicular to the chord of the arc formed by the dorsal margin of the valves, 2 mm.

Type.—No. 158891, U.S.N.M. Specimen from 14 fathoms sand, off the island of San Pedro Martir, Gulf of California. Some specimens reach a length of 85 mm.

This species recalls small specimens of the east American *E. minor*, which, however, differs by being wider distally than in front, larger when adult, with proportionately wider and more arcuate valves.

[1] Archiv für Naturgeschichte, 1840, p. 261.

In this connection I may add some supplementary data to my "Synopsis of the Psammobiidæ,"[1] which have come to hand since that article was printed.

Tagelus gibbus Spengler, as typically restricted, passes as far south as St. Thomas, West Indies, and probably to the northeast shores of Brazil. The variety called *T. platensis* by d'Orbigny differs by being shorter and more attenuated behind, and I have seen it only from the southern coast of Brazil and Uruguay. In all the typical species of *Tagelus* the posterior end is shorter than the anterior, the pallial sinus is deep, reaching to or forward of the perpendicular from the umbones, and the posterior adductor scar is rounded. The teeth are simple, erect, pedunculated, two in each valve. There is no central constriction or internal rib. Curiously enough, the shell figured by H. and A. Adams to illustrate *Tagelus* (or *Siliquaria*) *gibbus* is a *Novaculina*, while they describe the teeth as 3:2 (which is the dentition of *Novaculina*) and the sinus as deep beyond the umbones, which belongs to *Tagelus* and is untrue of *Novaculina*.

Owing to the fact that a number of externally similar but really different shells have been confused, the diagnoses of these groups are frequently inaccurate, and I have therefore reviewed the question in the light afforded by the specimens. The following are the characters:

Genus NOVACULINA Benson, 1830.

Type.—N. gangetica Benson.

Beaks subanterior; teeth (when fully developed) three in the left and two in the right valve; the anterior left tooth often obsolete or wanting, the anterior right tooth bifid; there is no median constriction, the pallial sinus is small, not reaching the beaks, the posterior adductor scar rounded; the scar of the ventral side of the sinus not coalescent with the pallial line below it; situs in fresh water.

Section CLUNACULUM Dall.

Type.—Solecurtus mollis (Gould) Sowerby, Conch. Icon. *Solecurtus*, 1874, pl. VI, fig. 26; coast of Brazil and Uruguay.

Valves obliquely constricted, the constriction reflected by an internal thickened elevation (not a clavicle); beaks subanterior; teeth, two in the left and two in the right valve, the posterior left tooth bifid, in some of the species there is an obsolete tooth behind it; the pallial sinus not reaching the beaks, the posterior adductor scar triangular, the scar of the sinus coalescent ventrally with the pallial line; situs marine.

Genus TAGELUS Gray, 1847.

Type.—Solen gibbus Spengler.

Valves not constricted and without a clavicle; beaks medium or subposterior; teeth simple, pedunculate, two in each valve; pallial sinus

[1] Proc. Acad. Nat. Sci. Phila., 1898, pp. 57-62.

deep, reaching to or beyond the beaks, posterior adductor scar rounded, the scar of the sinus coalescent ventrally with the pallial line; situs estuarine or marine.

Section MESOPLEURA Conrad, 1867.

Type.—Solen divisus Spengler.

Valves arcuate, not constricted, but with a more or less perfectly developed clavicular rib extending ventrally from the submedian beaks, otherwise as in *Tagelus*.

Gray in 1854 included species of *Clunaculum* under *Novaculina* as well as some species of true *Tagelus* like *T. dombuji*. I have not been able to examine all the described species, but *Solen constrictus* Lamarck, certainly, and probably *S. inequalis* and *S. complanatus* Sowerby, belong to *Clunaculum*.

TAGELUS POEYI, new species.

Shell resembling a young *T. gibbus*, but with more equal and evenly rounded ends, the beaks median, the teeth slender, long, but quite small, the nymphs for the ligament shorter and more central, the whole of the ventral side of the pallial sinus coalescent with the pallial line. Shell white, covered with a pale ashy gray, dehiscent epidermis; the anterior dorsal margin slightly decurrent. Length, 50 mm.; altitude, 18 mm.; diameter, 11.5 mm.

Types.—No. 27425, U.S.N.M., from Cuba (Poey); also from mouth of Old River, Belize (Stanton); beach at Greytown, Nicaragua (Dall); and Rio Grande do Sul, Brazil (Ihering).

This species can be instantly distinguished from *T. gibbus* by the different form of the pallial sinus and the different position of the beaks. It does not appear to attain more than half the size of the full grown *T. gibbus*.

Specimens of *T. gibbus* collected at Matagorda Bay, Texas, by Singley, of a light but distinct yellow color, are in the national collection, and more recently Hon. J. D. Mitchell has sent specimens, of which he has several in his collection, of a decided pink color, from the same vicinity. Both form a decided contrast to the white or slightly ferruginous tint of the average specimens of this species.

THE OSTEOLOGY AND RELATIONSHIP OF THE PERCOIDEAN FISH, DINOLESTES LEWINI.

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As a preliminary to this paper I will quote a paragraph from a paper by Dr. Theodore Gill, "On the identity of *Esox lewini* with the *Dinolestes mülleri* of Klunzinger," published about twenty-five years ago in the Annals and Magazine of Natural History. In it he gives the following concise history of *Dinolestes:*

In the tenth volume ("the class Pisces") of the "Animal Kingdom" of Cuvier, edited by Edward Griffith (1834), are a figure (plate 60) and a brief notice (p. 465) of a fish which has long been a puzzle to me. It is called *Esox lewini* and only noticed as follows: "Our figure of *Esox lewini* is from a drawing by Mr. Lewin, made in New Holland, of a species not hitherto noticed." It was evident that the species thus named belonged neither to the genus *Esox* nor anywhere near it; and (1) the relations of the fins, (2) the position of the ventrals with a spine and five rays each, (3) the form of the head, and (4) the teeth indicated for it affinity to *Chilodipterus* and allied forms; but no first dorsal fin was represented. The question then arose whether that fin had been atrophied (as in *Aspidophoroides, Gobiopus,* etc.) or (as was more likely) had been overlooked. After nearly forty years the species has been recovered, and singularly enough, after having escaped the observation of the numerous collectors in the Australian seas for so long a time,[1] has in the same year been obtained and described by three different naturalists under as many names, viz, *Dinolestes mülleri* by Klunzinger, *Neosphyræna multiradiata* by Castelnau, and *Lanioperca mordax* by Günther. There can be no question about at least the generic identity of the *Esox lewini* with the fishes described by the three contemporaries; and it now appears that the first dorsal fin exists, but is quite small, and sustained by only four or five spines. Klunzinger and Castelnau refer the type to the family Sphyrænidæ, and Günther (with more justification I think) to the "Apogonina," i. e., Chilodipteridæ.

This work was undertaken at Dr. Gill's suggestion in the hope of finding, in a comparative study of the skeleton of *Dinolestes* with those of the Sphyrænidæ and the Cheilodipteridæ, some characters that

[1] It is said, however, by Castelnau to be common [at Melbourne] in the months of May, June, and July; it attains 2 feet in length. The fishermen call it "Ship Jack," but that name is more particularly applied to *Temnodon saltator.*

would decide the question on which the authorities disagreed, as shown in the last sentence quoted from the above paper.

It would appear an easy matter to place this form under one or the other of two families arranged in different suborders, as the Sphyrænidæ and Cheilodipteridæ usually are: but the fact that two of the authorities consider it under one family and two under the other, indicates how close the resemblance must be to either.

Sphyræna argentea is the form chosen to represent the family Sphyrænidæ, while the only representative procurable of the Cheilodipteridæ was *Apogon maculatus*.

The skeleton of *Apogon* was found to be of but little assistance in this comparison. Though being undoubtedly Percoid, it differs as much from *Dinolestes* as they both differ from the more generalized Percoids, such as the bass or perch. Considering the difference between *Dinolestes* and *Apogon* in external appearance, we have probably little reason to expect the internal resemblance to be otherwise. Perhaps if one of the *Sphyræna*-like Cheilodipteroids could be examined there would be a closer resemblance.

To be sure *Dinolestes* differs from *Apogon* only in shape and comparative size of elements (that is, comparative between corresponding elements of each species), and not in arrangement, or lack or possession of elements; but it is so very different in shape of cranium, form of body, and shape of fins that it would seem better to consider the Cheilodipteroid side of the question partly by considering the Percoid fishes more or less as a whole. Though, of course, if it is placed with the Percoids it is only under the family Cheilodipteridæ, as the Percoids are now arranged, that *Dinolestes* could be admitted.

Were it not that the ventrals of *Dinolestes* are apparently thoracic, it might appear after a superficial external examination to be related to *Sphyræna*. The long head, projecting lower jaw, fanglike teeth, and elongate preorbital region are very *Sphyræna*-like. The shape of the body and dorsal fins are also suggestive of that relationship.

In internal characters we find that the ethmoid is wide and flat, somewhat overlying the vomer and prefrontals instead of being interposed between them. This is the condition found in *Sphyræna*. The nasals are very much like those of *Sphyræna*, being long and channeled and attached by their sides to the ethmoid for nearly their whole length. This, however, is probably caused by the elongate snout, and goes with it as a part in keeping with the surrounding conditions. It disposes of the characters by which an alliance with *Sphyræna* could be proved.

Though the shape of the body and head, the canine teeth, and dorsal fins exhibit perhaps a closer superficial resemblance to the Sphyrænidæ than to the Cheilodipteridæ, there are forms to be found in the latter family which approach this *Sphyræna*-like appearance also. These characters therefore denote nothing in favor of either relationship. The characters of the ethmoid and nasals are the only characters possessed by *Sphyræna* in common with *Dinolestes* that are not also shared

in by members of the family Cheilodipteridæ. They are of no great importance.

This, as has been said, is without considering the position of the ventrals. As the Percoid fishes have thoracic ventrals, and the members of the suborder Percesoces, under which the Sphyrænidæ is placed, have abdominal ventrals, it is difficult to see how *Dinolestes* could have been thought to be related to *Sphyræna* unless the ventrals were interpreted as being abnormally anterior abdominal ventrals. The ventrals, however, prove to be typical thoracic ventrals with the anterior point of the pelvic girdle interposed and attached between the opposing clavicles near their lower end above their symphysis. Anterior abdominal ventrals might have the point of the pelvic girdle touching the clavicles or even extending slightly under them, but never interposed between them.

Another character that refutes the Sphyrænoid relationship of *Dinolestes* is the lack of the long processes developed backward from the epiotics and supraoccipital crest, which are possessed in a greater or less degree by all the Percesoces and reaches its greater development in *Sphyræna*.

A more important difference is the structure of the teeth. Though both *Dinolestes* and *Sphyræna* have large backward-directed canines, they are entirely different in the way in which they are attached to the bone of the jaw. The calcified tooth substance of the teeth of *Dinolestes* reaches only to the bone, where it is anchylosed or so incorporated with the bone as to make it difficult to distinguish the line of junction. This attachment is effected by what Tomes calls "bone of attachment." A substance resembling cement, but unlike true cement, is developed from the periosteum rather than from the dental capsule. Such teeth may be developed from sockets, but as the calcified tooth substance is pushed out the cavity behind fills with the bone of attachment and becomes obliterated. The dentine never extends into a cavity of the bone in the mature tooth. This is a Percoid character.

The teeth of *Sphyræna*, on the other hand, are set in sockets. The attachment of teeth in alveoli is of such rare occurrence among fishes and must be so deep seated that we can hardly interpret it as less than a family character. Mr. W. G. Ridewood, in a paper,[1] has this to say in regard to this class of teeth:

> The tooth and bone are in organic continuity by means of a periosteal layer common to the tooth and the jaw; and this layer may remain uncalcified so that the teeth can be pulled out of their sockets, as in some Caracinoid fishes; or "bone of attachment" may, except in young teeth, anchylose the tooth to the wall of the socket, e. g., *Sphyræna*.

But whether or not the tooth becomes cemented in, the enamel and dentine extend into a cavity and do not become incorporated with the bone.

[1] Natural Science, VIII, June, 1896, p. 383.

There is also a difference in the shape of the teeth of *Sphyræna* and *Dinolestes*. Those of the former are lancelike—that is, compressed laterally and with cutting edges. Those of the latter are round in transverse section.

The vertebræ of *Dinolestes* are typical, or in general resembling the Percoids and most bony fishes in that they are of moderate length and not much constricted in the middle. They have parapophyses developed behind the fourth vertebra, two pits on the side of each vertebra separated by a longitudinal ridge, and the abdominal vertebræ with a pit on the ventral side with ridges on each side of it. The vertebræ of *Sphyræna* are long and smooth with scarcely any pits, much constricted in the middle, making them hourglass shaped, and with only one or two pairs of parapophyses.

The shape of the cranium of *Dinolestes* is also more typically Percoid in appearance than Sphyrænoid with the slightly rising supraoccipital crest and more wedge-shaped lateral view.

A recapitulation with these points condensed will show at once the affinity of *Dinolestes* to the Cheilodipteridæ.

1. The Percoid appearing cranium.
2. The thoracic ventrals.
3. The anchylosed teeth rather than teeth in sockets.
4. The character of the vertebræ, typical; not specialized as in *Sphyræna*.
5. The lack of the long posterior processes from the epiotics.

These conclusions are fortified by the following description.

DINOLESTES LEWINI.

Esox lewini GRIFFITH (?), Cuvier's Animal Kingdom, Griffith ed., X (1834), p. 465, pl. 60.

Dinolestes mülleri KLUNZINGER, Archiv für Nat., 38. Jahrg. I (1872), p. 30; Hobson Bay, South Australia.

Neosphyræna multiradiata CASTELNAU, Proc. Zool. and Acclim. Soc. Victoria, I (1872), p. 96; Melbourne.

Lanioperca mordax GÜNTHER, Ann. and Mag. Nat. Hist., 4th ser., X, (September, 1872), p. 183; Tasmania.

Dinolestes lewini GILL, Ann. and Mag. Nat. Hist., 4th ser., XIV (1874), p. 160.

DIAGNOSIS.

Body rather elongate; preorbital region produced; mouth large, the lower jaw projecting; canine teeth on lower jaw posteriorly and on premaxillaries at their symphysis; sharp, cardiform teeth in a single row on jaws, vomer and palatines; an inner row of villiform teeth on premaxillaries; three toothed superior pharyngeals; lower pharyngeals rather narrow, separate; gill rakers long and slender, about 4 + 13; opercles without spines or ridges; branchiostegals 7; maxillary with supplemental bone; nasals elongate, attached by their sides for nearly their whole length; parietals separated; ethmoid somewhat overlying prefrontals and vomer; posttemporal forked; postclavicle of two parts;

basisphenoid with a descending process; myodome present with a small pore to the exterior posteriorly; no suborbital shelf; vertebræ 27; parapophyses present on all abdominal vertebræ except first 3; scales cycloid; maxillaries, cheeks, opercles, and lower jaw with scales; lateral line straight, running well out on base of caudal, scales along its course systematically crowded; base of anal, soft dorsal, and caudal with small scales; anal with 2 spines and about 26 rays; dorsals remote, the first of about 5 slender spines, the second with 1 spine and about 18 rays; ventrals with 1 spine and 5 rays each; interspinous bones not extending between vertebral spines.

OSTEOLOGY.

Cranium, as viewed from above, rather elongate and narrow. Interorbital region a flattish area with the sides nearly parallel the greater part of its length, occupying at least a third of length of cranium. Preorbital region elongate, not tapering till near end, occupying another third of length of cranium. Region surrounding foramen magnum slightly produced. Lateral view of cranium tapering rather regularly to vomer.

Supraoccipital interposed between exoccipitals nearly to their posterior ends; its crest developed superiorly and posteriorly, scarcely extending past exoccipitals posteriorly.

Exoccipitals broadly meeting above basioccipital, entirely surrounding foramen magnum.

Parietals widely separated by supraoccipital, not extending over epiotics.

Epiotics with scarcely any process.

Prootics, opisthotics, sphenotics, and pterotics typical; that is, Percoid-like.

Alisphenoids widely separated. The anterior opening into brain case large.

Basisphenoid present; a foramen between it and basis cranii. A slender process descending from it and attached to parasphenoid.

Myodome present; opening to the exterior at its posterior end through an extremely small foramen.

Parasphenoid spreading out wide posteriorly.

Vomer bearing sharp short teeth in a single row around its anterior edges. Teeth becoming smaller anteriorly.

Prefrontals large and rather elongate, the olfactory foramen scarcely behind middle.

Ethmoid entirely superior to prefrontals and vomer, widely overlying them and extending to edge of rostrum. A raised area along its middle.

Nasals thin elongate rods of bone attached by their sides to ethmoid for nearly their whole length; their length over a fourth that of cranium.

Preorbital longer than wide; its outline triangular.

Suborbital ring of the usual number of five bones with a sensory canal through them. No suborbital shelf.[1]

Opercle without ridges or spines on outer surface. On inner surface a sharp horizontal ridge runs posteriorly from its condyle with hyomandibular.

Subopercle extending around lower corner of opercle, upward and backward, forming lower part of posterior opercular angle.

Interopercle very broadly attached to subopercle at its upper posterior side.

Preopercle with ridge and sensory canal as usual.

Lower limb of hyomandibular rather long and rod-like.

Palato-pterygoid process very long and stout. A single row of small teeth along lower edge extending anteriorly upon a process beyond main part of palatine somewhat similar to the usual process from upper edge of that bone. Suspensorium otherwise typical.

Lower jaw heavy and long. The articular half as wide as long. Teeth in a single row upon dentary, three or four canines present posteriorly.

Angular present, rather small.

Maxillary with long supplemental bone along posterior edge.

Premaxillary rather slender, much widened at middle into a wide process which extends behind maxillary; its lower end very slender. A single row of elongate pointed or small canine teeth along its edge, largest medially, growing gradually smaller toward each end. Inside of this row a villiform band, widest medially. At upper end of each maxillary are two large canines anchylosed immovably, the posterior pair much hooked back.

Clavicle and hypercoracoid typical, or as in the Percoids.

Hypocoracoid as usual broadly joined at upper end to clavicle and hypercoracoid, thence arching away and touching lower end of clavicle again with a rather slender process. Besides this, from its middle, running through the usual interspace between it and clavicle, is another process flat and thin, but strengthened through its middle, reaching to and joined to clavicle.

Actinosts four, rather short.

Pectoral not nearer upper end of clavicle than is usual in the Percoids, its upper ray working directly upon hypercoracoid.

Postclavicle in two parts, the inferior very long.

Supraclavicle of moderate length.

Post-temporal widely forked; its articulation with skull typical.

Inferior hypohyal scarcely visible on outer surface of hyoid arch, being covered by superior hypohyal, which forms the greater part of front of arch. Hypohyals of about equal size on inner surface of arch.

Ceratohyals, ephyals, and interhyals typical.

[1] Suborbital shelf: a small shelf of bone extending inward from the suborbital ring and conforming to the rotundity of the eyeball. Possessed by many of the higher bony fishes.

Branchiostegals seven, four being borne by ceratohyal and three by epihyal; the three anterior ones attached to inner surface of hyoid arch.

Glossohyal wide, flat, or slightly concave above.

Urohyal elongate, thin, without double heel below, except at extreme anterior end.

Basibranchials three—the first not supporting any arch, the second supporting the first arch, and to the third the second and third arches are joined. No ossified basibranchial to fourth arch.

Epibranchials of third arch meet behind last basibranchial; epibranchials of fourth arch absent.

Suspensory pharyngeals present on first arch.

Superior pharyngeals three in number, that is, on second, third, and fourth arches; the second largest, and with the third forming an elongate patch.

First two interspinal rays of dorsal and of anal not coalesced. None of the interspinals interposed between neural or hæmal spines.

The interval between first and second dorsals occupied by two free auxiliary interneural spines.

First interhæmal spine not enlarged or in any way differentiated from its fellows. Interhæmals equally graduated from behind forward.

Ventral fins truly thoracic. The pelvic girdle long and tapering to a slender point, which is interposed between the clavicles above their union.

The vertebral column composed of 10 abdominal and 16 caudal, which, with the usual hypural, number 27 vertebræ.

Superior zygapophyses both posteriorly and anteriorly present, but small, as is usual in the Percoid fishes.

Inferior zygapophyses well developed posteriorly near middle of column; anteriorly scarcely discernible.

Parapophyses developed on fourth and succeeding abdominal vertebræ, growing larger posteriorly; the last pair connected near their bases by a bridge of bone.

Hypural assisted in supporting caudal fin by spines from two preceding vertebræ.

Ribs and epipleurals typical.

EXPLANATION OF PLATES.

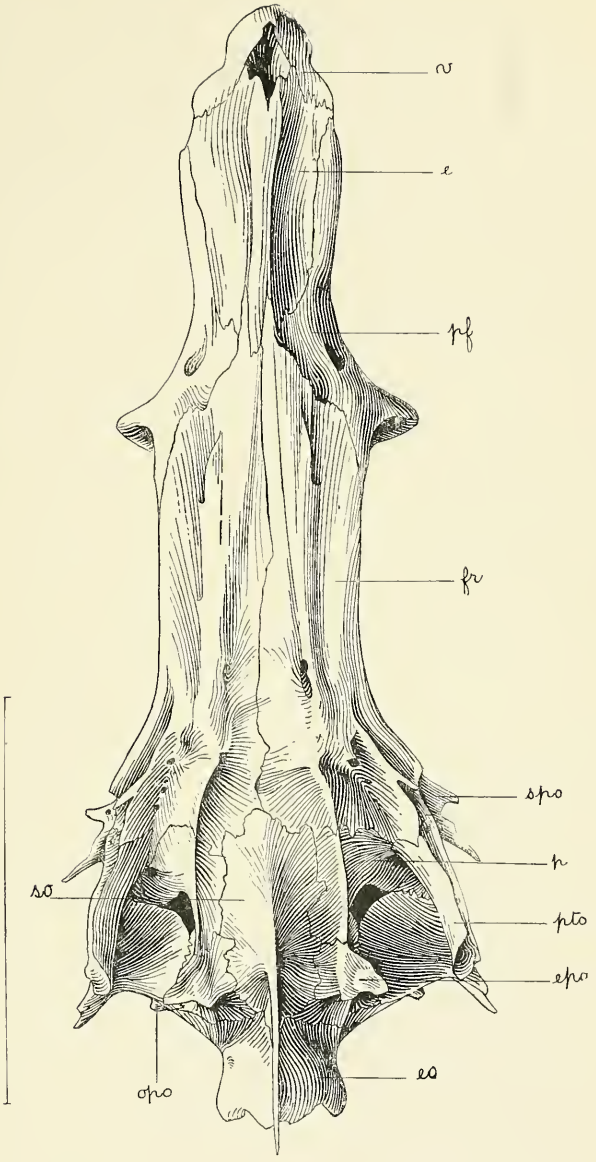
[Drawn by Chloe Lesley Starks.]

Plates VIII, IX, and X, superior, lateral, and posterior views of the cranium of *Dinolestes lewini*, skeleton No. 47877, U.S.N.M., from Port Jackson, Australia.

Plate XI, *Dinolestes lewini*, No. 47929, U.S.N.M., from Tasmania.

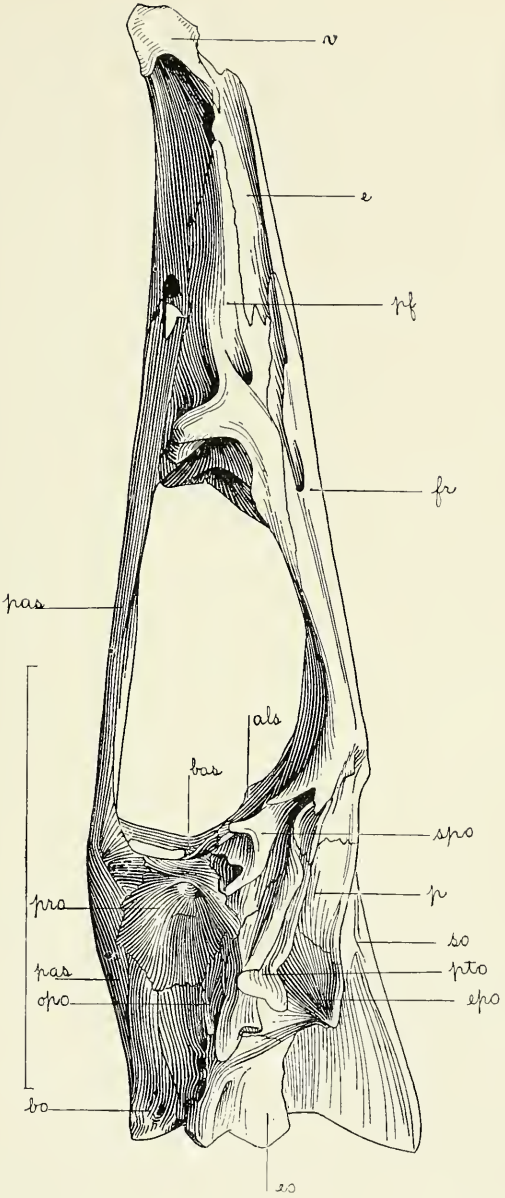
SIGNIFICANCE OF REFERENCE LETTERS USED ON PLATES.

als. Alisphenoid.
bas. Basisphenoid.
bo. Basioccipital.
e. Ethmoid.
eo. Exoccipital.
epo. Epiotic.
fr. Frontal.
opo. Opisthotic.
p. Parietal.
pas. Parasphenoid.
pf. Prefrontal.
pro. Prootic.
pto. Pterotic.
so. Supraoccipital.
spo. Sphenotic.
v. Vomer.



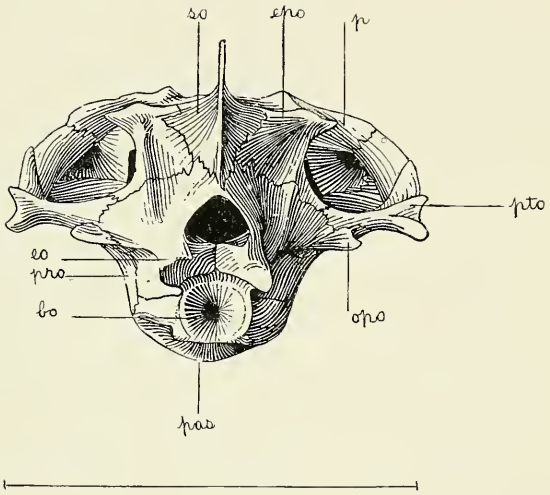
SUPERIOR VIEW OF CRANIUM OF DINOLESTES LEWINI.

FOR EXPLANATION OF PLATE SEE PAGE 120.



LATERAL VIEW OF CRANIUM OF DINOLESTES LEWINI.

FOR EXPLANATION OF PLATE SEE PAGE 120.



POSTERIOR VIEW OF CRANIUM OF DINOLESTES LEWINI.

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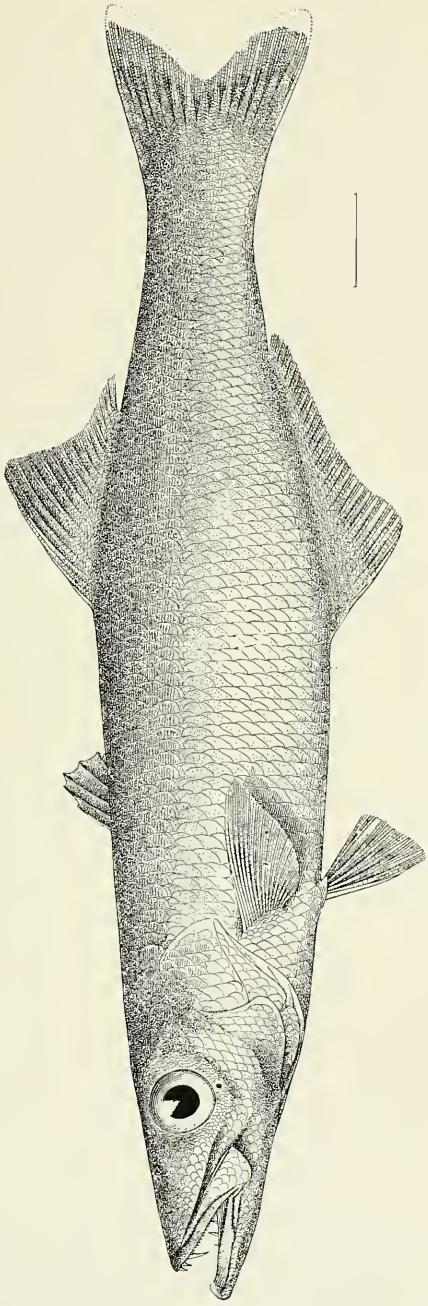


DINOLESTES LEWINI.

FOR EXPLANATION OF PLATE SEE PAGE 120.

DESCRIPTION OF TWO NEW SPECIES OF CRAYFISH.

By W. P. Hay, M. S.,
Central High School, Washington, D. C.

In working over the large collection of the Astacidæ in the possession of the U. S. National Museum the following new species have come to my notice:

CAMBARUS PILOSUS.

Type locality.—Beloit, Mitchell County, Kansas.

Type.—No. 19761, U.S.N.M.

Male, form I, not known.

Male, form II, rostrum of medium width, long, deeply excavated, with sharp, raised, slightly converging margins; lateral teeth well developed, acute; acumen long, slender, acute, nearly straight. Postorbital ridges grooved on their outer face; anterior spines small, acute. Carapace smooth and lightly punctate above, very finely granulate on the sides; anterior border not angulated and with a well-developed fringe of cilia extending along the lower side of the rostrum and around beyond the minute branchiostegian spine; cervical groove deep, sinuate, broken on the sides above the small lateral spine; areola narrow. Abdomen longer than the cephalothorax, telson rounded behind, anterior segment with two spines on each side of the posterior border. Second and third basal segments of the antennæ with well-developed, acute, external spines. Antennal scale a little longer than the rostrum, outer margin slightly concave, apical spine acute and rather long; tip concave, inner margin rounded. Epistoma subtriangular, the margins convex. Third maxillipeds hairy on their inner and outer faces. Chelipeds short; chelæ of moderate width, punctate above, nearly smooth

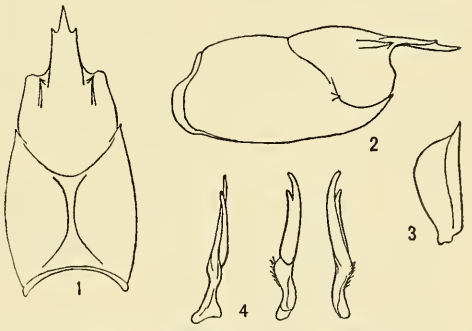


Fig. 1.—Nos. 1, 2, carapace; No. 3, antennal scale; No. 4. first abdominal appendages of male, form II.

and sparsely ciliate below; upper surface near the inner margin and both fingers thickly ciliate; inner border of hand short, serrate, the serrations hidden by the cilia; outer margin of hand ribbed; movable finger serrate and ciliate on outer margin; both fingers ribbed on upper surface and bearded at base on inner margins, the beard being most dense on the outer finger. Carpus triangular, lightly grooved above, ciliate along the distal margin; a small spine at the superior internal angle and behind it a few very minute denticles, inner surface heavily bearded along the distal margin; median spine large and curved strongly forward; distal border beneath ciliate, and with three well-developed, acute spines. Distal margin of meros bearded above and within, two small spines above at the distal end; beneath, of the usual two rows of spines, the outer row is represented by two or three strong spines, the inner by a row of small teeth; between the rows there is, in some specimens, a ciliated patch. Third pair of legs hooked. First pair of abdominal appendages of medium length, reaching forward to the middle of the basal segments of the second pair of legs, very slender and bifid for only a short distance from the tip; inner branch considerably shorter than the outer, the tip acute and turned slightly backward and outward across the outer branch, the tip of which is compressed and recurved.

Female.—Not known.

Seven specimens, the largest nearly 2 inches in length.

In some respects this species resembles quite closely *Cambarus naïs* Faxon, from the same region. I have not been able to compare Dr. Faxon's types with the species here described, but as his description makes no mention of the heavily ciliate chelipeds, a character which could not have escaped his observation, and fails to agree in other respects, I feel no hesitation in considering the specimens from Beloit representatives of a new species.

CAMBARUS CLYPEATUS.

Type locality.—Bay St. Louis, Mississippi; U. S. Biological Survey, collector, 1892.

Type.—No. 22778, U.S.N.M.

Male, form I, not known.

Male, form II, not known.

Female.—Rostrum long, very broad, flat, hardly at all excavated, sides slightly raised, sharp, diverging slightly from the base to about the middle, then converging to near the tip where they abruptly turn in to the middle line; the tip of the rostrum is round, and the usual lateral teeth are not represented, even by angles. Postorbital ridges short, grooved on outer face, anterior spines wanting. Carapace smooth and polished above, lightly punctate on the sides, anterior margin hardly angulated; cervical groove sinuate, broken on the sides; lateral spine wanting; branchiostegian spine minute; areola wide.

Abdomen longer than the cephalothorax; pleuræ punctate; telson rounded behind, anterior segment with four or more spines on each side of the posterior border. Antennæ shorter than the cephalothorax; antennal scale shorter than the rostrum, broadest near the middle, tip convex, inner margin rounded. Epistoma broader than long, sides convex, anterior angle denticulate. Third maxillipeds hairy on their inner faces. Chelipeds moderately strong; chelæ inflated, punctate above and below; inner margin of hand longer than the fingers; outer finger short, nearly straight, inner finger rather strongly incurved at tip; both fingers strongly ribbed above and provided on their cutting edges with two or three large teeth and numerous serrations. Thoracic sternum hairy. Annulus ventralis prominent, subcircular, the wall bituberculate and thin in front, broad and low behind. The fissure is very sharply bent to one side just within the anterior wall and is lost, but an accessory branch, separated by a thin wall from the first, bends back to the middle of the annulus and emerges at the posterior angle. The appendages of the first abdominal somite are not developed.

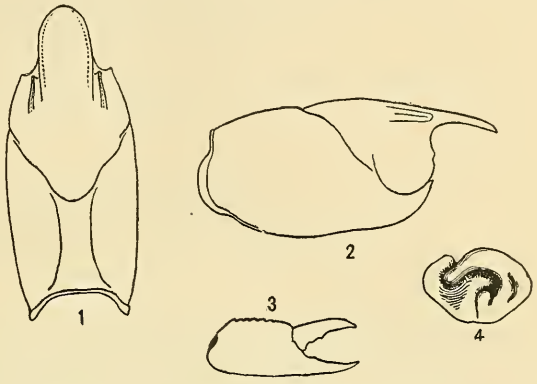


FIG. 2.—NOS. 1, 2, CARAPACE; NO. 3, CHELA; NO. 4, ANNULUS VENTRALIS.

A single specimen about 2 inches in length.

As no specimen of the male of this species has yet been collected, it is impossible to say with certainty where this species belongs. In general appearance it is very unlike any other North American species yet discovered. In the rounded, toothless rostrum and the peculiarly shaped chelæ it resembles somewhat some of the South American Parastacinæ, but the resemblance stops there. The closest relatives will probably be found to be some of the species of the second group of Faxon, and of these *Cambarus cubensis* approaches it most closely in appearance.

CONTRIBUTIONS TO THE NATURAL HISTORY OF THE COMMANDER ISLANDS.[1]

No. XIII.—A NEW SPECIES OF STALKED MEDUSÆ, HALICLYSTUS STEJNEGERI.

By K. Kishinouye,

Imperial Fisheries Bureau, Tokyo.

A large number of medusæ, belonging to the very interesting family of Stauromedusæ, were collected by Mr. Leonhard Stejneger at Nikolski, Bering Island, one of the Commander Islands, during the summer of 1897. These medusæ were preserved in formol and still remain in excellent condition. They belong to a single species of the genus *Haliclystus*. So far as I am aware, there are only three known species of this genus, and all of them are from the Atlantic coast. The species, how-

[1] The following "Contributions to the Natural History of the Commander Islands" have been published in these Proceedings thus far: I. Leonhard Stejneger: Notes on the natural history, including descriptions of new cetaceans, XI, 1883, pp. 58–89.——II. Leonhard Stejneger: Investigations relating to the date of the extermination of Steller's Sea-Cow, VII, 1884, pp. 181–189.——III. W. H. Dall: Report on the mollusca of the Commander Islands, Bering Sea, collected by Leonhard Stejneger in 1882 and 1883, VII, 1884, pp. 340–349, pl. II.——IV A. Asa Gray: Notes upon the plants collected on the Commander Islands (Bering and Copper islands) by Leonhard Stejneger, VII, 1885, pp. 527–529.——IV B. Leonhard Stejneger: Additional notes on the plants of the Commander Islands, VII, 1885, pp. 529–538.——V. Frederick W. True: Description of a new species of Mesoplodon, *M. stejnegeri*, obtained by Dr. Leonhard Stejneger, in Bering Island, VIII, pp. 584, 585, pl. XXV.——VI. W. H. Dall, Report on Bering Island mollusca collected by Mr. Nicolas Grebnitzki, IX, 1886, pp. 209–219.——VII. Leonhard Stejneger: Revised and annotated catalogue of the birds inhabiting the Commander Islands, X, 1887, pp. 117–145, pls. VII–IX.——VIII. George Vasey: Description of *Alopecurus stejnegeri*, a new species of grass from the Commander Islands, X, 1887, p. 153.——IX. W. Lilljeborg: On the Entomostraca collected by Mr. Leonhard Stejneger on Bering Island, 1882–83, X, 1887, pp. 154–156.——X A. Leonhard Stejneger: Contributions to the history of Pallas's Cormorant, XII, 1889, pp. 83–88.——X B. F. A. Lucas: Description of some bones of Pallas's Cormorant (*Phalacrocorax perspicillatus*), XII, 1889, pp. 88–94, pl. II.——XI. F. A. Lucas: The cranium of Pallas's Cormorant, XVIII, 1895, pp. 717–719, pls. XXXIV, XXXV.——XII. Tarleton H. Bean and Barton A. Bean: Fishes collected at Bering and Copper islands by Nikolai A. Grebnitzki and Leonhard Stejneger, XIX, 1896, pp. 237–251.

ever, differs in many points from those already known, and it is so far the only representative of the genus *Haliclystus* found on the Pacific coast.

HALICLYSTUS STEJNEGERI, new species.

Type.—No. 18942, U.S.N.M.

Habitat.—Bering Island, North Pacific Ocean.

The medusa is funnel-shaped and has a rather short peduncle. The largest specimen of the collection is 18 mm. in height (including the peduncle) and 18 mm. in diameter. The peduncle is 5½ mm. in height and 2½ mm. in breadth. I shall give a short description of such larger specimens.

The preserved specimens are grayish or pale brown, semitransparent, with a dark brown or nearly black streak at the umbrella margin and

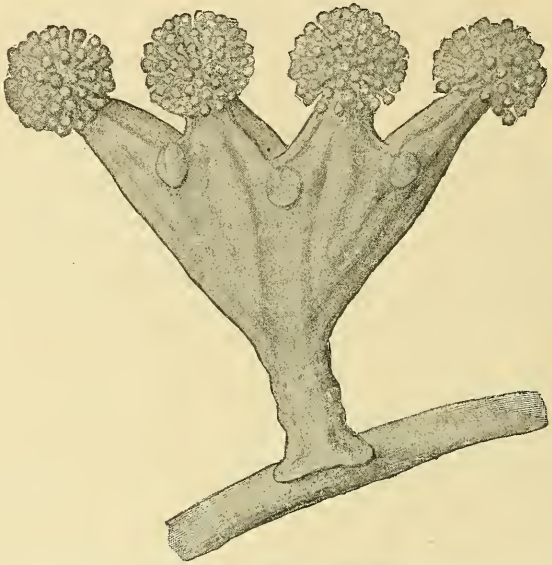


FIG. 1.—HALICLYSTUS STEJNEGERI, NEW SPECIES. SIDE VIEW. × 4.
Drawn by K. Kishinouye.

each perradial corner of the peduncle (figs. 1, 2). Besides these there are 16 radial streaks of the same color (fig. 1). Each two of these 16 streaks are paired along the adradii, and each two adradial pairs unite together in turn at the perradii at the junction of the umbrella (sometimes called the calyx) and the peduncle. These dark streaks are found in the exumbrella. In the subumbrella, too, a dark streak is found at each perradial edge of the œsophagus, and moreover there are pigment cells around the genital sacs. In all these cases the pigment is found in endoderm cells.

The umbrella, or the so-called calyx, is funnel-shaped or conical, gradually increasing in breadth from the peduncle to the umbrella margin. The breadth of the umbrella is one and one-third to one and one-half times as long as its height.

The peduncle is nearly quadrate in cross section. It is about half the length of the umbrella. It has four interradial longitudinal grooves which are formed by the attachment of the tæniola (fig. 1). These tæniola meet at the longitudinal axis and divide the internal space of the peduncle into four chambers. The demarcation between the umbrella and the peduncle is distinct.

The exumbrella is smooth, without prominent ridges or groups of nematocysts. The gelatinous layer is equally thin everywhere and firm in consistence. In the subumbrella we find a few small groups of nematocysts at the perradial sinuses of the umbrella margin only.

The muscle plates are as in other species. The perradial muscles are more weakly developed than the interradial. The four interradial infundibular deepenings nearly reach the junction of the umbrella with the peduncles.

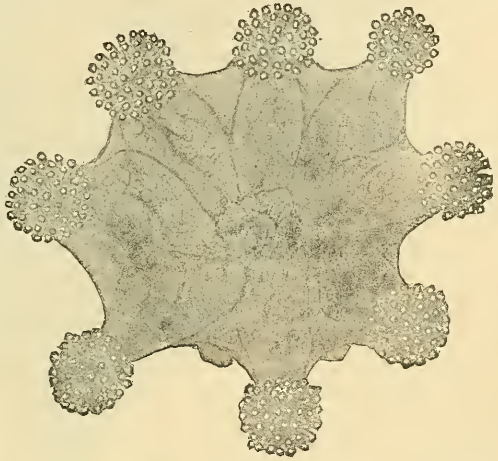


FIG. 2.—HALICLYSTUS STEJNEGERI, NEW SPECIES. VIEW FROM THE OVAL SIDE. × 3½.
Drawn by K. Kishinouye.

The umbrella margin is cut into eight adradial arms, which are equal in size and equally distant from each other (fig. 2). The depth of the incisions is about half the length between a principal tentacle and the peduncle. Each arm bears a bunch of tentacles, 70 to 100 in number. Tentacles are of equal thickness, but they differ in length. Their length decreases gradually as they approach the periphery of the bunch.

The eight principal tentacles are transformed into adhesive marginal bodies (figs. 1, 2). They are large, sessile, egg-shaped, and about one-half as long as the diameter of the peduncle.

The œsophagus or manubrium (fig. 2) is short, quadrangular, as in other species of *Haliclystus*. Its wall has many longitudinal folds, and its free margin is reflected outward. The eight rows of well-developed gastral filaments extend from the base of the œsophagus to the proximal end of the genital glands.

Genital glands are eight in number, broad and leaf-shaped, tapering at both ends. They extend almost along the entire length of the umbrella. As they are touching each other along the proximal half their length (fig. 2), the subumbrella is almost entirely occupied by them. Each gland consists of 100 to 150 round sacs. These sacs are not arranged in rows. Those nearest to the perradii are larger than the others. We find six to eight sacs abreast at the broadest part of

each gland. Each gland is turned over at the perradial sides and forms a part of the mesentery (fig. 2).

Small specimens (3 to 4 mm. in umbrella diameter) of the collection differ more or less from larger specimens in the proportion of the parts of the body, number of tentacles, and genital sacs, etc. Generally, smaller specimens have the narrower umbrella, longer peduncle, shorter arms shallower umbrella cavity, fewer and not much crowded genital

FIG. 3.—HALICLYSTUS STEINEGERI. AN IMMATURE FORM, 3 MM. IN HEIGHT, DRAWN FROM A PREPARATION IN TRANSMITTED LIGHT.

Drawn by J. Urata.

sacs, and a very little pigment in endoderm epithelium. Moreover, the genital sacs vary in size much more greatly than in larger specimens. The peduncle is not four-chambered. Such differences may be easily understood by comparing figs. 1 and 2 with fig. 3.

Almost all the specimens of the collection were found to contain a number of *Gammarus* in the stomach.

Characteristics of different species of Haliclystus.

Name.	Umbrella.	Peduncle.	Eight arms.	Eight marginal anchors.	Sexual glands.
Haliclystus octoradiatus.	Conical, surface flat, 2 to 3 times as broad as its height.	Cylindrical, almost as long as the height of umbrella; no outward longitudinal grooves.	Equally distant from each other. Each arm with 30 to 60 tentacles.	Large, egg-shaped or nearly club-shaped, one-fourth as long as the breadth of the peduncle.	In each gland 20 to 30 large sacs in two longitudinal rows.
Haliclystus salpinx.	Pyramidal, octangular, much broader than its height.	Quadrangular prismatic, considerably larger than the height of umbrella.	Equally distant from each other. Each arm with 60 to 70 tentacles.	Very large, as long as arms, obliquely trumpet-shaped.	In each gland 40 to 50 sacs in four longitudinal rows.
Haliclystus stejnegeri.	Conical, surface flat, a little broader than its height.	About half as long as the height of umbrella, with four longitudinal grooves.	Equally distant from each other. Each arm with 70 to 100 tentacles.	Large, egg-shaped, half as long as the breadth of peduncle.	In each gland 100 to 150 sacs, 6 to 8 sacs abreast in the broadest part.
Haliclystus auricula.	Pyramidal, octangular, almost as broad as its height.	Almost as long as the height of umbrella, with four deep longitudinal grooves.	United in pairs. Each arm with 100 to 120 tentacles.	Large, shaped like coffee beans, as long as the breadth of the peduncle.	In each gland 100 to 150 sacs in 6 to 8 radial rows.

TOKYO, *May 22, 1899.*

DESCRIPTION OF A NEW SPECIES OF IDOTEA FROM HAKODATE BAY, JAPAN.

By Harriet Richardson.

Two distinct species were included by Miers[1] with *Idotea ochotensis* Brandt. In a former paper[2] the author has endeavored to define the limits of *Idotea ochotensis* on the one side by preserving the specific distinctions of *Idotea rectilineata* Lockington. It is the object of the present paper to further define the limits of *Idotea ochotensis* on the other side by showing the specific differences of another species, formerly included. Two specimens from Hakodate Bay, Japan, in the collection in the U. S. National Museum, when compared with a large series of *I. ochotensis* from various localities, extending all the way from Kamchatka to Bering Sea and the Aleutian Islands, confirms the impossibility of uniting them with *I. ochotensis*. The specimen which Miers saw in the British Museum collection from Yeddo Island, and which he figures, undoubtedly belongs to the same species as our two specimens from Hakodate Bay. In regard to it Miers says:

> It differs from Brandt's figure of *I. ochotensis* only in its relatively longer and slenderer body and somewhat shorter antennæ, which when retracted would not reach to the posterior margin of the fourth thoracic segment, but whose peduncular joints are longer than in Brandt's figure.

Further on he speaks of the tooth at the distal extremity of the terminal segment as being very prominent in the specimen from Japan. It is probable that Miers had specimens of all three species, the one spoken of obtained at Vancouver Island being *I. rectilineata* Lockington, the specimen from British Columbia being *I. ochotensis* Brandt, and the Japanese specimen the one herein described.

In comparing the species, specimens have been selected which are of nearly the same size, in order to better compare the corresponding parts.

[1] Journal Linnæan Society of London, XVI, 1883, pp. 32–34, pl. 1, figs. 8–10.
[2] Proc. U. S. Nat. Mus., XXI, 1899, p. 845.

IDOTEA JAPONICA, new species.

Body slender, elongated, five times longer than broad, with sides parallel. A dorsal median keel extends the entire length of the body. Color, brownish yellow.

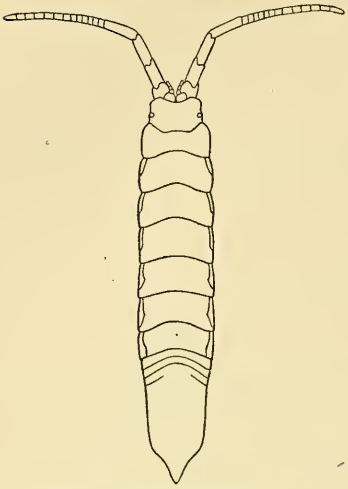


FIG. 1.—IDOTEA JAPONICA. ×2.

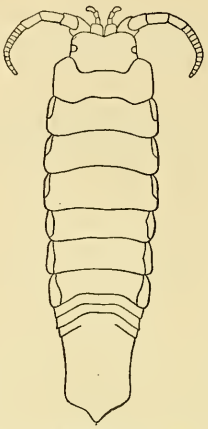


FIG. 2.—IDOTEA OCHOTENSIS. ×2.

Head with the anterior margin deeply and roundly excavate and with the antero-lateral angles broadly rounded. Eyes situated on the extreme lateral margin in the median transverse line. The first pair of antennæ reach only a little beyond the second joint of the peduncle of the second pair of antennæ. The second pair of antennæ are half as long as the body, and when retracted would extend to the middle of the fifth thoracic segment; first joint of the peduncle short and concealed by the antero-lateral angles in a dorsal view; second and third joints nearly equal in length; fourth and fifth joints equal in length, and each equal to the second and third taken together; flagellum composed of 14 joints, and shorter than the peduncle.

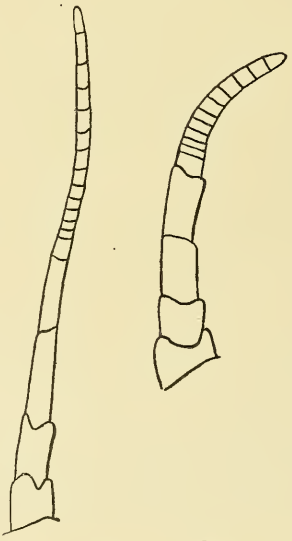


FIG. 3.—*a*, ANTENNA OF SECOND PAIR OF IDOTEA JAPONICA; *b*, ANTENNA OF SECOND PAIR OF IDOTEA OCHOTENSIS. ×8.

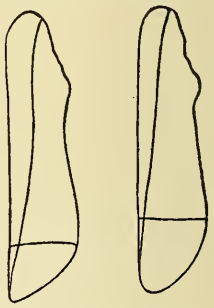
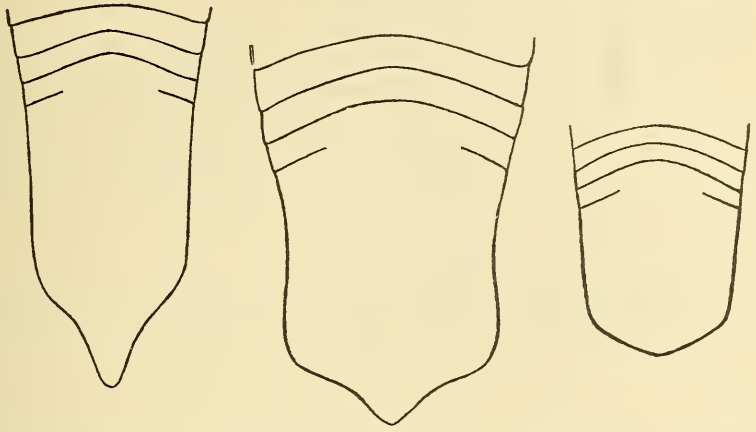


FIG. 4.—*a*, OPERCULAR VALVE OF IDOTEA OCHOTENSIS; *b*, OPERCULAR VALVE OF IDOTEA JAPONICA. ×8.

Segments of the thorax about equal in length. First segment with a deep excavation and with antero-lateral angles rounded. Epimera narrow; those of the second, third, and fourth segments occupying only the anterior half of the lateral margins; those of the fifth and sixth segments, the anterior two-thirds, and of the seventh segment, the entire margin.

The abdomen (including the terminal segment) is composed of three segments, with suture lines indicative of another partly coalesced segment. The terminal segment, with sides slightly converging, has the



a *b* *c*

FIG. 5.—*a*, ABDOMEN OF IDOTEA JAPONICA; *b*, ABDOMEN OF IDOTEA OCHOTENSIS; *c*, ABDOMEN OF IDOTEA RECTILINEATA. × 8.

apex triangulate and produced much beyond the lateral angles, which are roundly obtuse.

The legs are slender.

Two specimens come from Hakodate Bay, Japan; depth, 8 fathoms in gravel.

Type.—No. 9348, U.S.N.M.

This species differs from *I. ochotensis* Brandt in the following points:

1. The proportions of the body. *I. ochotensis* is stouter and shorter, the relative proportion of breadth and length being 2:7, while in *I. japonica* the body is longer and narrower, the relative proportion being 2:10.

2. The proportionately greater length of the second pair of antennæ.[1]

In *I. ochotensis* the joints of both the peduncle and the flagellum are stouter and shorter and the antennæ extend only to the posterior margin of the third thoracic segment or the middle of the fourth thoracic segment, while in *I. japonica* these joints are longer and more slender, and the antennæ reach the middle of the fifth thoracic segment.

a *b*

FIG. 6.—*a*, LEG OF SECOND PAIR OF IDOTEA JAPONICA; *b*, LEG OF SECOND PAIR OF IDOTEA OCHOTENSIS. × 10.

[1] Although there is some variation in the length of the second pair of antennæ of *Idotea ochotensis*, nevertheless these antennæ are always shorter than those of *Idotea japonica* in specimens of the same size, and the peduncle of the antennæ is also shorter.

3. The form of the antero-lateral angles of the first thoracic segment.

In *I. ochotensis* these angles are markedly truncate, while in the present species they are rounded.

4. The narrower epimera in *I. japonica.*

5. The shape of the terminal segment.

In *I. ochotensis* the lateral margins of this segment are concave, the lateral angles prominent and rectangular, the median posterior tooth or apex not greatly produced, while in *I. japonica* the lateral margins are straight, the lateral angles less prominent and obtuse, and the median posterior tooth or apex greatly produced, being twice the length of that in *I. ochotensis.*

6. The more slender and shorter legs of *I. japonica.*

7. The differently shaped opercular valves.

8. The more slender joints in the first pair of antennæ of *I. japonica.*

LIST OF SHELLS COLLECTED BY VERNON BAILEY IN HERON AND EAGLE LAKES, MINNESOTA, WITH NOTES.

By Robert E. C. Stearns, Ph. D.,
Honorary Associate in Zoology.

The species listed below have been received at various times from the United States Department of Agriculture. They form a part of the collection of the United States National Museum, and were collected by Mr. Vernon Bailey, an assistant in the Division of Biological Exploration, in charge of Dr. C. Hart Merriam.

Heron Lake is in southwestern Minnesota, in Jackson County, near the Iowa line. The material from this place was, to quote Mr. Bailey, "scraped up on the beach," in 1887.

Eagle Lake is in Sherburne County. This county is nearer the center of the State, being rather south and east of the center. The collections from both places are small, so far as the number of species is considered, but not without interest, as certain forms, which are commented on at some length, indicate peculiar environmental conditions. These conditions can only be surmised from the material itself, in the place of personal investigation of the lakes and their waters as well as the immediate region in which they are situated. The testimony of the numerous examples of *Planorbis trivolvis* from Heron Lake and *Limnæa emarginata* from Eagle Lake points to considerable fluctuation in the volume of the water one season compared with another, and in the more northerly Eagle Lake to the influence of extreme cold, or alternations of temperature conditions as related to volume of water in some seasons or years, as well as possible alkalinity or some chemical fluctuation due to diminished volume of water at times, or, briefly, to fluctuations in the quantity and temperature of the waters and the chemical quality or proportions in the same.

The Eagle Lake shells were collected in 1891.

LIMNÆA PALUSTRIS Müller.

Heron Lake; a few examples.

LIMNÆA CAPERATA Say.

Heron Lake; infrequent.

LIMNÆA DESIDIOSA Say.

Eagle Lake; two living examples (Cat. No. 123895, U.S.N.M.).

LIMNÆA EMARGINATA Say.

Eagle Lake; abundant. Of the total number of shells from this lake, nine-tenths belong to this species and its varieties, numbering, perfect and imperfect being counted, probably four hundred examples.

A. *Normal form* (Cat. No. 123887, U.S.N.M.); smooth; spire moderately elevated; rather solid and ventricose; columellar fold or twist, rather strong.

B. *Spire short* (Cat. No. 123888, U.S.N.M.); rather thin and ventricose, ranging from young to adult.

C. *Body whorl shouldered above* (Cat. No. 123889, U.S.N.M); spire short to elevated; surface smooth to malleated; solid.

D. *Deeply sutured; spire rather high* (Cat. No. 123890, U.S.N.M.); surface smooth; some individuals marked by strong incremental lines; others inconspicuously lirate; young to adult.

E. *Malleated; obtusely lirate* (Cat. No. 123891, U.S.N.M); in some examples partially obtusely lirate; others showing sharply developed growth lines; spire moderate; shell rather solid; aperture effuse; numerous examples.

F. *Patulous; aperture more or less reflected* (Cat. No. 123892, U.S.N.M); surface smooth or malleated; obtusely lirate in some instances; spire moderate; several examples.

G. *Distorted, bulging* (Cat. No. 123893, U.S.N.M); shells globose or elongated; solid; smooth or malleated; suture deep; aperture in some examples effuse; numerous specimens.

H. *Immature* (Cat. No. 123894, U.S.N.M.); this number and tube includes juvenile examples of many of the foregoing, and other varietal facies.

PLANORBIS TRIVOLVIS Say.

Heron Lake; abundant (Cat. No. 104462, U.S.N.M.). A dwarfed and apparently arrested form of this widely distributed species was obtained in great numbers by Mr. Bailey. The largest individual measured, maximum, only 12.50 mm., while the average of numerous examples is not over 9 mm., maximum. There are two varietal forms, which point to hybridization, suggesting *campanulatus* in one direction and *bicarinatus* in the other. Among 143 perfect individuals, 6 exhibit the abrupt varicose character of aperture so conspicuous in *campanulatus*, and there are many examples that lean toward *bicarinatus*, with a pretty sharp angle on the upper and an obtuse keel on the under side of the whorls. These are registered in the United States National Museum, as follows:

P. trivolvis var. A (Cat. No. 104463, U.S.N.M.).

P. trivolvis var. B (Cat. No. 104464, U.S.N.M.).

PLANORBIS BICARINATUS Say.

Heron Lake (Cat. No. 104465, U.S.N.M.); Eagle Lake (Cat. No. 123897, U.S.N.M.). The 4 specimens from the first-named place are distinctly characteristic; from the last numerous examples were obtained.

PLANORBIS PARVUS Say.

Heron Lake (Cat. No. 104461, U.S.N.M.); Eagle Lake (Cat. No. 123899, U.S.N.M.). From each of the lakes, a few individuals were found in the general mass of material; apparently less common than the larger species.

PLANORBIS CAMPANULATUS Say.

Eagle Lake (Cat. No. 123898, U.S.N.M.); two examples.

PHYSA HETEROSTROPHA Say.

Heron Lake; Eagle Lake (Cat. No. 123896, U.S.N.M.). From the former several examples; from the latter two rather undersized specimens.

PHYSA GYRINA Say.

Heron Lake; a few specimens.

BYTHINELLA OBTUSA Lea.

Heron Lake (Cat. No. 104459, U.S.N.M.); Eagle Lake (Cat. No. 123902, U.S.N.M.). Many examples from each of the lakes, but apparently less frequent than the following:

AMNICOLA CINCINNATIENSIS Anthony.

Heron Lake (Cat. No. 104458, U.S.N.M.); Eagle Lake (Cat. No. 123901, U.S.N.M.). Abundant in Heron Lake, frequently of large size; also common in Eagle Lake.

VALVATA TRICARINATA Say.

Heron Lake (Cat. No. 104460, U.S.N.M.); Eagle Lake (Cat. No. 123900, U.S.N.M.). Exceedingly common and of large size in Heron Lake; the median keel sometimes obsolete. Eight examples from Eagle Lake.

SUCCINEA OVALIS Gould.

Near Heron Lake (Cat. No. 104466, U.S.N.M.). A single example of this terrestial form was detected near the margin of the lake.

SPHÆRIUM STRIATINUM Lamarck.

Heron Lake (Cat. No. 104467, U.S.N.M.); not uncommon.

SPHÆRIUM SOLIDULUM Prime.

Heron Lake; many dead valves.

PISIDIUM COMPRESSUM Prime.

Heron Lake; a single dead valve.

PISIDIUM VARIABILE Prime.

Eagle Lake (Cat. No. 123903, U.S.N.M.); numerous odd valves.

It is presumable that these lakes contain many species not mentioned above. It should be borne in mind that no attempt was made by Mr. Bailey to make an exhaustive collection of the molluscan life in these bodies of water; he simply collected such material as came readily to his hand without interfering with his special work.

DESCRIPTION OF A NEW VARIETY OF HALIOTIS FROM CALIFORNIA, WITH FAUNAL AND GEOGRAPHICAL NOTES.

By Robert E. C. Stearns, Ph. D.,

Honorary Associate in Zoology.

Of the littoral fauna of that long line of coast extending from Point Bonita, on the north side of the entrance to San Francisco Bay, to Cape Flattery, the southerly point of the entrance to the Strait of Juan de Fuca, a stretch of nearly 700 nautical miles, but little is known. The general aspect of the coast throughout most of its extent is broken, jagged, and rocky, with bold abrupt bluffs, against which in ordinary weather the ocean dashes with greater or less violence, and therefore unfavorable to the field work of the naturalist.

There are, however, many reaches of a more inviting character, where the rocky shore dips under the sea with so moderate a slope that the zone uncovered at extreme low tides is of considerable width, often seamed and cut up by narrow furrows and channels, with many shallow pools, and frequently clothed with a heavy growth of bladder weed, altogether presenting a tempting challenge to the collector.

Then there are sandy flats of considerable area, as at Tomales and Bodega, and gravelly beaches occur, of moderate extent, with occasional, sometimes numerous, detached rock masses and bowlders.

While there are many so-called ports, embarcaderos, or landing places between the points above named, especially along the California coast, a large proportion, perhaps one-half or more of the coastwise settlements indicated on the map, consist of small communities incidental to the limited local business. At these places it is often the case there is no harbor, merely a simple roadstead or anchorage, available only in good weather. For the purposes of the collector the immediate neighborhood of many of these places is of trifling importance. The desirable portions of the coast are generally inaccessible by sea and require an outfit for land service, with camp equipage and the usual requisites, with ample appliances for shore work. The best time of the year is the spring, the months of March, April, and May, before the harsh westerly winds begin to sweep in from the sea—usually from the first to the middle of June.

Bolinas, Tomales, and Bodega bays, particularly the first and the adjacent Duxbury reef, being near San Francisco, have been visited by a few collectors, by Colonel Jewett and myself in 1866, and since by Raymond, Hemphill, and Wood, and again by the author, but nothing like thorough work has been done even at these places, the number of species of mollusks usually obtained being from 90 to 100. At Bodega, visited by Dr. Newcomb and myself in 1867, some 90 species were collected. Mr. Hemphill has collected at Fort Bragg and Humboldt Bay, at the latter place securing some interesting forms, including *Paludinella newcombiana*, a new species. On the coast of Mendocino County, nearly thirty years ago, Mr. Harford found near Big Spanish Flat a new *Fusus* (*F. harfordii*). His collection was exceedingly meager, most of his time having been devoted to botany. A visit to Crescent City made by the author in 1862 was a failure so far as shell collecting was concerned, for the beaches and shores in every direction were so piled up with driftwood and the refuse of the great flood of the previous winter as to be absolutely inaccessible. Some little collecting has been done at Coos and Shoalwater[1] bays and at Grays Harbor, on the coast of Washington.

It will be seen from the foregoing that the totality of research throughout this great stretch of coast is quite insignificant. The same may be said in great measure of the biological investigation of the uplands back from and bordering on the shore.

The occurrence of *Olivella intorta* in quantity somewhere along the coast in the neighborhood of Trinidad is implied by the large number of this rare species contained in a necklace[2] obtained from the Hoopa Indians by Lieutenant Ray.

Another peculiar form has recently been added to the few that have been detected in the region herein reviewed.

HALIOTIS FULGENS Philippi var. WALALLENSIS Stearns.

On the coast of Mendocino County, California, in the extreme southwest corner, close to the northerly boundary line of Sonoma County, is an embarcadero, or shipping point of the lumber interests of that neighborhood. Here is situated a small settlement known as Gualala.[3] The coast hereabout is broken and rocky, with bluffs 50 to 100 feet high. In the immediate vicinity of this village Mr. J. J. Rivers some years ago collected the form here described,[4] specimens of which are contained

[1] It may be well to recall what I have elsewhere mentioned, the planting of *Mya arenaria* in Shoalwater Bay by Captain Simpson, of San Francisco. This was some fifteen years ago.

[2] Cat. No. 77185, U.S.N.M., Ethnological department.

[3] Gualala, which is the official post-office name of the village, is a localized corruption of the Indian *Walalla*, which latter, I think, should be perpetuated.

[4] A preliminary description of this variety was published in The Nautilus, No. 9, XII, January, 1899.

in the U. S. National Museum (Cat. No. 98327) and in the museum of the University of California.

The examples in the U. S. National Museum collection were presented to me by Mr. Rivers, and are a part of the original lot. The largest adult is of much smaller size than average full-grown examples of the ordinary form of *H. fulgens*. My examination of the entire series collected by Mr. Rivers suggested the European *H. tuberculata* of the Channel Islands. There is a Japanese species figured in Reeves's Conchologia Iconica, *H. planata* Sowerby, which it somewhat resembles. As my notes were unfortunately destroyed some years ago, Mr. Dall has kindly furnished the following from the U. S. National Museum examples:

Shell of an oval form, considerably flattened, and with about two and a half whorls; color, dark brick red, with occasional mottlings of pale bluish green; holes, four in the young to six in the adult; sculpture of fine, somewhat irregular spiral threads, crossed by fine, close, slightly elevated, sharp concentric lamellæ, and a few small obscure wavelets which radiate obliquely from the apex; nacre rather pale, with pink and pale-green reflections, but much less deep in color than the typical *fulgens*.

This variety differs from the type in its more elongate and flattened form, its constantly finer, spiral threading, and its paler nacre. The concentric lamellation is sometimes undeveloped on the young shells. It has the same number of holes as the type.

The above may be regarded as the extreme northerly expression of *H. fulgens*, which has not heretofore been credited to any part of the coast north of Point Concepcion. From that point to Gualalla is an immense jump, about 320 nautical miles.

Regarding the number of holes in certain species of *Haliotis*, I find the following in my notes: *H. fulgens*, from Lower California, fifty-six show a total of 326 complete and incomplete, an average of six and a fraction; one example had 8 and five 7 holes. Of *H. rufescens* twenty-four had 87 complete, fifteen showing 60, and nine 27 holes, an average of $3\frac{5}{8}$. *H. cracherodii*, thirty-seven examples gave a total of 236 complete holes, an average of about $6\frac{1}{2}$; one individual had only 2, two had 4, while five had 9, approaching the insular form known as *Californiensis* Swainson. All of the foregoing were adult shells.

The "Abalone fishery" on the west coast has been pursued unceasingly for about thirty-five years. My notebook shows that as long ago as the year 1866 no less than 1,697 sacks, each containing from a bushel to a bushel and a half, were exported to China. At that time, and for many years after, the "dried meats" only were of commercial value, there being but a very limited demand for the shells. Later the shells came into general use for a great variety of purposes, so the fishery has been followed more energetically than ever, with the result that in many places the supply has been nearly exhausted. In certain localities where the principal species, *Haliotis rufescens*, *H. cracherodii*, and *H. fulgens*, were abundant they are now comparatively scarce. Recently

the attention of the authorities of some of the seaboard counties having been called to the matter, it is likely that before long the fishery will be either prohibited for a term of years or in some way regulated by law. From the little island of Anacapa in the Santa Barbara channel two persons obtained over 2 tons of shells and meats, being their second catch within a few months. Fortunately there are numerous places along the coast that are inaccessible, so there is but little danger of any of the species becoming absolutely extinct.

ON THE LOWER SILURIAN (TRENTON) FAUNA OF BAFFIN LAND.

By Charles Schuchert,
Assistant Curator, Division of Stratigraphic Paleontology.

INTRODUCTION.

In the summer of 1897, a number of men took advantage of the Seventh Peary Arctic Expedition to cruise in Arctic seas and to hunt and fish in Baffin Land. The author had the pleasure of meeting these men while on board the steamer *Hope*, and learned that they intended to make a whale-boat trip to the head of Frobisher Bay. As many Lower Silurian fossils had been seen by Hall during his exploration of this bay, the author requested the Baffin Land party to search for fossils. On the subsequent return of the steamer *Hope* from North Greenland, it was a great surprise to find that Messrs. J. N. Carpender, R. W. Porter, A. V. Shaw, A. H. White, and F. G. Goodridge, had made splendid collections of fossils during their stay of but a few hours at Silliman's Fossil Mount, which is at the head of Frobisher Bay.

These fossils are well preserved, and here, as is so often the case in Paleozoic faunas, the brachiopod specimens predominate. However, unlike other Trenton faunas, the Arctic mollusca usually preserve the shell, and this is the more remarkable because all the fossils weather out of a bluish clay. The author's interest in and admiration for these well-preserved fossil forms from a rarely visited region was so great that he could not resist asking the loan of the various collections for the purpose of making them known to paleontologists. Mr. J. N. Carpender, of New Brunswick, New Jersey, who had the most extensive collection, with great liberality allowed the author to make a selection from these fossils for the U. S. National Museum. From him, therefore, this Museum has received 54 species represented by 113 specimens. The next largest lots were gathered by Messrs. A. H. White and A. V. Shaw, and purchased for the Museum. Mr. F. G. Goodridge presented one of the finest trilobites found. Mr. R. W. Porter also made a good collection, which he deposited in the American Museum

of Natural History, and these specimens were kindly placed at the author's disposal for study, by Prof. R. P. Whitfield. To these gentlemen, therefore, paleontology is indebted for rendering it possible to describe one of the best collections of fossils made in Arctic regions.

With the aid of a camera lucida, Mr. E. O. Ulrich, of Newport, Kentucky, made the figures, which are accurate representations of the species. The author is further indebted to him for paleontological assistance, and his various notes are incorporated in this paper in their proper places.

DESCRIPTION OF LOCALITIES.

Frobisher Bay.—Previous to 1897, all that was known of the geology of Frobisher Bay was included in a few incidental notes by Charles Francis Hall.[1] His collections were partly studied by Mr. R. P. Stevens[2] and Prof. B. K. Emerson.[3]

During the months of August and September, 1861, Hall, in company with Innuit men, women, and children, explored, by means of whale boats, the greater part of Frobisher Bay, which up to that time was believed by civilized man to be a strait. On this trip he was also greatly rejoiced to find unmistakable evidence of Frobisher's visit of 1556–57. The book cited is interesting reading, and from it are taken the following notes regarding the geology of this Bay.

Jones Cape.—Hall "ascended a mountain in the rear of our encampment. * * * On my way I observed a considerable quantity of the stone I had noticed upon Iron Island, and I also saw many small pieces of limestone on the very summit about a thousand feet above the level of the sea."[4]

This may be the locality which furnished the fossils from the Utica stage, described by Professor Emerson and listed beyond.

Cape Stevens.—This locality is nearly 100 miles farther inland than Cape Jones, and here Hall on the top of a mountain "found numerous shells and fossils, some of which [he] brought away."[5]

This may be the locality furnishing the Trenton fossils described by Professor Emerson and listed beyond.

Silliman's Fossil Mount.—At this place fossils were first brought to Hall by the natives.

At my left, across the river, was a ridge of white, which I afterward named Silliman's Fossil Mount (thus named after Benjamin Silliman, jr., of New Haven, Connecticut. This fossil mount is on the west side of the termination of Frobisher Bay. It is in latitude 63° 44′, longitude 68° 56′), and behind it the unbroken front of a line

[1] Arctic Researches and Life Among the Esquimaux, New York, 1865.

[2] Amer. Journ. Sci., 2d ser., XXXV, 1863, p. 404.

[3] Narrative of the Second Arctic Expedition made by Charles F. Hall, edited by J. E. Nourse, Washington, 1879. Appendix III, On the Geology of Frobisher Bay, and Field Bay, by B. K. Emerson.

[4] Ibidem, p. 373.

[5] Ibidem, p. 381.

of mountains extending northwesterly to the opening which I have called the Great Gateway.[1] * * *

I visited that phenomenon; I mounted it, and went around it also. It is a mount of marine fossils in limestone, half a mile long, and over a hundred feet high [340 feet aneroid, according to Porter]. * * * The débris of the fossils begins at or near the top of the mount, falling at such an angle as broken stone from a mountain always make, an inclination of about 40°. Above the talus, or heap of broken stones, is a mass of fossils in limestone, strata-like. A smaller mount of the same character is close by, but all in débris. It seems to have been divided from the main mount by the rushing down of waters from the mountains behind. A small stream comes down the mountains, passes along, and finally makes its way out between the two fossil mounts. This is also indicated in the course of this stream, as an acre or more of the plain is covered several feet in depth with the washed-down débris of fossils. * * * The top of Silliman's Fossil Mount is covered with boulders and grass. Even when close to the small mount it looks like sand, but on examination it is fine broken limestone and fossils.[2]

FIG. 1.—A DISTANT VIEW OF SILLIMAN'S FOSSIL MOUNT.
(Photograph by R. W. Porter.)

Mr. R. W. Porter, who visited Silliman's Fossil Mount in August, 1897, described it to the writer as follows:

ON BOARD S. S. HOPE,
September 18, 1897.

CHARLES SCHUCHERT, Esq.

MY DEAR SIR: In accordance with your request, I take pleasure in handing to you the following notes on Silliman's Fossil Mount (Hall's) of Frobisher Bay, Baffin Land. They are very meager—the results of only a few hours' visit to this formation, as I had intended to give the place a more thorough search next year.

Silliman's Fossil Mount lies at the head of Frobisher Bay, some 3 miles south of the Jordan River and about 1 mile from tide water. It lies close against the mountains of Meta Incognita [apparently unconformably], is about 1,000 yards long and 340 feet high (aneroid; not 100 feet, as given by Hall), general direction northwest and southeast. The fossils were taken from the talus slopes, the bed of the brook flowing at the base of the mount, in the limestone near the summit, and on the top itself.

At its northern end there is a smaller mount of lesser height. The mount forms a striking feature of the landscape, and is composed of limestone, disintegrated to such an extent that the talus reaches nearly to the summit, which is very flat and composed of the ledge itself. This limestone ledge of nearly horizontal beds out-

[1] Narrative of the Second Arctic Expedition made by Charles F. Hall, edited by J. E. Nourse, Washington, 1879. Appendix III, On the Geology of Frobisher Bay, and Field Bay, by B. K. Emerson, p. 405.

[2] Ibidem, pp. 410–411.

crops all around the summit with vertical sides 10 to 20 feet high. The summit or table top is covered with moss and grass and several large bowlders of glacial origin. At its southeastern extremity it is joined to the range of mountains running parallel to the mount and rising to altitudes of from 500 to 800 feet. Between the mount and neighboring mountain side flows a good-sized brook, flowing northwardly and out into the valley between the greater and lesser mounts.

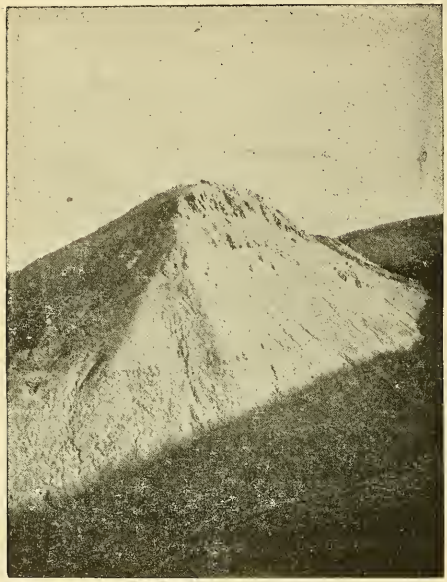


FIG. 2.—A NEAR VIEW OF SILLIMAN'S FOSSIL MOUNT. (Photograph by R. W. Porter.)

This brook has probably caused the separation of these two elevations, and has carried a quantity of clay and limestone out into the valley for several hundred yards.

A close scrutiny of the adjacent mountain range revealed no limestone formation on its side. The rock of this range is a dark mica-schist, the dips making an angle of about 30° with the horizon. Its surface in many places shows the marks of glaciation (one moraine lying against the northern side of the smaller mount), but for the most part the parent ledge is hidden under a quantity of its own rock broken up by frost action.

I found a great number of limestone bowlders, erratics, scattered through the valley of the Jordan River and on the sides and summits of the mountains which border it.

Finally, it may be interesting to know that the natives told me that these same formations containing fossils existed in several localities in the lake region of the interior.

Very truly, yours,

RUSSELL W. PORTER.

Region west and northwest of Frobisher Bay.—From Mr. Porter's account of Silliman's Fossil Mount, it is evident that similar Lower Silurian strata occur in the lake region of the interior of Baffin Land.

Mr. E. M. Kindle[1] reports that Missionary Peck obtained from Lake Kennedy, which lies northwest of the head of Cumberland Sound, the following drift fossils:

Zaphrentis sp.? [probably *Streptelasma corniculum*].
Halysites catenulatus [probably var. *gracilis* Hall].
Maclurea magna? [probably *Maclurina manitobensis*].
Endoceras proteiforme.

With the fauna of Silliman's Fossil Mount as a guide, it is probable that no horizon other than the Trenton is indicated by the species cited.

Dr. Robert Bell[2] reports that—

On ice pans farther up the coast [from Big Island in Hudson Strait], or to the

[1] Amer. Journ. Sci., 4th ser., II, 1896, p. 456.

[2] Observations on the Geology, etc., of Hudson Strait and Bay, made in 1885. Ann. Rept. Geol. and Nat. Hist. Survey of Canada, new ser., I, 1885, pp. DD. For a summary of North American Arctic geology see the report of the same Survey for 1886, II, 1887, p. R.

northwestward, I found fragments of shaly marl and of gray limestone with fossils, among which *Receptaculites Oweni* was easily distinguished. Shells and bryozoa, belonging to moderately deep-water species, were found on the same pans. The limestone fragments, just mentioned, would point to the occurrence of Silurian rocks on or near the great bays in the western part of the north shore of the straits, where the land is said to be low [see also the description of Akpatok Island]. Dr. Franz Boas of Berlin [now of New York] has recorded the existence of these rocks in the interior of Baffin Land, about 2 degrees of latitude north of this region. He says:[1] "Through the occurrence of the Silurian rocks in the Nettilling (Lake) (= Lake Kennedy), the discovery of the same formation at the upper end of Frobisher Bay increases in value. We must now suppose that the Silurian limestones, which appear at Prince Ruperts Inlet, extend from there to Frobisher Bay, and overlie the granites and gneisses of Baffins Bay and Davis Strait. We will not be far astray if we connect this extensive Silurian district with the limestones which occur to the south of Igluling; and which form the flat eastern half of Melville Peninsula. Southward from Nettilling, these rocks rise in low hill ranges."

Farther to the north, great areas of Upper Silurian rocks occur, yielding characteristic fossils of this age. In association with this fauna also occur species of Lower Silurian age. Two of these are *Receptaculites arcticus* Etheridge, and *R. occidentalis* Salter. The latter may be the same as *R. oweni* of this paper, a species closely related to *R. occidentalis*. One or both of these species are found associated with a typical Upper Silurian fauna at Cape Louis Napoleon (latitude 79° 38′ north), and Cape Frazer (latitude 79° 45′ north). *Maclurea arctica* Haughton, *M. logani* Salter, and *M. magna* Lesueur, are also identified as occurring in this region in Upper Silurian faunas. Such localities are Fury Point (latitude 72° 50′ north, longitude 92° west), Depot Bay (latitude 72° north, longitude 94° west), Cape Hilgard (latitude 79° 41′ north), and Bessels Bay (latitude 81° 6′). *Maclurea arctica* with *Actinoceras crebriseptum* Hall and *Receptaculites neptuni* Defrance (probably = *R. oweni*) are found with Upper Silurian fossils on the west coast of King Williams Island. *Maclurea*, or *Maclurina*, is a genus restricted to the Lower Silurian, and the same is true of *Actinoceras crebriseptum*. On the other hand, Etheridge has described as *Helicotoma naresii*, a similar shell from the Upper Silurian of Offley Island (latitude 81° 16′ north) and with this the author has identified a specimen in the U. S. National Museum collected by Dr. E. Bessels at Polaris Bay (latitude 81° 38′ north). The preservation of these shells, however, is such that any identification will have little value.

The foregoing facts can be interpreted in various ways:

First, Arctic collections of fossils are usually made by explorers who pick up loose fossils, some of which may have been carried by the ice considerable distances. In this way, specimens from several horizons become mixed. The author, however, does not believe that this is generally the case here, since the apparant mixtures occur in seven localities distributed between latitudes 72° to 81° 6′ north.

Secondly, the identifications are not uniform, and this is particularly true of the specimens of *Maclurea*. For the present, therefore, it will

[1] Petermann's Mittheilungen, November, 1885.

be necessary to eliminate such identifications as horizon markers from the Upper Silurian local faunæ.

Thirdly, *Receptaculites arcticus*,[1] *R. occidentalis*, and *R. oweni* are good Lower Silurian horizon markers and are easily identified. Therefore the writer accepts the presence of these forms as indicative of Lower Silurian rocks. Such localities are Cape Louis Napoleon, Cape Frazer, and the west coast of King Williams Island.

From this evidence, it appears that to the north of Baffin Land other areas of Trenton strata occur, and likewise that at Cape Louis Napoleon, Cape Frazer, and on the west coast of King Williams Island, they underlie the Upper Silurian beds. Probably, it is this occurrence rather than the transportation by ice, which has led to the mixing of the faunas.

Akpatok Island.—The Trenton of Frobisher Bay and Lake Kennedy apparently continues southward to Hudson Strait, where, in the vicinity of Big Island, *Receptaculites oweni* was found by Dr. Bell on pan ice, as described above. Another Trenton limestone area occurs more to the east, and near the south shore of Hudson Strait, on Akpatok Island, in Ungava Bay. Here Dr. Bell[2] obtained 90 fossils of Trenton age. He writes:

> The portion of the island which I saw [northern end to middle of east side] consists of unaltered gray limestone in horizontal beds, and it presents a perpendicular wall 400 to 500 feet high all along. This sea wall is clear cut and the beds appear thick and solid, but wherever their edges have been long exposed to the weather or in the hillsides and ravines of the interior, they split up into thinner layers. Some fragments observed in one place had the appearance of lithographic stone. * * * This formation must here have a thickness of 900 feet above sea level, and there is possibly a great additional thickness of Cambro-Silurian rocks beneath the sea level.

EXTENT OF THE ARCTIC TRENTON.

From the foregoing description of localities, it appears that Middle Lower Silurian horizons are very extensive in eastern Arctic America. Such are known in places on either side of Hudson Strait, Frobisher Bay, the interior of Baffin Land, and to the north of this land at various localities between latitudes 79° and 80° north. As far as known, these strata unconformably overlie very ancient crystalline rocks and are in turn overlain by Upper Silurian beds of Niagara or Wenlock age. Lower Cambrian rocks are found in southern Labrador, but in the region of Baffin Land such are not known to be present. Here, then, there seems to be a complete break from the Laurentian to the Trenton, followed by another break paleontogically, in the absence of the Cincinnatian beds, and probably the lower horizons of the Upper Silurian. The Lower Silurian fossils of this area indicate nothing older than the typical Trenton of New York and the Galena of Wisconsin and

[1] The types of this species are in the British Museum, and Dr. Hinde in his work on the Receptaculitidæ (Quart. Jour. Geol. Soc., London, November, 1884, p. 845) gives the horizon as Lower Silurian.

[2] Summary Rept. of Geol. Surv. Dept. for the year 1897–98, pp. 82, 83.

Minnesota, and nothing younger than the Utica stage of the United States. The thickness of these beds is not less than 900 feet and probably exceeds this.

This summary is based on information known to the author, and, while the evidence is meager, the essential geological age and the sequence of the rocks of Baffin Land seem to be established.

PALEONTOLOGY.

Hall's collections.—The few fossils collected at Silliman's Fossil Mount and brought to America by Mr. Hall were identified by R. P. Stevens[1] for the New York Lyceum of Natural History, as follows:

Maclurea magna Leseuer [probably *Maclurina manitobensis*].
Endoceras proteiforme Hall? [=*Cameroceras proteiforme*].
Orthoceras (badly worn specimens).
Heliolites (new species).
Heliolites (new species).
Halysites catenulata.
Receptaculites (new species) [=*?R. oweni* of this paper].

There is apparently nothing in this list but what was again discovered in 1897. Mr. Stevens writes that "the fossils, without doubt, are all Lower Silurian," and on the basis of the *Maclurea magna* "would place the limestone containing it on the horizon of the Chazy limestone of New York." However, it does not appear that this writer announced any particular age beyond Lower Silurian for the rocks comprised in Silliman's Fossil Mount.[2]

Another lot of fossils collected by Hall on his first expedition to Frobisher Bay was given to Amherst College, and forms the basis of Prof. B. K. Emerson's report "On the Geology of Frobisher Bay and Field Bay." In this lot, there is apparently nothing from Silliman's Fossil Mount, but Utica and Trenton fossils are present from localities more to the eastward and from the north shore of Frobisher Bay. These are:

TRENTON SPECIES.	UTICA SPECIES.
["Gray argillaceous limestone." ?Cape Stevens.]	["Flinty bituminous limestone." ?Jones Cape.]
Buthotrephis cfr. gracilis Hall.	*Diplograptus dentatus*(Brongniart).
Stictopora ramosa Hall?	*Lingula curta* Conrad.
Rhynchonella.	*Endoceras proteiforme* Hall.
Tellinomya levata Hall.	*Orthoceras laqueatum* Hall?
Murchisonia gracilis?	*Triarthrus becki* Green.
Conularia trentonensis Hall.	*Calymmene senaria* Conrad.

[1] Amer. Journ. Sci., 2d ser., XXXV, 1863, pp. 293, 294.

[2] Prof. B. K. Emerson says: "We made inquiry, but can find no traces of this or the other fossils reported upon in Mr. Stevens's article quoted." See "On the Geology of Frobisher Bay and Field Bay." Appendix III to "Narrative of the Second Arctic Expedition made by Charles F. Hall," edited by Prof. J. E. Nourse, Washington, 1879, p. 576.

TRENTON SPECIES—continued.

["Gray argillaceous limestone." ?Cape Stevens.]

Tentaculites.
Leperditia alta Conrad.
Leperditia canadensis Jones.
Primitia muta Jones.
Primitia frobisheri Emerson.
Beyrichia symmetricus Emerson.
Asaphus sp.

UTICA SPECIES—continued.

["Flinty bituminous limestone." ?Jones Cape.]

Cyphaspis frobisheri Emerson.

The Trenton horizon may be the same as that of Silliman's Fossil Mount. In any event, the foregoing lists indicate horizons intimately connected, and it is probable that all the fossiliferous strata at the head of Frobisher Bay are of Trenton and Utica age.

Akpatok Island.—The fossils collected by Dr. Bell on Akpatok Island have been studied by Professor Whiteaves,[1] with the following results:

The species indicate the Trenton limestone, and "are remarkably similar to the fossils of the Trenton formation of the Red River Valley in Manitoba." "Eleven had previously been found in the Manitoba Trenton, and nine are species that are common at East Selkirk and Lower Fort Garry." This fauna also connects directly with that of Silliman's Fossil Mount.

The following is a list of the species:

Receptaculites oweni Hall.
Streptelasma robustum Whiteaves.
Calapœcia canadensis Billings.
Rafinesquina lata Whiteaves.
Leptæna unicostata (Meek and Worthen).
Plectambonites sericea (Sowerby).
Orthis tricenaria Conrad.
Orthis (*Dinorthis*) *meedsi arctica* Schuchert.
Orthis (*Hebertella*) *bellirugosa* (Conrad).
Orthis (*Dalmanella*) *testudinaria* (Dalman).
Platystrophia biforata (Schlotheim).
?Rhynchotrema inœquivalvis (Castelnau).
Cyrtoceras manitobense Whiteaves.

[1] Amer. Journ. Sci., 4th ser., VII, 1899, pp. 433, 434.

List of fossils from Silliman's Fossil Mount and their distribution.

Species.	Horizons.				Regions.	
	Birdseye or Lowville.	Black River.	Trenton or Galena.	Cincinnatian.	Minnesota, Manitoba.	New York, Ottawa.
Receptaculites oweni Hall	.....	.....	×	.....	×	.....
Ischadites iowaensis (Owen)	.....	.....	×	.....	×	.....
Halysites catenulatus gracilis (Hall)	.....	.....	×	.....	×	.....
Lyellia affinis (Billings)	.....	.....	.....	×	.....	.....
Plasmopora lambi, new species	.....	.....	.....	.....	.....	.....
Calapœcia canadensis Billings	×	×	.....	×	×	×
Streptelasma corniculum Hall	.....	.....	×	.....	×	×
Porocrinus shawi, new species	.....	.....	.....	.....	.....	.....
Lichenocrinus affinis Miller	.....	.....	.....	×	.....	.....
Crepipora, species undetermined	.....	.....	.....	.....	.....	.....
Orthis tricenaria Conrad	×	×	×	.....	×	×
Orthis (*Dalmanella*) *testudinaria* (Dalman)	×	×	×	×	×	×
Orthis (*Plectorthis*) *plicatella* Hall	.....	.....	×	×	×	.....
Orthis (*Hebertella*) *borealis* (Billings)	.....	.....	×	.....	×	×
Orthis (*Hebertella*) *bellirugosa* (Conrad)	×	×	×	.....	×	.....
Orthis (*Dinorthis*) *meedsi* Winchell and Schuchert	.....	.....	×	.....	×	.....
Orthis (*Dinorthis*) *meedsi arctica*, new variety	.....	.....	.....	.....	.....	.....
Platystrophia biforata (Schlotheim)	×	×	×	×	×	×
Parastrophia hemiplicata Hall	.....	.....	×	.....	×	×
Rhynchotrema inæquivalvis (Castelnau)	.....	.....	×	.....	×	×
Ctenodonta subnasuta Ulrich ?	.....	.....	×	.....	×	.....
Ctenodonta frobisherensis, new species	.....	.....	.....	.....	.....	.....
Ctenodonta carpenderi, new species	.....	.....	.....	.....	.....	.....
Ctenodonta baffinensis, new species	.....	.....	.....	.....	.....	.....
Modiolodon arctica, new species	.....	.....	.....	.....	.....	.....
Whiteavesia symmetricus, new species	.....	.....	.....	.....	.....	.....
Cyrtodonta sillimanensis, new species	.....	.....	.....	.....	.....	.....
Cyrtodonta gibbera, Ulrich variety	.....	.....	.....	.....	.....	.....
Vanuxemia abrupta Ulrich	.....	.....	×	.....	×	.....
Vanuxemia baffinensis, new species	.....	.....	.....	.....	.....	.....
Whitella arcticus, new species	.....	.....	.....	.....	.....	.....
Saffordia modesta Ulrich	.....	.....	×	.....	×	.....
Protowarthia pervolutus Ulrich and Scofield	.....	×	×	.....	×	.....
Tetranota obsoleta Ulrich and Scofield	×	×	×	×	×	×
Kokenia costalis Ulrich and Scofield	.....	.....	×	.....	×	.....
Bellerophon similis Ulrich and Scofield	.....	.....	×	.....	×	.....
Lophospira spironema Ulrich and Scofield	.....	×	.....	.....	×	.....
Liospira americana (Billings)	×	×	×	.....	×	×
Clathrospira conica Ulrich and Scofield	.....	×	×	×	×	×
Seelya (*?*) *ulrichi*, new species	.....	.....	.....	.....	.....	.....
Helicotoma (*?*) *larvata* Salter	.....	×	.....	.....	.....	×
Maclurina manitobensis (Whiteaves)	.....	.....	×	.....	×	.....
Maclurina cuneata (Whitfield)	.....	.....	×	.....	×	.....
Maclurea crassa Ulrich and Scofield	.....	.....	×	.....	×	.....
Trochonema umbilicatum (Hall)	×	×	×	?	×	×
Trochonema (*Eunema*) *robbinsi* Ulrich and Scofield	.....	.....	×	.....	×	.....
Holopea arctica, new species	.....	.....	.....	.....	.....	.....
Trochus (*?*), species undetermined	.....	.....	.....	.....	.....	.....
Fusispira inflata (Meek and Worthen)	.....	.....	×	.....	×	.....
Fusispira nobilis Ulrich and Schofield	.....	.....	×	.....	×	.....
Cameroceras proteiforme (Hall)	×	×	×	.....	×	×
Orthoceras olorus baffinensis, new variety	.....	.....	.....	.....	.....	.....
Orthoceras bilineatum Hall	.....	×	×	.....	×	.....
Orthoceras porteri, new species	.....	.....	.....	.....	.....	.....
Orthoceras scalariformis, new species	.....	.....	.....	.....	.....	.....
Cyrtoceras manitobense Whiteaves	.....	.....	×	.....	×	.....
Cyrtoceras cornulum, new species	.....	.....	.....	.....	.....	.....
Cyrtoceras baffinensis, new species	.....	.....	.....	.....	.....	.....
Clinoceras exiguum (Billings)	.....	.....	×	.....	×	×
Oncoceras arcticum, new species	.....	.....	.....	.....	.....	.....
Poterioceras, species undetermined	.....	.....	.....	.....	.....	.....
Eurystomites plicatus Whiteaves	.....	.....	×	.....	×	.....
Bythocypris granti Ulrich	.....	×	.....	.....	×	.....
Primitia or *Klœdenia*	.....	.....	.....	.....	.....	.....
Krausella, 2 new species	.....	.....	.....	.....	.....	.....
Nileus vigilans (Meek and Worthen)	.....	×	×	×	×	.....
Illœnus crassicauda americanus (Billings)	.....	.....	×	.....	×	.....
Isotelus gigas De Kay	.....	.....	×	×	×	×
Dalmanites (*Pterygometopus*) *goodrigi*, new species	.....	.....	.....	.....	.....	.....
Ceraurus pleurexanthemus Green	×	×	×	×	×	×
Total	10	17	38	11	41	17

Age of Silliman's Fossil Mount.—From Mr. Porter's description, it will be seen that the fossils recently collected at Silliman's Fossil Mount are from various horizons, and yet there is nothing to indicate the presence of more than one fauna. The foregoing list shows that at present there are 72 species known from this locality, and of these 28 are restricted to it. There are, therefore, 54 species which are common to other localities, a goodly number with which to make safe correlations. Of these 54 species, 41, or 57 per cent of the known fauna, are also found in the region of Minnesota, Wisconsin, and Iowa, while 17 are known to occur in New York and Ottawa.

On comparing the 54 widely distributed species with those from definite stages in Minnesota, it is seen that 10 are also found in Birdseye (= Lowville), 17 in the Black River, 38, or about 70 per cent, in the Galena, the direct equivalent of the New York Trenton, and 11 in the Cincinnatian group.

From these figures it is evident that the stage of Silliman's Fossil Mount belongs in the Galena, and that the fauna is more intimately related to that of the Minnesota region than to the Trenton of New York. When the New York Trenton fauna is restudied in the light of recent researches in Minnesota,[1] however, it will be shown that the two faunas have more in common than now appears. On the other hand, the lithological similarities of the Minnesota Galena and Silliman's Fossil Mount—light-colored shales predominating in both areas—may explain in large measure the close identity of these widely separated faunas.

This little fauna likewise brings out the fact that the corals, brachiopods, gastropods, and the trilobites are slow in their evolutional change, and the species can therefore spread over very great areas, while the cephalopods, and particularly the pelecypods, are more sensitive to change, and are thus restricted to localities.

DESCRIPTION OF SPECIES.

Uncertain Class.

Family RECEPTACULITIDÆ Roemer.

RECEPTACULITES OWENI Hall.

Receptaculites oweni HALL, Geol. Rept. Wis., 1862, p. 46, fig. 2; p. 429.—WINCHELL and SCHUCHERT, Geol. Minn., III, Pt. 1, 1893, p. 57, pl. F, figs. 1–4.

In the present collection, this species is represented by a large disk-shaped specimen which measures 6 inches from the central apex to the

[1] See the two magnificent volumes on the paleontology of the Lower Silurian fossils of Minnesota, entitled Geology of Minnesota, III, Pts. 1, 2, published by the Geological and Natural History Survey of Minnesota, N. H. Winchell, State Geologist.

circumference, making the species originally not less than 12 inches over all. This is about the usual size for the larger specimens of *R. oweni* in Minnesota, although examples have been seen 20 inches in diameter.

Etheridge has described *R. arcticus* from Cape Frazer and Cape Louis Napoleon in Grinnell Land. This is also a large disk-shaped species, similar in growth to *R. oweni*, but the walls are usually twice as thick, and the transverse tubes are much larger and fewer in a given space than in the species last named.

Collectors.—J. N. Carpender, A. H. White, and A. V. Shaw. Cat. No. 28143, U.S.N.M.

ISCHADITES IOWAENSIS (Owen).

Selenoides iowensis OWEN, Geol. Surv. Wis., Iowa, Minn., 1852, p. 587, pl. 2B, fig. 13.
Ischadites iowensis WINCHELL and SCHUCHERT, Geol. Minn., III, Pt. 1, 1893, p. 64, pl. F, figs. 5, 6.

A well-preserved fragment of this species is identical with specimens from Goodhue County, Minnesota.

Collector.—J. N. Carpender. Cat. No. 28144, U.S.N.M.

Class CŒLENTERATA.

Order ALCYONARIA Edwards and Haime.

Family HALYSITIDÆ.

HALYSITES CATENULATUS, var. GRACILIS Hall.

Halysites catenularia var. *gracilis* LAMBE, Geol. Surv. Canada, Cont. to Canadian Pal., IV, 1899, p. 69, pl. III, figs. 5–7.

Of this widely distributed species, which begins in the Trenton and dies out in the Lower Helderberg, there are several excellent specimens present. These Arctic Trenton specimens are in harmony with the variety *gracilis*, which is restricted to the Trenton and Lorraine stages.

Collectors.—J. N. Carpender, A. H. White, and A. V. Shaw. Cat. No. 28138, U.S.N.M.

Family HELIOPORIDÆ Moseley.

LYELLIA AFFINIS (Billings).

For synonymy see Lambe, Geol. Surv. Canada, Cont. to Canadian Pal., IV, 1899, p. 84.

This species, of which there are in the present collection three well-preserved examples, Mr. Lambe says occurs in the "Hudson River and Niagara formations, in the four divisions of the Anticosti group, and in the Lower Helderberg group." To this range is now added the Trenton stage.

Collectors.—J. N. Carpender and A. V. Shaw. Cat. No. 28139, U.S.N.M.

PLASMOPORA LAMBII, new species.

This species begins growth on some small foreign object, and expands to a diameter exceeding 12 cm. by 7 cm. in height. Beyond the place of attachment the lower surface is irregularly concave and covered by a thin epitheca. The upper surface is in form depressed hemispheric to conical. Corallites from 1 to 1.75 mm. in diameter, commonly about 1.25 mm., circular, and separated from one another from 0.5 to 1.25 mm. Septa not prominent, and where the original surface is well preserved not easily distinguishable from the radial striations, or granular surface, of the tubular area. Corallites with very closely adjoining tabulæ, which are generally decidedly vesicular, but in places they are flat. In longitudinal sections there are from two to five tubules between neighboring corallites; the tabulæ are convex, generally giving the inter-corallite space a decided vesicular structure.

The general vesicular condition of the tabulæ in both the tubules and corallites distinguishes *P. lambii*. This feature was pointed out by Mr. Lawrence M. Lambe of the Canadian Geological Survey, and the writer takes pleasure in connecting his name with this new species in appreciation of his excellent work on the corals of Canada.

Collectors.—J. N. Carpender, A. H. White, and A. V. Shaw. Cat. No. 28140, U.S.N.M.

CALAPŒCIA CANADENSIS Billings.

For synonymy see Lambe, Geol. Surv. Canada, Cont. to Canadian Pal., IV, 1899, p. 43.

Of this species, there is a small, depressed, hemispheric specimen in which the corallites are in contact, and therefore there is little interzooecial vesicular tissue. The hexagonal, nearly uniform corallites are from 3 to 4 mm. in width, and each has from 18 to 20 septa.

The above identification is confirmed by Mr. Lawrence M. Lambe.

Collector.—J. N. Carpender. Cat. No. 28142, U.S.N.M.

Order MADREPORARIA Edwards and Haime

Suborder TETRACORALLA Haeckel.

Family STREPTELASMIDÆ Nicholson.

STREPTELASMA CORNICULUM Hall.

Streptelasma corniculum HALL, Pal. N. Y., I, 1847, p. 69, pl. XXV, figs. 1*a*–1*e*.—WINCHELL and SCHUCHERT, Geol. Minn., III, Pt. 1, 1893, p. 90, pl. G, figs. 20, 21.

This characteristic Trenton cup coral is common in the strata of Silliman's Fossil Mount, and agrees well with specimens from the Galena horizon of Minnesota.

Collectors.—J. N. Carpender, A. V. Shaw, and A. H. White. Cat. No. 28141, U.S.N.M. The American Museum of Natural History has a number of specimens collected by Mr. R. W. Porter.

CYSTOIDEA.

Family CRYPTOCRINIDÆ Zittel.

POROCRINUS SHAWI, new species.

(Plate XII, figs. 1–3.)

This species is most nearly related to *P. smithi* Grant,[1] as far as the shape of the dorsal cup, elevation of the costæ, and form of the plates are concerned. It differs, however, from all American species in that the circular pore-rhomb spaces are larger. This is particularly true of the lowest series, which occupy nearly the entire basal plates besides portions of two adjoining subradials. The rhombs are also very large in the interradial areas on each side of the arm bases.

The ambulacral grooves are narrow and short, and within the shallow vestibule terminate abruptly below into the body cavity. The margin bordering the large, central, circular opening is somewhat notched at each ambulacral groove, giving the impression that there may have been communication between the oral opening and each ambulacral groove. The smaller ventral plates are not preserved in this specimen, which is the only one known.

Named for Mr. A. V. Shaw, of Boston, Massachusetts, who was one of the Frobisher Bay party of 1897.

Collector.—A. H. White. Cat. No. 28145, U.S.N.M.

Family LICHENOCRINIDÆ.

LICHENOCRINUS AFFINIS Miller.

Lichenocrinus affinis Miller, Journ. Cinn. Soc. Nat. Hist., V, 1882, p. 229, pl. IX, figs. 7, 7*a*.

But a single specimen of this species has been noted, and this was attached to an Orthoceras. It has the general aspects of *L. affinis* in the pentagonal column, form of body, slight convexity, number of plates, and the general irregularity of these, both in form and arrangement.

The genus *Lichenocrinus* has not been previously recorded from rocks below the Utica. In the Cincinnatian group specimens are often abundant where *L. affinis* occurs in the upper third or Richmond stage.

Collector.—J. N. Carpender. Cat. No. 28146, U.S.N.M.

[1] Ottawa Field Nat. Club, Trans. No. 2, 1881, p. 42, plate, figs. 1–8.

BRYOZOA.

Family CERAMOPORIIDÆ Ulrich.

CREPIPORA, species undetermined.

Specimens of this species were sent to Mr. E. O. Ulrich, who identified them as belonging to *Crepipora*. The minute structure, however, is poorly preserved, and no thin sections were made.

Collectors.—A. H. White, J. N. Carpender, and A. V. Shaw. Cat. No. 28147, U.S.N.M.

Class BRACHIOPODA.

Order PROTREMATA Beecher.

Family ORTHIDÆ Woodward.

ORTHIS TRICENARIA Conrad.

Orthis tricenaria CONRAD, Proc. Acad. Nat. Sci. Phila., 1843, p. 333.—WINCHELL and SCHUCHERT, Geol. Minn., III, Pt. 1, 1893, p. 418, pl. XXXII, fig. 18–23.

This well-known and characteristic Trenton species is represented by two specimens, which are small for this form, but otherwise closely resemble those from the Galena shale of Minnesota. On Akpatok Island the species attained the largest growth known, being more than three times as large as those found in Baffin Land.

Collector.—J. N. Carpender. Cat. No. 28149, U.S.N.M. One specimen was also found by Mr. R. W. Porter and is now in the American Museum of Natural History.

ORTHIS (DALMANELLA) TESTUDINARIA (Dalman).

Orthis (*Dalmanella*) *testudinaria* WINCHELL and SCHUCHERT, Geol. Minn., III, Pt. 2, 1893, p. 441, pl. XXXIII, figs. 17–22.

This ubiquitous Lower Silurian species is very abundant at Silliman's Fossil Mount, and at this locality is quite constant in its characters. The specimens belong to the variety with fine striæ, in which the dorsal valve is often slightly convex, recalling the subgenus *Rhipidomella* rather than *Dalmanella*. However, other examples have the typical flat dorsal valve, with a well-defined median sinus.

Collectors.—J. N. Carpender, A. H. White, and A. V. Shaw. Cat. No. 28148, U.S.N.M. The American Museum of Natural History also has a number of specimens collected by Mr. R. W. Porter.

ORTHIS (PLECTORTHIS) PLICATELLA Hall.

Orthis (*Plectorthis*) *plicatella* WINCHELL and SCHUCHERT, Geol. Minn., III, Pt. 1, 1893, p. 436, pl. XXXIII, figs. 5–7.

As a rule, this species is not abundant in the Trenton either in New York or in Minnesota, but at Silliman's Fossil Mount it is a common shell.

The Arctic examples are large and robust, and agree rather with specimens from Watertown, New York, than with those from Minnesota, which are somewhat smaller. The species is often confounded with *Orthis* (*Hebertella*) *borealis*, but can be easily distinguished by the almost entire absence of fold and sinus. When these are present, however, they are found to occupy a position the reverse of that seen in the latter species.

Collectors.—J. N. Carpender, A. V. Shaw, and A. H. White. Cat. No. 28150, U.S.N.M. A number of specimens collected by Mr. R. W. Porter are in the American Museum of Natural History.

ORTHIS (HEBERTELLA) BOREALIS (Billings).

Orthis (*Hebertella*) *borealis* WINCHELL and SCHUCHERT, Geol. Minn., III, Pt. 1, 1893, p. 433, figs. 33*a*–33*c*.

This well-developed species is represented by six typical specimens. They much resemble *O.* (*P.*) *plicatella* externally except in the position of the fold and sinus, which is the reverse of that seen in Hall's species.

Collector.—J. N. Carpender. In the American Museum of Natural History there are three specimens collected by R. W. Porter. Cat. No. 28151, U.S.N.M.

ORTHIS (HEBERTELLA?) BELLIRUGOSA (Conrad).

Orthis (*Hebertella?*) *bellarugosa* WINCHELL and SCHUCHERT, Geol. Minn., III, Pt. 1, 1893, p. 434, pl. XXXIII, figs. 1–4.

This species is never abundant in the Trenton, and the same is true in Baffin Land. Mr. Russell W. Porter found a single specimen, which is now in the American Museum of Natural History. This form also occurs on Akpatok Island, Ungava Bay, Labrador.

ORTHIS (DINORTHIS) MEEDSI Winchell and Schuchert, var. ARCTICA, new variety.

(Plate XII, figs. 7, 8.)

Orthis (*Dinorthis*) *meedsi* WINCHELL and SCHUCHERT, Geol. Minn., III, Pt. 1, 1893, p. 427, pl. XXII, figs. 39-45.

This species, which is common in the Galena or Trenton stage of Minnesota, is also abundant at the Frobisher Bay locality. As in Minnesota, it is here also a very variable species. However, among the Arctic specimens this variation tends toward the equalization and increase of the number of plications, while in Minnesota, bundling of the plications accompanied by the development of a conspicuous dorsal sinus, is the chief trend of variation. The specimens having the last-named characters were given the varietal name *germana*. On the same ground it may be advisable to name the Arctic variation—those with the more numerous and equal plications, and an obsolete or nearly obsolete dorsal-sinus variety—*arctica*.

O. (*D.*) *meedsi* of Silliman's Fossil Mount also recalls *O.* (*D.*) *proavita* and *O.* (*D.*) *subquadrata*, showing that the three probably belong to one stock.

Collectors.—J. N. Carpender and A. H. White. Cat. Nos. 28152,3, U.S.N.M. A number of specimens are in the American Museum of Natural History, which were collected by Mr. R. W. Porter.

PLATYSTROPHIA BIFORATA (Schlotheim).

Platystrophia biforata WINCHELL and SCHUCHERT, Geol. Minn., III, Pt. 1, 1893, p. 455, pl. XXXIII, figs. 51–54.

This ubiquitous Silurian species appears to be rare at the Frobisher Bay locality, since but three specimens are present. These are small, a condition in harmony with their Trenton age, and have short hinge lines devoid of hinge extensions. The latter feature is best developed in the upper or Richmond stage of the Cincinnatian group.

Collectors.—J. N. Carpender and A. H. White. Cat. No. 28154, U.S.N.M. A single specimen is in the collection of the American Museum of Natural History.

Family PORAMBONITIDÆ Davidson.

PARASTROPHIA HEMIPLICATA Hall.

Parastrophia hemiplicata SCHUCHERT, Bull. U. S. Geol. Surv., No. 87, 1897, p. 300.

These small early pentameroids are under size in the Arctic locality, but otherwise are more in harmony with examples from New York than with those from Minnesota.

Collector.—A. H. White. Cat. No. 28156, U.S.N.M.

Order TELOTREMATA Beecher.

Family RHYNCHONELLIDÆ Gray.

RHYNCHOTREMA MINNESOTENSIS (Sardeson).

Rhynchotrema inæquivalvis WINCHELL and SCHUCHERT (part), Geol. Minn., III, Pt. 1, 1893, p. 459, pl. XXXIV, figs. 9–11, 15–23 (not figs. 12–14, 24, 25).

Rhynchonella minnesotensis SARDESON, Bull. Minn. Acad. Nat. Sci., III, 1892, p. 333, pl. IV, figs. 21–23; Amer. Geol., XVIII, 1896, p. 184.

The common *Rhynchonella* from the Birdseye or Lowville and Black River stages, which is usually identified as *R. increbescens* Hall, is always devoid of the concentric lamellæ so characteristic of *R. increbescens*=*R. inæquivalvis* of the Trenton stage. Occasional specimens occur with a few of the lamellæ near the anterior margin, but generally the shell is devoid of these, their places being occupied by very fine, wavy, concentric lines. In higher beds, these fine lines develop into stronger and more extended lamellæ, which find their greatest development in *Rhynchotrema perlamellosum* of the upper or Richmond stage of the Cincinnatian group.

The form of *R. minnesotensis* is quite variable and can not be of much aid in distinguishing this shell from *R. inæquivalvis*. The two are often found associated in the same beds, and it is then difficult to identify them correctly. This fact led Winchell and Schuchert, in 1893, to regard both as belonging to one species, *R. inæquivalvis*.

Locality and formation.—In the Lowville and particularly in the Black River stages of the Trenton in Minnesota and Wisconsin, Lexington, Kentucky, and in the Cincinnatian group at Savannah, Illinois. This species and *R. inæquivalvis subtrigonalis* are unknown at Silliman's Fossil Mount.

RHYNCHOTREMA INÆQUIVALVIS (Castelnau).

Spirifer inæquivalvis CASTELNAU, Essai Système Sil. l'Amérique Septentrionale, 1843, p. 40, pl. XIV, fig. 8.

Atrypa increbescens HALL, Pal. N. Y., I, 1847, p. 146, pl. XXXIII, figs. 13*a*–13*h* (probably not p. 289, pl. LXXIX, fig. 6).

Rhynchotrema inæquivalvis WINCHELL and SCHUCHERT (part), Geol. Minn., III, Pt. 1, 1893, p. 459, pl. XXXIV, figs. 12–14, 24, 25 (not figs. 9–11, 15–23=*R. minnesotensis*).

This species was first described by Castelnau, who obtained his specimens from the "magnesian limestone" of Drummonds Island. His figures show the characteristic concentric lamellæ which are almost always present on these shells coming from the Trenton, and this feature distinguishes them from those found in the Lowville and Black River stages. Hall subsequently described this shell as *Atrypa increbescens*, but it is now generally known as *Rhynchonella increbescens*. The species is a characteristic form of the Trenton, while in the Cincinnatian group its descendant *R. capax* attains large size, often great rotundity, with marked concentric lamellæ. The lamellar development finds its extreme in *R. perlamellosum*.

R. inæquivalvis is abundant at Silliman's Fossil Mount, the concentric lamellæ being also strongly developed in the specimens found.

Collectors.—J. N. Carpender, A. H. White, and A. V. Shaw. Cat. No. 28155, U.S.N.M. A number of specimens collected by Mr. R. W. Porter are in the American Museum of Natural History.

RHYNCHOTREMA INÆQUIVALVIS SUBTRIGONALIS (Hall).

Atrypa subtrigonalis HALL, Pal. N. Y., I, 1847, p. 145, pl. XXXIII, fig. 12.

This shell is only an elongate variety of *R. inæquivalvis* and appears to be a rare form in the Trenton of New York, yet at Curdsville, Kentucky, it is abundant. As in *R. inæquivalvis*, the lamellæ are well developed.

Class PELECYPODA.

Family NUCULIDÆ Gray.

CTENODONTA SUBNASUTA Ulrich?

(Plate XIII, figs. 4-6.)

Ctenodonta subnasuta ULRICH, Geol. Minn., III, Pt. 2, 1894, p. 585, pl. XLII, figs. 34-36.

There are two examples of this species, and these appear to agree best with Minnesota specimens of *C. subnasuta*. They were sent to Mr. E. O. Ulrich for direct comparison with his types. He writes:

You can not be far wrong if you identify these specimens with *C. subnasuta*. Still, there is some doubt as to their identity. The Arctic specimens are larger than the types, and relatively a little more elongate, while the basal outline is scarcely as convex, and the umbones not so full and evenly rounded. Finally, the smaller end, which I am now somewhat inclined to regard as the anterior, is relatively wider in your shells. I may add that the larger specimen indicates a thinner hinge plate than in the types, so that, after all, these specimens may belong to a distinct species. Typical *C. subnasuta* occur in the Trenton of Manitoba.

Collectors.—J. N. Carpender and A. H. White. Cat. No. 28163, U.S.N.M.

CTENODONTA CARPENDERI, new species.

(Plate XIII, figs. 1-3.)

This is the most abundant pelecypod from Silliman's Fossil Mount and appears to be closely related to *C. cuneiformis* Ulrich.[1] It differs, however, in various details, particularly in always being considerably larger. *C. carpenderi* has also the general aspect of small specimens of *C. nasuta*, but differs in the straight hinge line, especially that of the posterior end, which terminates abruptly into the regularly convex outline of this portion of the shell.

Mr. E. O. Ulrich, to whom several examples were sent, wrote as follows:

These specimens are closely related to *C. cuneiformis* Ulrich. The types of that species are much smaller, with the narrower end relatively shorter and the constriction more distinct. Good specific differences are found in the postcardinal region (i. e., assuming that the wider end is posterior). Here the Arctic species is more impressed, causing the umbonal ridge to be much more prominent, the postcardinal slopes wider and concave instead of flat. Just behind the beaks there is a triangular shaped area (ligamental probably) which is wanting in *C. cuneiformis*.

Named after Mr. J. N. Carpender, of New Brunswick, New Jersey, who made the most extensive collection of fossils at the head of Frobisher Bay.

Collectors.—J. N. Carpender, A. H. White, and A. V. Shaw. Cat. No. 28164, U.S.N.M. Other specimens collected by Mr. R. W. Porter are now in the American Museum of Natural History.

[1] Geol. Minn., III, Pt. 2, 1894, p. 597, pl. XLII, figs. 31-33.

CTENODONTA BAFFINENSIS, new species (Ulrich).

(Plate XIII, figs. 7–10.)

There is but a single example of this species present, and this was provisionally identified as *C. scofieldi* Ulrich.[1] The author of the species writes that, while it has the general aspect of *C. scofieldi*, it is nevertheless sufficiently distinct to be recognized as new. Mr. Ulrich has made the following comparisons:

At first sight this is extremely like *C. scofieldi*, but on closer inspection, and particularly when compared with the types of that species, certain peculiarities become so prominent that I wonder that they were not observed at once. The first of these is a depression, or rather widening furrow, extending vertically from the beaks across the valves. This is sufficient to cause a straightening, even a slight concavity, in the ventral outline. The outline of the valves differs further in the postventral (wider) region being more prominent and more narrowly rounded here. In a cardinal view the species agrees best with *C. scofieldi*, but in a lateral view the outline corresponds better with *C. medialis* and *C. nitida* Ulrich. The contour of the valves, however, shows it to be a distinct form, the mesial depression possibly indicating relations to species of the type *C. carinata* Ulrich. *C. scofieldi* also has no radiating lines; the concentric lines are equally as delicate.

Collector.—R. W. Porter. The type is in the American Museum of Natural History.

CTENODONTA FROBISHERENSIS, new species.

(Plate XIII, figs. 11–14.)

Of this little shell there are two well-preserved specimens, which appear to be distinct from all other Ordovician Ctenodontas. Probably the species most nearly related is *C. albertina* Ulrich,[2] from which it differs in having the beaks more centrally situated, the valves shallower, and in being less drawn out anteriorly. At first this form was thought to be most closely related to *C. oviformis* Ulrich,[3] but the author of the latter species writes that the Arctic shell "has different proportions" and that it represents a new species. *C. oviformis* is less high, has narrowly rounded ends, and the beaks are situated nearer the midlength. Its rounded-ovate form distinguishes it from the other Frobisher Bay species, all of which are nasute forms.

Collectors.—J. N. Carpender and A. V. Shaw. Cat. No. 28165, U.S.N.M.

Family MODIOLOPSIDÆ Ulrich.

MODIOLODON ARCTICUS, new species.

(Plate XIII, figs. 18, 19.)

There is a good cast of the interior of the valves of this shell in the present collection. The species is very much like *M. patulus* Ulrich,[4]

[1] Geol. Minn., III, Pt. 2, 1894, p. 593, pl. XLII, figs. 53–58.
[2] Ibidem, p. 598, pl. XLII, figs. 76–82.
[3] Ibidem, p. 586, pl. XLII, fig. 29.
[4] Ibidem, p. 521, pl. XXXVII, figs. 20–24.

and was at first regarded by the writer as a variety of that form. *M. arcticus* is, however, nearer subquadrate than ovate, shorter and more erect, the post-cardinal portion more alate, and the beaks smaller and more pointed than in *M. patulus* Ulrich.

Collector.—J. N. Carpender. Cat. No. 28166, U.S.N.M.

WHITEAVESIA SYMMETRICUS, new species (Ulrich).

(Plate XIII, figs. 15–17.)

This little shell was thought by the writer to be probably identical with *Crytodonta affinis* var. *fillmorensis* Ulrich,[1] and for confirmation of this opinion sent the specimen to Mr. Ulrich. He, however, refers it to the genus *Whiteavesia* of the family Modiolopsidæ. As his notes are detailed, they are given at length.

Remains of the black ornament-bearing epidermis prove the specimen to belong to the Modiolopsidæ. It is a new species, with an anterior end reminding of *Modiolopsis arguta,* while the rest of the outline and general aspect is more nearly like *M. similis.* It is also like *M. obsoleta,* but it is too high posteriorly. It is, however, not a true *Modiolopsis,* the umbones being too prominent and full, the ventral outline convex, and the anterior muscular scars scarcely distinguishable in the cast. These characters make it a *Whiteavesia,* and it does not seem to be closely related to any of the described species of that genus. The rather uniform convexity of the valves is peculiar to this species.

Collector.—J. N. Carpender. Cat. No. 28162, U.S.N.M.

Family CYRTODONTIDÆ Ulrich.

CYRTODONTA SILLIMANENSIS, new species (Ulrich).

(Plate XIII, figs. 31–33.)

Mr. Ulrich has kindly made the following notes on this species:

Have compared this with every Cyrtodonta known to me without finding one with which it is identical. In a general way it reminds of *C. affinis, C. parva,* and *C. halli,*[2] but am satisfied it is not closely related with any of that group of species. Its true affinities seem to be with *C. subcarinata* Billings, but is readily distinguished by its shorter form and much broader posterior. From *C. huronensis* Billings,[3] which I regard as another close ally (also *C. billingsi* Ulrich [2]), it differs not only in size but in its greater convexity and much better defined antero-median sulcus. The specimen is preserved in part as a cast of the interior, and I am therefore inclined to doubt that the sulcus is as strongly defined on the exterior of the shell as shown on the specimen.

Collector.—J. N. Carpender. Cat. No. 28159, U.S.N.M.

CYRTODONTA (?) GIBBERA Ulrich, variety.

(Plate XIII, figs. 34–36.)

Cyrtodonta gibbera ULRICH, Geol. Minn., III, Pt. 2, 1894, p. 542, pl. XXXIX, figs. 13–15.

The only example of this species was sent by the writer to Mr. Ulrich, who made the following comparisons:

[1] Geol. Minn., III, Pt. 2, 1894, p. 540, pl. XXXIX, fig. 23.

[2] Ibidem.

[3] Canadian Nat. and Geol., III, 1858, p. 432.

It differs from my type specimen, which is a cast of the exterior, in being somewhat less gibbous, particularly in the umbones, the beaks also coming closer, i. e., they are almost in contact, while they are rather widely separated and less incurved in the type.

In the absence of evidence concerning the hinge, the generic position of the shell is necessarily doubtful. Therefore, although admitting provisionally that it is closely allied to *Cyrtodonta gibbera*, I am not at all satisfied that it will not turn out to be a *Vanuxemia* near *V. abrupta*.

Collector.—J. N. Carpender. Cat. No. 28161, U.S.N.M.

VANUXEMIA ABRUPTA Ulrich.

Vanuxemia abrupta ULRICH, Geol. Minn., III, Pt. 2, 1894, p. 560, pl. XXXVIII, figs. 39–44.

Of this species there are two examples, which Mr. Ulrich has compared with the types. In Minnesota this form is found in the Middle Galena of Fillmore and Goodhue counties.

Collector.—J. N. Carpender. Cat. Nos. 28157, 8, U.S.N.M.

VANUXEMIA BAFFINENSIS, new species.

(Plate XIII, figs. 26–28.)

This species finds its nearest relatives in *V. hayniana* Safford and *V. niota* (Whitfield[1]). It dffiers from these species in the greater obliquity of the shell. The largest specimen figured (figs. 29 and 30) is a worn example, and is provisionally referred to *V. baffinensis* as a variety. When additional material is secured, it may prove to be a distinct species. (Another specimen just received from Mr. A.V. Shaw shows that the variety is probably a distinct species.)

Collector.—J. N. Carpender. Cat. No. 28160, U.S.N.M.

WHITELLA ARCTICUS, new species.

(Plate XIII, figs. 23–25.)

Ulrich writes that this species of *Whitella* is nearest his *W. rugatina*,[2] from which it differs in being much more erect. In fact, *W. arcticus* is more erect than any other species of the genus. The escutcheon is very narrow.

Collector.—J. N. Carpender. Cat. No. 33059, U.S.N.M.

Family GRAMMYSIIDÆ Hall.

SAFFORDIA MODESTA Ulrich.

Saffordia modesta ULRICH, Geol. Minn., III, Pt. 2, 1894, p. 627, pl. XLI, figs. 29–31.

Of this form there are two specimens in the American Museum of Natural History, collected by Mr. R. W. Porter. Externally they agree with the Minnesota species.

[1] See Geol. Minn., III, Pt. 2, 1894, p. 560.

[2] Ibidem, p. 569, pl. XLI, fig. 1.

Class GASTROPODA.

Family PROTOWARTHIIDÆ Ulrich.

PROTOWARTHIA PERVOLUTA Ulrich and Scofield.

Protowarthia pervoluta ULRICH and SCOFIELD, Geol. Minn., III, Pt. 2, 1897, p. 871, pl. LXIII, figs. 21–27.

This species is fairly common at Silliman's Fossil Mount, and in some specimens the shell is preserved. Testiferous examples of *P. pervoluta* are distinguished from other species of the genus by the columella-like development of the inner lip. The specimens were sent to Mr. Ulrich, who has compared them with his types. He writes that the Arctic examples are somewhat more angular on the back of the volutions than the type specimens.

Collectors.—J. N. Carpender and A. H. White. Cat. No. 28173, U.S.N.M.

Family BUCANIIDÆ Ulrich.

TETRANOTA OBSOLETA Ulrich and Scofield.

Tetranota obsoleta ULRICH and SCOFIELD, Geol. Minn., III, Pt. 2, 1897, p. 880, pl. LXV, figs. 19–23.

Of this widely distributed shell there are eight examples in the present collection. Three were sent to Mr. Ulrich, who pronounced them typical examples of his *T. obsoleta*.

In the United States, this shell ranges from the Lowville stage into the Utica, and is found in Minnesota, Wisconsin, Kentucky, and at Cincinnati, Ohio.

Collectors.—J. N. Carpender and A. H. White. Cat. No. 28175, U.S.N.M. Three specimens collected by Mr. R. W. Porter are in the American Museum of Natural History.

KOKENIA COSTALIS Ulrich and Scofield.

Kokenia costalis ULRICH and SCOFIELD, Geol. Minn., III, Pt. 2, 1897, p. 882, pl. LXIV, figs. 46–49.

Two specimens of this interesting species, from the Galena shales of Goodhue County, Minnesota, the type locality for this species, are in the United States National Museum. The two specimens from Frobisher Bay agree with the present examples in every way excepting in the number of revolving lines. Of these there are seven in the Minnesota specimens, while in the Arctic individuals there are from eleven to twelve, of which the fourth, sixth, and eighth are the most prominent. The first, second, fourth, sixth, and eighth revolving lines are continuous into the aperture, the others being interpolated on the last volution. Extremely fine transverse lines of growth and a few varices indicating stages of growth are also present.

Collector.—J. N. Carpender. Cat. No. 28176, U.S.N.M.

Family BELLEROPHONTIIDÆ.

BELLEROPHON SIMILIS Ulrich and Scofield.

Bellerophon similis ULRICH and SCOFIELD, Geol. Minn., III, Pt. 2, 1897, p. 919, pl. LXIV, figs. 31–39.

Of this species there are two examples, one of which is identical with Ulrich's figures thirty-two and thirty-three of the work cited. It is one of the characteristic fossils of the Trenton or Galena stage of Minnesota.

Collector.—A. H. White. Cat. No. 28174, U.S.N.M.

Family PLEUROTOMARIIDÆ d'Orbigny.

LOPHOSPIRA SPIRONEMA Ulrich and Scofield.

Lophospira spironema ULRICH and SCOFIELD, Geol. Minn., III, Pt. 2, 1897, p. 983, pl. LXXII, figs. 44–47.

This is the most abundant gastropod found at Silliman's Fossil Mount. The species was at first thought by the writer to be *L. fillmorensis* Ulrich and Scofield, but Mr. Ulrich, to whom three examples were sent, pronounced it *L. spironema*. The Arctic examples attained a far larger size than the Black River specimens of Minnesota.

Collectors.—A. H. White and J. N. Carpender. Cat. No. 28177, U.S.N.M. Other specimens collected by R. W. Porter are in the American Museum of Natural History.

LIOSPIRA AMERICANA (Billings).

Liospira americana ULRICH and SCOFIELD, Geol. Minn., III, Pt. 2, 1897, p. 996.

This very widely distributed and common species is abundant at Silliman's Fossil Mount. The large umbilicus is completely filled with shell matter, but above in the earlier whorls it is open.

Collectors.—A. H. White, A. V. Shaw, J. N. Carpender, and R. W. Porter. Cat. No. 28180, U.S.N.M.

CLATHROSPIRA CONICA Ulrich and Scofield.

Clathrospira conica ULRICH and SCOFIELD, Geol. Minn., III, Pt. 2, 1897, p. 1008, pl. LXX, figs. 1–4.

This is one of the abundant species at Silliman's Fossil Mount, and in the United States ranges from the Black River group into the middle of the Cincinnatian group. The Arctic examples attained a larger size than elsewhere, but otherwise are considered by Mr. Ulrich to be in harmony with his species.

Collectors.—J. N. Carpender, A. V. Shaw, and A. H. White. Cat. No. 28178, U.S.N.M. The American Museum of Natural History also has specimens collected by Mr. R. W. Porter.

SEELYA (?) (PLETHOSPIRA?) ULRICHI, new species.

(Plate XII, figs. 9, 10.)

This interesting little shell has many of the characteristics of *S. ventricosa* Ulrich,[1] from the Calciferous (Beekmantown) stage. It is, however, a much smaller shell, and differs from all known species of Seelya in having the revolving bands nearly obsolete.

There are four of these shells, which were sent to Mr. Ulrich for identification. He writes:

The specimens are casts of the interior, and the revolving peripheral furrows probably have nothing to do with the revolving sculpture of the true *Seelya*. Similar furrows occur in good casts of *Lophospira bowdeni* and other Pleurotomariidæ. The band, I believe, was of the flat or concave type, as in *Seelya, Plethospira,* and *Hormotoma*, but, as it was evidently close to the suture and partly covered by same, it is too low on the whorls to be in strict accordance with these genera.

Collector.—A. H. White. Cat. No. 28187, U.S.N.M. The American Museum of Natural History has two specimens collected by Mr. R. W. Porter. The species is named for Mr. E. O. Ulrich, who has accomplished much in bringing about a better understanding of the fossils of the American Lower Silurian.

Family EUOMPHALIDÆ.

HELICOTOMA (?) (LIOSPIRA?) LARVATA Salter.

Helicotoma larvata BILLINGS, Canadian Organic Remains, Decade I, 1859, p. 15, pl. II, figs. 11–14.

Of this species there is a single excellent specimen, which the writer at first labeled *Liospira angulata* Ulrich, variety. However, when Ulrich compared the Arctic example with the type species he concluded it to be *Helicotoma larvata* Salter. He has kindly made the following notes on this specimen:

This species resembles *Liospira mundula, L. angulata,* and other species of that section of this genus very greatly, and it may be, as I once thought, truly referable to *Liospira*. Excepting that the Arctic specimen is small, it is the best preserved yet seen by me. Still I am unable to settle the difficulty. Whatever light it casts upon the problem is in favor of retaining the species under *Helicotoma*.

In Canada this is a Black River species.

Collector.—A. H. White. Cat. No. 28179, U.S.N.M.

Family MACLURIIDÆ Woodward.

MACLURINA MANITOBENSIS (Whiteaves).

Maclurina manitobensis ULRICH and SCOFIELD, Geol. Minn., III, Pt. 2, 1897, p. 1041, pl. LXXVI, figs. 4, 5; pl. LXXXII, fig. 45.

This species is common at Silliman's Fossil Mount and attains a large size, one specimen measuring nearly 5 inches in diameter. In

[1] Geol. Minn. III, Pt. 2, 1897, p. 1009, figs. 7, *b, c, d,* in text.

Manitoba, it attains a diameter of 8½ inches. It is a characteristic species of the Trenton.

Collectors.—J. N. Carpender, A. V. Shaw, and A. H. White. Cat. No. 28183, U.S.N.M.

MACLURINA CUNEATA (Whitfield).

Maclurina cuneata ULRICH and SCOFIELD, Geol. Minn., III, Pt. 2, 1897, p. 1042, pl. LXXVI, figs. 1–3; pl. LXXXII, fig. 46.

Of this species there are two typical specimens with the characteristic, small umbilical perforation.

Collector.—J. N. Carpender. Cat. No. 28184, U.S.N.M.

MACLUREA CRASSA Ulrich and Scofield.

Maclurea crassa ULRICH and SCOFIELD, Geol. Minn., III, Pt. 2, 1897, p. 1040, pl. LXXV, figs. 12–14.

One example of this species measures nearly 3 inches in diameter, which is larger than the Minnesota specimens, but this is in keeping with the greater size attained by the Maclureas and Maclurinas in the far north.

Collectors.—J. N. Carpender and A. V. Shaw. Cat. No. 28182, U.S.N.M.

Family TROCHONEMATIDÆ Ulrich.

TROCHONEMA UMBILICATUM (Hall).

Trochonema umbilicatum ULRICH and SCOFIELD, Geol. Minn., III, Pt. 2, 1897, p. 1047, pl. LXXVII, figs. 1–3.

Of this widely distributed Lower Silurian shell, six specimens are present. They preserve most of the shell, and show considerable surface detail.

Collectors.—J. N. Carpender, A. V. Shaw, and A. H. White. Cat. No. 28186, U.S.N.M. Other specimens collected by Mr. R. W. Porter are in the American Museum of Natural History.

TROCHONEMA (EUNEMA) ROBBINSI Ulrich and Scofield.

Trochonema (*Eunema*) *robbinsi* ULRICH and SCOFIELD, Geol. Minn., III, Pt. 2, 1897, p. 1053, pl. LXXVI, figs. 11-15.

Three examples of this species are present, only one of which is well preserved. These were sent to Mr. Ulrich for comparison with *T. robbinsi* and *T. salteri*. He writes as follows:

> These specimens possibly indicate a form intermediate between *T.* (*E.*) *similis* and *T.* (*E.*) *robbinsi* Ulrich and Scofield. The upper whorls of the best specimen agree rather closely with the former, while the last whorl, with its relatively narrow peripheral band, is more in accordance with the latter species. It is to be borne in mind, however, that it is only the shell-less portion of the specimen that agree with *T.* (*E.*) *similis*, the opposite side of the same whorls showing no trace of the ridge near the suture, which is strongly developed and is characteristic of *T. similis*.

Collector.—J. N. Carpender. Cat. No. 28185, U.S.N.M. The best specimen was found by Mr. R. W. Porter, and is now in the American Museum of Natural History.

HOLOPEA ARCTICA, new species.

(Plate XII, figs. 14-16.)

This little Holopea has its nearest relation in *H. ampla* and *H. similis* Ulrich and Scofield.[1] It differs from the latter in having the upper sides of the whorls less flat, the sutures deeper, and the lines of growth more regular than in any other species of *Holopea*. From *H. ampla*, the Arctic species differs in having the whorls expand less rapidly.

Collector.—A. H. White. Cat. No. 28190, U.S.N.M.

? Family TROCHIDÆ.

TROCHUS (?), species undetermined.

(Plate XII, figs. 11-13.)

Of this form there is only one good specimen, and this has none of the ornamental surface preserved. The specimen was sent to Mr. Ulrich, and he kindly made the following notes:

I regard it as related to some of the Gotland shells referred to *Trochus* by Lindström, but as the specimen retains no trace of the sculpture-bearing layer of the shell it can not be compared satisfactorily with described species. Lindström's *T. densistriatus*, *T. kolmodini*, and *T. wisbyensis* seem not far removed.

The specimen is in the American Museum of Natural History.

Family SUBULITIDÆ.

FUSISPIRA INFLATA Meek and Worthen.

Fusispira inflata Ulrich and Scofield, Geol. Minn., III, Pt. 2, 1897, p. 1075, pl. LXXX, figs. 17, 18.

The only example of this species is an imperfect shell with most of the smaller part of the spire missing. So far as comparison can be made, the species is in harmony with *F. inflata*. Mr. Ulrich agrees that the specimen belongs to this species.

Collector.—J. N. Carpender. Cat. No. 28189, U.S.N.M.

FUSISPIRA NOBILIS Ulrich and Scofield.

Fusispira nobilis Ulrich and Scofield, Geol. Minn., III, Pt. 2, 1897, p. 1078, pl. LXXX, figs. 2-4.

The two Arctic specimens of this form are imperfect, and the largest fragment indicates that the species here attained as large a growth as in Minnesota, being about 4 inches in length. Mr. Ulrich has seen the fragments and agrees that they represent his species.

[1] Geol. Minn., III, Pt. 2, 1897, pp. 1065, 1066.

Class CEPHALOPODA.

Order TETRABRANCHIATA.

Family ENDOCERATIDÆ.

CAMEROCERAS PROTEIFORME (Hall).

Cameroceras proteiforme CLARKE, Geol. Minn., III, Pt. 2, 1897, p. 777, pls. XLVIII–LI, LIII.

Of this common species there is one small but well-preserved fragment showing the submarginal siphon. In a length of 2 inches, there are seven chambers and eight septa.

Collector.—J. N. Carpender. Cat. No. 28191, U.S.N.M.

Family ORTHOCERATIDÆ.

ORTHOCERAS OLORUS Hall, var. BAFFINENSIS, new variety.

(Plate XII, figs. 19–22.)

Orthoceras vertebrale HALL, Pal. N. Y., I, 1847, p. 201, pl. XLIII, figs. 5–5*c* (not Schlotheim, 1820).

Orthoceras olorus HALL, Miller's Amer. Pal. Foss., 1st ed., 1877, p. 245.

The Arctic examples of this form, of which there are three, do not appear to attain the large size of the New York specimens. Hall describes the species with "strong longitudinal striæ," while the Arctic specimens have very fine equidistant lines, between each of which are from 3 to 6 exceedingly delicate ones. This difference in the ornamentation, together with the smaller size, is regarded of sufficient importance for varietal distinction. There is no other American Lower Silurian annulated species with which it can be compared.

Collectors.—J. N. Carpender and A. H. White. Cat. No. 28192, U.S.N.M.

ORTHOCERAS BILINEATUM Hall.

Orthoceras bilineatum CLARKE, Geol. Minn., III, Pt. 2, 1897, p. 786, pl. XLVII, figs. 20, 21; pl. LIV, figs. 6, 7.

Of this species there is one small specimen annulated throughout. The characteristic, regularly alternating, larger and smaller lines of ornamentation are preserved.

Collector.—A. H. White. Cat. No. 28193, U.S.N.M.

ORTHOCERAS PORTERI, new species.

(Plate XII, figs. 23–25.)

This annulated species of Orthoceras appears to be related to *O. bilineatum*. The apical angle in both is about the same, but in *O. porteri* the annulations and septa are farther apart, the siphuncle is more eccentric, and the ornamentation is entirely different. The longitudinal lines are double throughout, and consist of prominent primary ones,

between which there are always three equally strong secondary lines. Transverse, or growth, lines are fine and numerous, and in crossing the longitudinal lines they cause these to be slightly nodose.

Collector.—J. N. Carpender. Cat. No. 28194, U.S.N.M.

This name is given as a mark of appreciation to Mr. Russell W. Porter, of Boston, Massachusetts, who, with his associates, made it possible to revisit Frobisher Bay and to make a most complete collection of Arctic Trenton fossils.[1]

ORTHOCERAS SCALARIFORMIS, new species.

(Plate XII, figs. 17, 18.)

Shell small, not annulated, tapering slowly, with an apical angle of about 7°, section originally circular, septa 9 in the length of 1 inch; siphuncle large, and apparently in contact with the outer wall. Surface with 13 widely separated prominent longitudinal costæ, which are crossed somewhat irregularly by concentric lamellæ, anteriorly directed, and 1 to each septum. Here and there two or three intermediate vertical lines occur between the longitudinal costæ.

Collector.—J. N. Carpender. Cat. No. 28195, U.S.N.M.

Family CYRTOCERATIDÆ.

CYRTOCERAS MANITOBENSE Whiteaves.

Cyrtoceras manitobense WHITEAVES, Trans. Royal Soc. of Canada, Sec. 4, VII, 1889, p. 80, pl. XIII, figs. 3, 4; pl. XV, fig. 4; Geol. Surv., Canada, Pal. Foss., III, 1897, p. 223.

Oncoceras manitobense CLARKE, Geol. Minn., III, Pt. 2, 1897, p. 799.

This species is the most abundant of the Cephalopoda at Silliman's Fossil Mount. The writer sent the specimens to Professor Whiteaves, who compared them with the types, and subsequently reported that they are "apparently exactly the same species as *C. manitobense* Whiteaves from Lake Winnepeg, Manitoba. We have very similar specimens from Akpatok Island, Hudson Strait." The Baffin Land specimens are smaller than those from Manitoba.

Collectors.—J. N. Carpender, A. V. Shaw, and A. H. White. Cat. No. 28119, U.S.N.M.

CYRTOCERAS CORNULUM, new species.

(Plate XIV, figs. 8–10.)

This little shell is clearly related to the previous species, having many of its characters. It differs, however, in its smaller growth, greater curvature, and most decidedly in the very rapid increase of the cone. The greater curvature is due to the rapid increase in depth of the air chamber toward the ventral side, where near the living chamber it is

[1] A description of this trip is given by Mr. Porter in Bull. Amer. Geog. Soc., XXX, May, 1898, pp. 97–110, the paper being entitled "Frobisher Bay Revisited."

often three times the depth on the dorsal side. The siphuncle is very small, almost in contact with the ventral wall, and swells but little between the septa.

Professor Whiteaves, who saw the type, states that among the fragments of *Cyrtoceras* from Manitoba "are some apparently like *C. cornulum* in section, curvature, and much in the position of siphuncle."

Collectors.—A. V. Shaw and A. H. White. Cat. No. 28121, U.S.N.M.

CYRTOCERAS BAFFINENSIS, new species.

(Plate XIV, figs. 11–13.)

This small species of Cyrtoceras has the general aspect of *C. manitobense*, and for a time was regarded as the young of that species, yet a comparison shows that *C. baffinensis* has a somewhat smaller apical angle. The diagnostic feature, however, is in the depth of the air chambers. These are much more shallow and do not increase in depth with growth nearly as rapidly as in *C. manitobense*, there being twenty-two of these in 25 mm., while in the latter species at a similar stage of growth there are about sixteen.

Collector.—A. H. White. Cat. No. 28198, U.S.N.M.

Family ONCOCERATIDÆ.

CLINOCERAS EXIGUUM (Billings).

Cyrtoceras exiguum BILLINGS, Can. Nat. and Geol., V, 1860, p. 172, figs. 17, 18.
Oncoceras exiguum CLARKE, Geol. Minn., III, Pt. 2, 1897, p. 798, pl. LVIII, figs. 10, 11.

In this collection there are five specimens of this species, three of which preserve more or less of the body chamber, and permit a reconstruction of the form of the shell. The body chamber was not less than 15 mm. in length and the entire shell not less than 58 mm. Billings gives the probable length as about 50 mm., which is very close to the protraction based on Arctic material. Clarke writes that the Minnesota specimens probably did not exceed 30 mm., but as his specimens are very small fragments, this estimate is probably short of the actual length. The first twelve septa back of the living chamber occupy 22 mm., and in another specimen there are nine in 19 mm. The depth of the air chambers decreases very little toward the apex, the average being a little less than 2 mm. down to where the shell has a diameter of 3.5 mm.

Specimens from shale are usually compressed, and this is the condition of the Arctic material, but the shell was circular in outline, with a very small central siphuncle.

This species is related to *Oncoceras mumiæformis* Whitfield, which Clarke referred to *Clinoceras*. The Arctic material shows the shell to be gently arcuate and to possess the other generic characters of *Clinoceras*. Billings's species should be referred to Maschke's genus.

Collectors.—J. N. Carpender and A. H. White. Cat. No. 28199, U.S.N.M.

ONCOCERAS ARCTICUM, new species.

(Plate XIV, figs. 4–7.)

As shown by the figures, this species differs from all other American *Oncoceras* in the great antero-posterior curvature of the ventral side of the shell. This is caused by the rapidly increasing depth of the air chambers toward the ventral side, where they are about twice the depth of the dorsum. Siphuncle small, slightly constricted at each septum, and closely adjoining the ventral wall except immediately beneath the living chamber, where it is slightly deflected dorsally. Venter more broadly rounded than the dorsum. Living chamber large, with the sides slightly constricted, not less than 24 mm. deep, 33 mm. dorso-ventrally, and 24 mm. transversely. The cast is smooth and preserves no markings of the exterior.

Cyrtoceras cornulum was first thought to be the young stage of *Oncoceras arcticum*, but its section is more elongate-oval, with the dorsal side more rounded, the reverse being true in the latter species. The chambers also are deeper on the ventral side, the ventral curvature is less strong, and the shell thicker, with longitudinal plications.

Collector.—J. N. Carpender. Cat. No. 28196, U.S.N.M.

ONCOCERAS TUMIDUM, new species.

(Plate XIV, figs. 1–3.)

This species is much larger than any other in the Trenton of the United States, although much smaller than *O. magnum*, the giant of the genus, which is found at East Selkirk, in Manitoba. The present form seems to be most closely related to *O. gibbosum* Whiteaves[1] (=*O. whiteavesi* Miller), but has not the numuloidal siphuncle of that species, nor the sigmoid outline of the septa on the dorsum. The living chamber, also, is shallower, being about 28 mm. deep. The constriction of *O. tumidum* recalls that seen in *Poterioceras* or *Gomphoceras*, but unlike these shells is not bilaterally symmetrical. The specimen preserves but 6 septa and the living chamber, and throughout all there is a rapid regular convergence toward the anterior end. Dorsal end of shell broadly rounded, with the ventral side somewhat acutely rounded. The 5 air chambers are dorsally 13 mm. deep and ventrally 25 mm. The siphuncle is small and situated about 6 mm. inside the ventral wall. Septa regularly but deeply concave.

The type specimen was sent to Professor Whiteaves for comparison with *O. whiteavesi* Miller. He reports that *Oncoceras tumidum* is "very much like *O. whiteavesi* Miller (=*O. gibbosum* Whiteaves, not Hall) in lateral contour, but in your specimen the body chamber does not seem to narrow so abruptly as it always does in *O. whiteavesi*, and shows no sign of any constriction at the aperture."

Collector.—J. N. Carpender. Cat. No. 28190, U.S.N.M.

[1] Trans. Royal Soc. Canada, Sec. 4, IV, 1889, p. 80, pl. XV, fig. 43.

POTERIOCERAS, species undetermined.

There is a poor specimen of this genus from the Frobisher Bay locality. It was thought to be a small specimen of *P. nobile*, and was therefore sent to Professor Whiteaves[1] for comparison. He, however, writes:

We have nothing exactly like this. It is very similar in shape to *P. nobile*, except that the latter is somewhat compressed and yours is not. The difference in size between your specimen and ours is, of course, enormous. Your shell also is not very unlike the so-called *Gomphoceras eximium* Billings, but that species is ovate in transverse section, possibly from lateral pressure. Your specimen is, I should think, most likely a *Poterioceras*, but too imperfect to show its specific characters or affinities.

Collector.—J. N. Carpender. Cat. No. 28122, U.S.N.M.

Family TARPHYCERATIDÆ Hyatt.

EURYSTOMITES PLICATUS Whiteaves?

Eurystomites plicatus WHITEAVES, Can. Rec. Sci., VI, 1896, p. 395; Geol. Surv. Canada, Pal. Foss., III, Pt. 3, 1897, p. 225, figs. 15, 16; pl. XXVII, fig. 2.

The only specimen of this species present is not well preserved, but has parts of one and one-half whorls. Professor Whiteaves, who saw the specimen, writes that it is "probably *Eurystomites plicatus* Whiteaves. At any rate, it has the same outline in transverse section, with the dorsum impressed by a shallow and rather narrow furrow of contact, and the same amount of involution." The specimen, however, shows no surface markings nor any siphuncle.

Collector.—J. N. Carpender. Cat. No. 28123, U.S.N.M.

Class ARTHROPODA.

Subclass CRUSTACEA.

Order OSTRACODA.

Ostracoda are abundant at Silliman's Fossil Mount, 10 specimens having been found attached to the larger fossils. These were sent to Mr. E. O. Ulrich for determination. He has identified them as follows:

Bythocypris granti Ulrich.[2]

Primitia or *Klœdenia*.

Krausella, two new species.

Order TRILOBITA.

NILEUS VIGILANS (Meek and Worthen).

Nileus vigilans CLARKE, Geol. Minn., III, Pt. 2, 1894, p. 712, figs. 17–19.

Of this widely distributed species there is one very fine enrolled but small specimen and fragments of three other individuals. These agree exactly with Mr. Clarke's description and figures.

[1] Trans. Royal Soc. Canada, Sec. 4, VII, 1889, p. 77, pl. XIV, fig. 1.

[2] Geol. Minn., III, Pt. 2, 1894, p. 689, pl. XLIV, figs. 39–42.

Collectors.—J. N. Carpender, A. V. Shaw, and A. H. White. Cat. No. 28168, U.S.N.M. The American Museum of Natural History has two specimens collected by Mr. R. W. Porter.

ILLÆNUS CRASSICAUDA AMERICANUS (Billings).

Illænus americanus CLARKE, Geol. Minn., III, Pt. 2, 1894, p. 714, figs. 20–23.

One fine enrolled specimen of this well-known species was found by Mr. F. G. Goodridge, of New York City, and was very kindly given to the U. S. National Museum. Mr. R. W. Porter also collected two fine specimens, which are now in the American Museum of Natural History. These agree excellently with this species, the best examples of which are from Trenton Falls, New York.

Collectors.—F. G. Goodridge, J. N. Carpender, A. V. Shaw, and A. H. White. Cat. No. 28167, U.S.N.M.

ISOTELUS GIGAS De Kay.

Isotelus gigas CLARKE, Geol. Minn., III, Pt. 2, 1894, pp. 701–706, with text figures.

Of this species several fragments were found by J. N. Carpender and A. V. Shaw.

DALMANITES (PTERYGOMETOPUS) GOODRIDGII, new species.

(Plate XII, figs. 5, 6.)

The cephalon of this species recalls that of *D.* (*P.*) *eboraceus* Clarke in the characters of the glabella and in the great prominence of the eyes. However, in *D.* (*P.*) *goodridgii*, the eyes are even more elevated, the cephalon is smooth and devoid of all granulation, while the most marked difference is seen in the posterior outline of the head, which is broadly rounded or subquadrate, with a central, short projection. The occipital ring is also much wider, and is strongly elevated medio-posteriorly into an obtuse apex. Of thoracic segments, nine are preserved in these specimens.

The pygidium is likewise less triangular than in *D.* (*P.*) *eboraceus*, and while there are ten or eleven annulations on the axis, there are not more than five pleuræ. These are well developed anteriorly, becoming rapidly more and more obsolete.

Named for Mr. F. G. Goodridge, of New York City, one of the collectors of fossils on the Peary expedition of 1897.

Collectors.—J. N. Carpender and A. H. White. Cat. No. 28170, U.S.N.M.

CERAURUS PLEUREXANTHEMUS Green.

Ceraurus pleurexanthemus GREEN, Pal. N. Y., I, 1847, p. 242, pl. LXV, figs. 1*a*–1*n*; pl. LXVI, figs. 1, 1*c*–1*h*.—CLARKE, Geol. Minn., III, Pt. 2, 1894, p. 734.

There are three examples of this species in the collection, none of which are entire, but all agree well with New York specimens. The species did not here attain quite the large size of New York specimens, but one glabella shows a growth about two-thirds of the largest from the latter locality.

Collector.—A. H. White. Cat. No. 28169, U.S.N.M.

SUMMARY.

The only Lower Silurian horizons known in northeastern Arctic America are of Trenton and Utica age. The latter zone appears only on the north shore of Frobisher Bay, but the Trenton is found in various places from the north shore of Hudson Strait to latitude 81° north. The Lower Silurian is thickest on Akpatok Island, where it is from 400 to 500 feet in depth. Dr. Bell, however, estimates the entire thickness of these strata in this region to be not less than 900 feet.

In Baffin Land, and apparently elsewhere in Arctic America, the Lower Silurian strata rests unconformably on old crystalline rocks. To the north of Baffin Land, the former are overlain by beds of Niagara or Wenlock age.

The Trenton faunas, occurring in various places around the insular Archæan nucleus of North America, have much in common, and this indicates that the conditions at that time were very similar, while the sea was in communication throughout. As yet, however, the distribution of the strata, together with their faunas, are well known only to the south and southeast of the Archæan nucleus, yet that of the west (Manitoba) and of the northeast (Baffin Land) show direct communication.

The Baffin Land fauna had an early introduction of Upper Silurian genera in the corals *Halysites*, *Lyellia*, and *Plasmopora*. In Manitoba similar conditions occur in the presence of *Halysites*, *Favosites*, and *Diphyphyllum*. Other Upper Silurian types do not appear to be present.

The Trenton fauna of Silliman's Fossil Mount, at the head of Frobisher Bay, has seventy-two species, of which twenty-eight are restricted to it. This fauna shows an intimate relationship with that of the Galena of Minnesota, Iowa, and Wisconsin. Fifty-seven per cent of the species of Baffin Land also occur in the Galena of the regions just mentioned.

The Trenton fauna of Baffin Land shows that the corals, brachiopods, gastropods, and trilobites have wide distribution, and are therefore less sensitive to differing habitats apt to occur in widely separated regions. On the other hand, the cephalopods, and particularly the pelecypods, indicate a shorter geographical range. The almost complete absence of Bryozoa in the Baffin Land Trenton contrasts strongly with the great development of these animals in Minnesota and elsewhere in the United States.

EXPLANATION OF PLATES.

[From drawings by Mr. E. O. Ulrich.]

Plate XII.

Porocrinus shawi, p. 155.

Fig. 1. Posterior view of the calyx; enlarged.
2. Anterior view; natural size.
3. Ventral view; enlarged.

Dalmanites (*Pterygometopus*) *goodridgii*, p. 174.

4. The pygidium supposed to be of this species.
5, 6. Two views of the cephalon.

Orthis (*Dinorthis*) *meedsi arctica*, p. 157.

7, 8. Dorsal and profile views.

Seelya (?) (*Plethospira* ?) *ulrichi*, p. 166.

9, 10. Two views showing the nearly obsolete revolving bands.

Trochus ?, species undetermined, p. 168.

11–13. Three views of the only specimen of this genus.

Holopea arctica, p. 168.

14, 15. Two views of the best specimen.
16. Surface ornamentation; x5.

Orthoceras scalariformis, p. 170.

17. The ornamentation.
18. Sectional view, with the position of the sipho.

Orthoceras olorus baffinensis, p. 169.

19, 21, 22. Views of three specimens.
20. Surface ornamentation; x10.

Orthoceras porteri, p. 169.

23. View of the exterior.
24. Surface ornamentation; x5.
25. Sectional view, with the position of the sipho.

Plate XIII.

Ctenodonta carpenderi, p. 160.

Figs. 1–3. Three views of the largest specimen.

Ctenodonta subnasuta Ulrich ?, p. 160.

4–6. Three views of the best specimen.

Ctenodonta baffinensis, p. 161.

7–9. Three views of the type specimen.
10. Surface ornamentation; x10.

Ctenodonta frobisherensis, p. 161.

11–13. Three views of the best specimen.
14. Left valve of another specimen.

Whiteavesia symmetricus, p. 162.

15–17. Three views of the type specimen.

Modiolodon arcticus, p. 161.

18, 19. Views of the cast of the interior.

Allodesma (?) species undetermined.

20–22. Three views of the only specimen. This species is for the present not described.

Whitella arcticus, p. 163.

23–25. Three views of the type specimen.

Vanuxemia baffinensis, p. 163.

26–28. Three views of the type specimen.
29, 30. Two views of a large specimen which probably is a distinct form.

Cyrtodonta sillimanensis, p. 162.

31–33. Views of the type specimens.

Cyrtodonta (?) *gibbera* Ulrich, var., p. 162.

34–36. View of the only example.

PLATE XIV.

Oncoceras tumidum, p. 172.

Fig. 1. Ventral side.
2. Side view.
3. Sectional view of the larger end.

Oncoceras arcticum, p. 172.

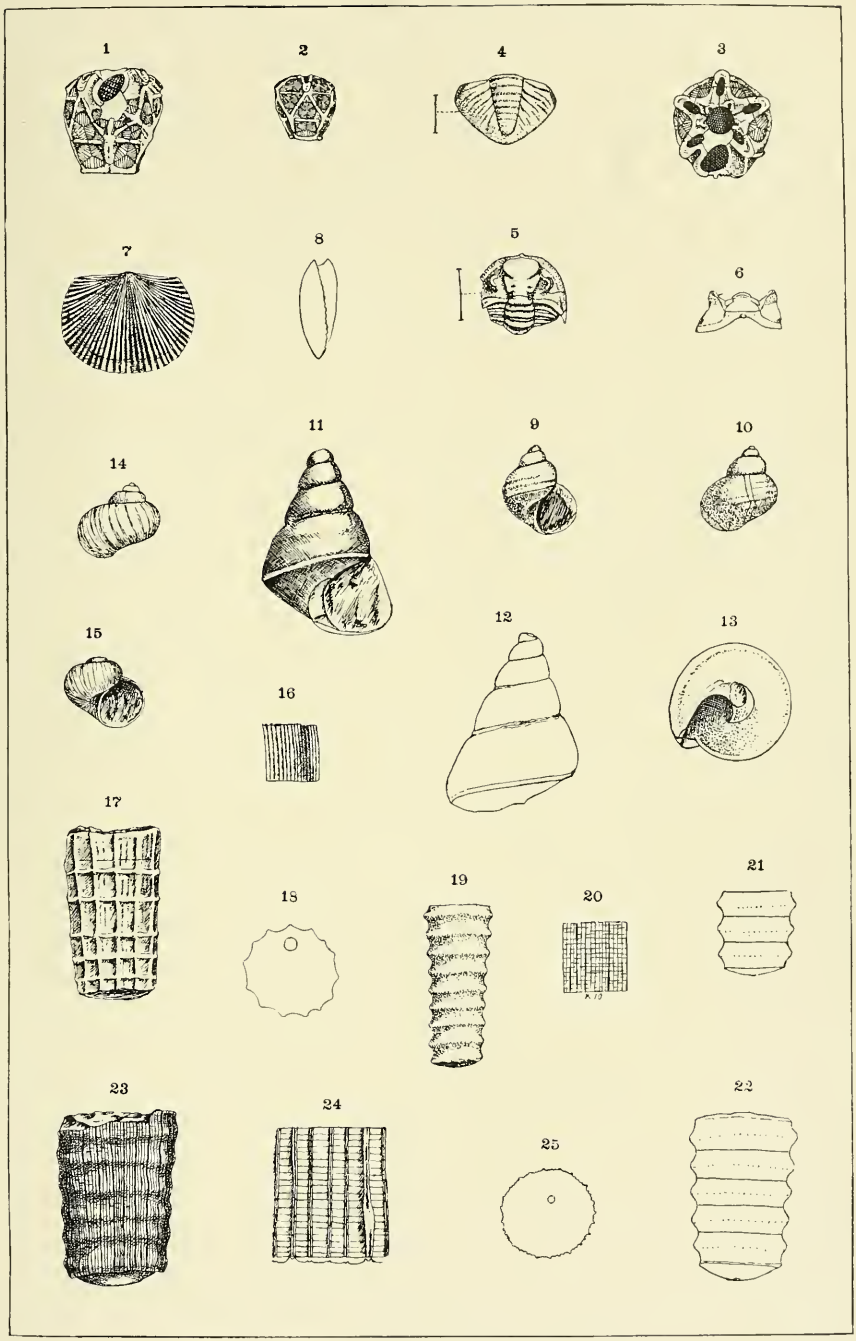
4. View of the dorsum.
5. Side view.
6. Sectional view, with the position of the sipho.
7. Ventral side.

Cyrtoceras cornulum, p. 170.

8. Side view, showing the radiating furrows of the inner side of the shell.
9. Ventral view.
10. Outline of the shell transversely.

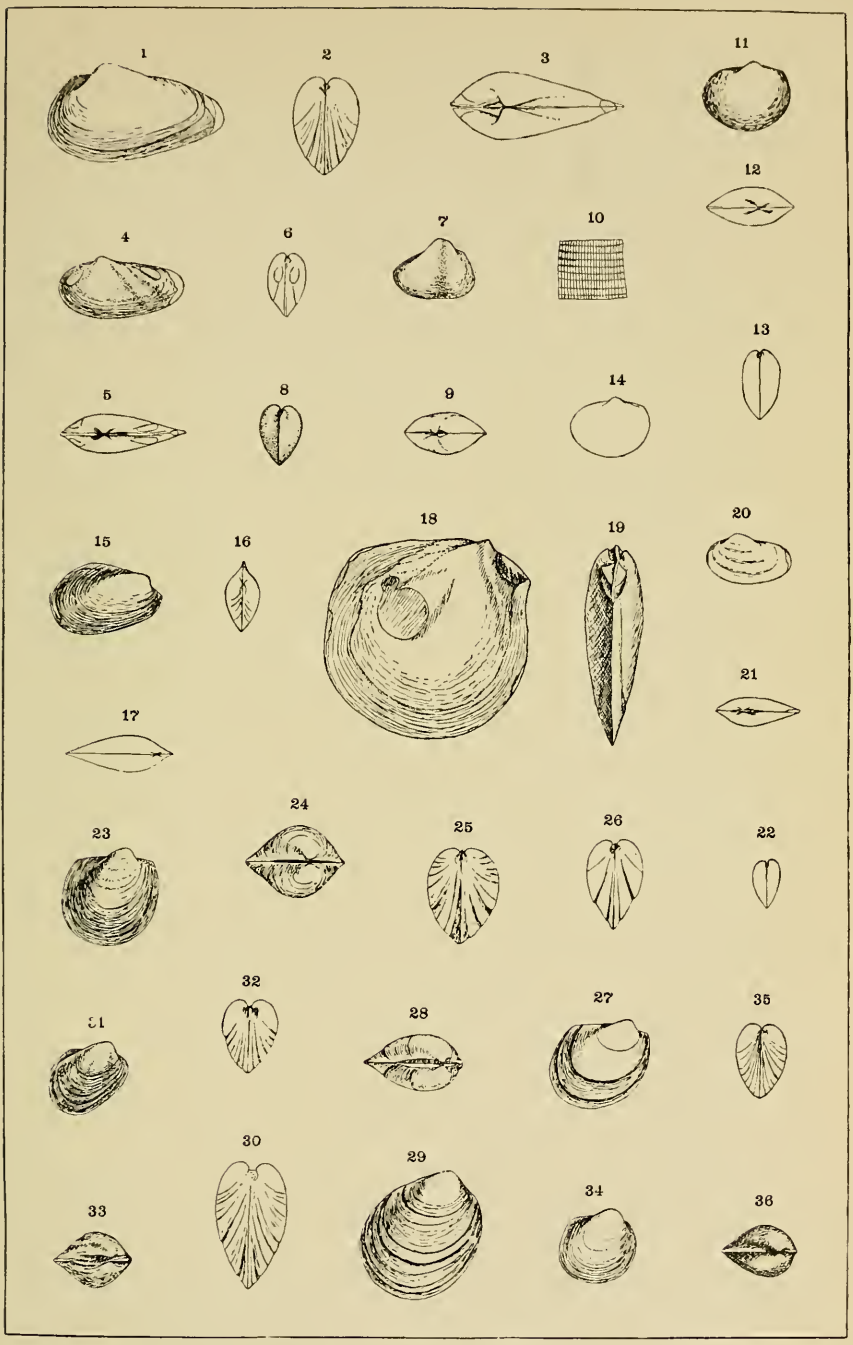
Cyrtoceras baffineusis, p. 171.

11. Side view.
12. Ventral view.
13. End view with about half the length of the shell drawn in.



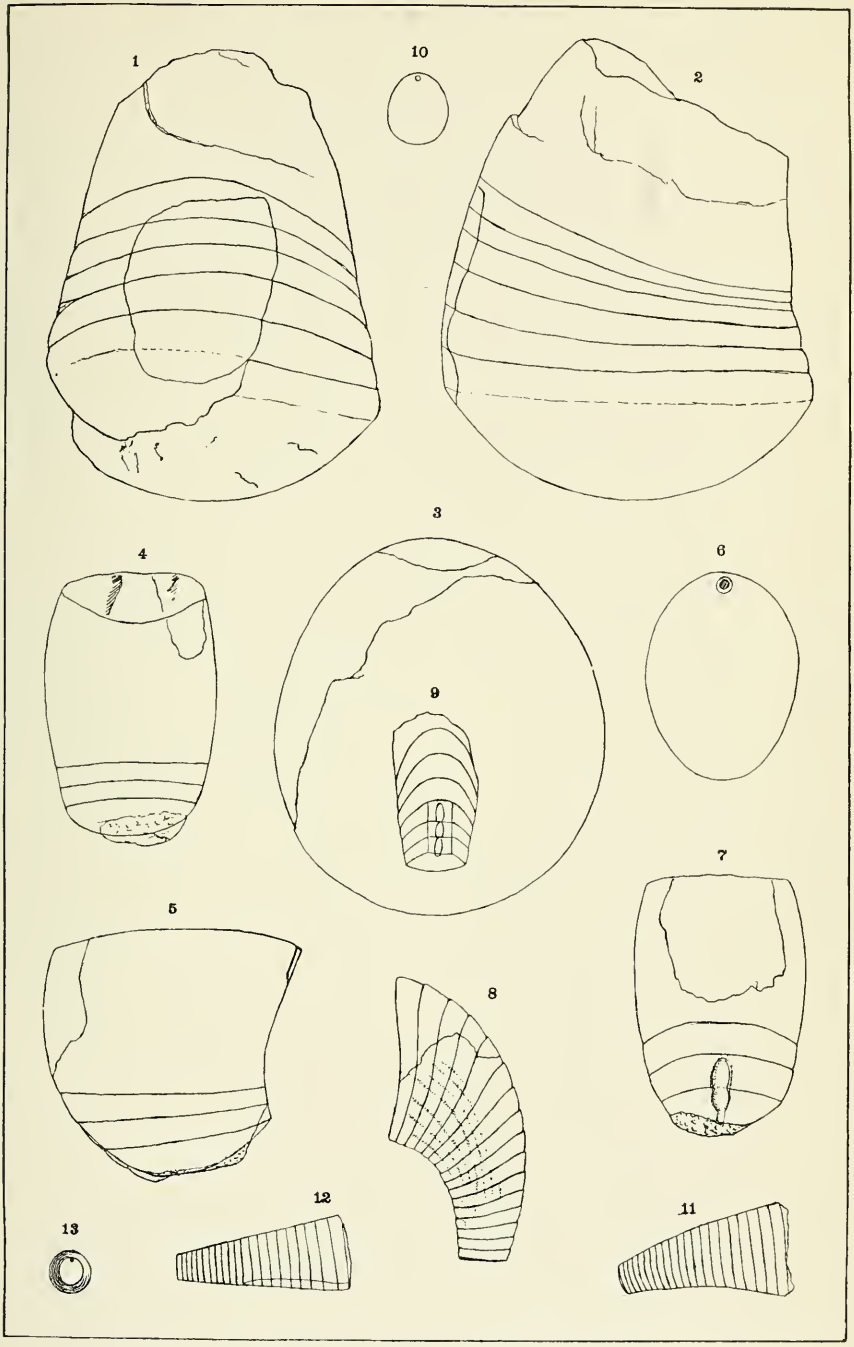
FOSSILS FROM SILLIMAN'S MOUNT.

FOR EXPLANATION OF PLATE SEE PAGE 176.



PELECYPODS FROM SILLIMAN'S MOUNT.

FOR EXPLANATION OF PLATE SEE PAGES 176, 177.



CEPHALOPODS FROM SILLIMAN'S MOUNT.

FOR EXPLANATION OF PLATE SEE PAGE 177.

SOME NEOCENE CORALS OF THE UNITED STATES.

By Henry Stewart Gane, Ph. D.,
Fellow in Geology, Johns Hopkins University, 1894–95.

INTRODUCTION.

At the suggestion of Prof. William B. Clark, of the Johns Hopkins University, the writer was encouraged to undertake the study and systematic description of the Neocene corals of the United States. Furthermore, the present paper has been constructed both as to method of treatment and arrangement of subject-matter upon the general plan of Professor Clark's bulletin on the Mesozoic Echinodermata of this country.

No attempt had been made hitherto to treat this subject from the present standpoint, the few corals previously described being offered to science either as possessing only zoological interest, or else to complete a local fauna.

The first mention of a Neocene coral from this country is found in the Petrefacta Germaniæ of Goldfuss (1829), where *Madrepora palmata* is both described and figured. During the thirty years following this first description there were at irregular intervals a number of scattered contributions to the subject. The more important were those of T. A. Conrad, W. Lonsdale from the collections made by Sir Charles Lyell, and Milne-Edwards and Jules Haime. More recently there have been but two papers worthy of notice, one in 1887 by Prof. P. M. Duncan on the genus *Septastræa* d'Orbigny, from the Miocene of Maryland, and one in 1888 by Dr. G. J. Hinde as a criticism of Professor Duncan's article. It is of interest to note that the researches of Dr. Hinde on this American species are almost unprecedented, no similar coral having been treated in so exhaustive a manner. In considering all the references we notice the somewhat remarkable fact that by far the most important writings have appeared both in foreign journals and from the pens of foreign paleontologists.

The material treated has been loaned to the writer from the collections of the U. S. National Museum, Wagner Free Institute of

Science, the Philadelphia Academy of Sciences, the private cabinet of Mr. Joseph Willcox, of Philadelphia, and the Johns Hopkins University. The state of preservation of the forms is as a rule excellent, with the exception of the silicified corals from Florida. These latter are often very difficult of determination, owing to prefossil wear and the mineralogical change the specimens have since undergone. Frequently the poorly preserved calices alone remain, the entire inside of the individual or the colony being dissolved away and represented by a cavity with walls of botryoidal character. When the original substance of the coral, with the exception of the outer surface, is thus replaced, it becomes impossible, as an aid to identification, to cut sections showing the coral structure below the calice. The cause and method of silification of these corals has never been satisfactorily proven. Professor Heilprin,[1] in discussing the phenomena in his treatise on the Explorations on the West Coast of Florida, attributes the change to an infiltration of silica in a heated condition, but adds that he can not even hazard a guess, much less explain in what precise manner the peculiar method of hollowing was brought about. Especially is this true of the colonial types with botryoidal-shaped cavities. Furthermore, in the genera possessed of very small calices, as in *Porites* and *Stylophora*, their delicate structure is often so destroyed as to render a specific diagnosis impossible.

The writer has also been at a great disadvantage from the fact that a number of the species have been described from single specimens, and until further collecting is done in the field it will be impossible to give a more detailed specific description of these forms.

The fauna under discussion embraces in its geological distribution, the Neocene and Oligocene epochs. On the other hand, geographically the range of these forms is remarkably confined. With the single exception of a few casts from the Miocene of Griswoldville, Fresno County, California, we find them limited to the Atlantic seaboard States, from New Jersey to Florida, inclusive.

In considering this fauna as a unit, its most striking feature is the great number and variety of the genera represented as compared with the species, there being twenty-eight of the former to thirty-five of the latter. This proportion of genera to species is quite unusual, the number of species in any given fauna more often being far in excess of the genera. As an instance, we may cite the present fauna of Bermuda, with its twenty-eight species to only ten genera, or the results reported by the *Challenger*, which during its entire cruise obtained only sixty-nine genera of reef corals to two hundred and ninety-three species, and many of these presenting considerable variation. We find, further, in taking account of the Neocene corals, that the colonial far outnumbers the individual type.

In examining the bathymetric distribution of the species, it is doubt-

[1] Trans. Wagner Free Inst. Sci., I, p. 62.

ful whether any truly deep-sea forms are represented. The few genera that might be so classed are also frequently found living in shallow depths. When we add to the above the fact that they occur in the deposits side by side with true reef builders, we may consider that the corals living in the Oligocene and Pliocene periods flourished as shallow-water forms with preponderating reef-building tendencies.

Both from their kind and the relations which the coral genera and species of a particular area bear to one another, it is possible to judge of the similarity or of the variation of the physical conditions prevailing in the region.

Regarding this hypothesis, Prof. P. M. Duncan,[1] in his first article on the West Indian fossil corals, says:

> The range, in strata, of the genera of corals is often so great, and the species of remote formations are so frequently closely allied; that the *Zoantharia* form better guides for estimating the external physical circumstances of the regions in which they existed than for determining the age of the strata. There are few subjects better understood than the relation between the presence of certain genera and species of coral and certain definite, external physical conditions. Depth of sea, purity of sea water, its intense aeration, force of wave, absence of fresh water, the climate and nature of the coast line, with all their possible varieties, appear to determine, according to their mutual reactions, the presence and persistence of species and genera. Indeed, very slight variations from the general rule of the external circumstances in a coral sea would appear to prevent the development of certain genera. It is a reasonable induction that, if a species be found in strata of any age and distant in space, the two sets of strata were formed under the same external physical circumstances.

If this be true, then the conditions prevailing upon the Atlantic coast during Neocene time were most varied, both from a geological and a geographical standpoint; for we find that in the fauna under discussion the genera of the corals are quite varied, and that the individual species are very limited, both vertically and horizontally, in their stratigraphic distribution. In this distribution the Pliocene species are perhaps more liable to be limited in their geographical range than in their geological, since a number of the forms are either found as recent or having closely related living allies, whereas the Miocene species appear to be about equally confined both from a geographical and a geological aspect.

A majority of the corals represented belong to extinct species. A few are now found living in the Caribbean Sea, and some belong to closely allied fossil forms from Santo Domingo and other West Indian islands.

We should expect that the Neocene corals of the United States would have close kinship with those of like age in the West Indies, but such does not seem to be generally the case. On the other hand, according to Professor Duncan the fossil Oligocene corals of the West Indies are closely related to those of the Miocene of Europe and the recent faunas of the Pacific and Indian oceans. Regarding the affinities of the Neo-

[1] Quart. Jour Geol. Soc., XIX, p. 453.

cene fauna of the United States as a whole, we come to the conclusion that it has more of a likeness to that at present living in the Caribbean Sea and Atlantic Ocean than to the fauna, recent or fossil, of any other region.

The descriptions of families and genera will not be repeated in the present work, as they are to be found in the paper of Prof. P. Martin Duncan on "A Revision of the Families and Genera of the Sclerodermic Zoantharia, Edwards and Haime, or Madreporaria (*M. rugosa* excepted)," which also contains the system of classification employed in the present memoir.

The author wishes to express his thanks, through Mr. William H. Dall and Mr. Joseph Willcox, to the Wagner Free Institute of Science for the loan of many of the specimens herein described; also to Mr. T. Wayland Vaughan for much kindly assistance and advice. Mr. Vaughan has looked over the paper after it was written and has attended to having the figures drawn.

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Class ANTHOZOA.

Suborder ZOANTHARIA SCLERODERMATA (or MADREPORARIA).

Section MADREPORARIA APOROSA.

Family TURBINOLIDÆ (part) Edwards and Haime.

Genus DESMOPHYLLUM Ehrenberg.

DESMOPHYLLUM WILLCOXI Gane.

(Plate XV, figs. 1-3.)

1895. *Desmophyllum willcoxi* GANE, Johns Hopkins Univ. Circ., XV, No. 12, October, 1895, p. 9.

Corallum quite variable in shape, more or less compressed, conical, attached at base by a moderately long pedicle, which may be either broad or narrow. Surface of the wall and costal ridges smooth, at times showing the development of an epitheca. Costæ well developed, corresponding to all septa, more prominent near the calicular margin, margins not acute, some granulations over the surface. The summits of the calice in the shorter diameter are higher than in the longer. The margin of the calice is irregularly dentate. The interior of the wall coarsely pitted here and there between the septa. There are six systems of septa with four well-developed cycles, and a fifth rudimentary. The septa are exsert, rather stout, thicker near the wall and in the vicinity of the base of the calicular fossa; they are generally straight but often curved, with granulated sides, and the surface often shows quite distinct striations. In well-preserved specimens the fossa is deep and narrow, and the free margins of the septa at the base of the fossa often form by means of small rod-like projections a sort of columella as in Flabellum.

Such a pseudocolumella similar to that found in the present species is described by Mr. H. N. Mosely [1] in his report on the "Deep Sea Madreporaria" as occurring in the *Desmophyllum ingens* from the fjords of western Patagonia.

This species is respectfully dedicated to Mr. Joseph Willcox, of Philadelphia.

Dimensions.—The dimensions of the largest specimen are: Height, 28 mm.; greatest length and least width of calice, respectively, 32 and 25 mm. The calices of the majority of the specimens are, however, more compressed than in this one.

Geological horizon.—Upper Oligocene.

Locality.—Ballast Point, Tampa Bay, Florida.

Collections.—Wagner Free Institute of Science, and in the private cabinet of Mr. Joseph Willcox, of Philadelphia.

[1] *Challenger* Expedition, Zoology, II, Pt. 7. Report on certain Hydroid, Alcyonarian, and Madreporarian corals procured during the voyage of H. M. S. *Challenger*, in the years 1873-1876, p. 161.

Genus PARACYATHUS Edwards and Haime.

PARACYATHUS VAUGHANI Gane.

(Plate XV, figs. 4–6.)

1895. *Paracyathus vaughani* GANE, Johns Hopkins Univ. Circ., XV, No. 121, October, 1895, p. 9.

Corallum small, broad and low, with the calice about the same diameter as the base, above which the wall is somewhat constricted. Wall thin, costulate to its base. Costæ low, unequal, finely granular, more prominent near the calicular margin where they are considerably thicker than their corresponding septa. Calice circular in the young, slightly oval in the adult individual; fossa broad, moderately deep. Septa in six systems of five cycles lacking part of the sixth order of the last cycle; in forms of medium size, only four cycles are present. Primaries and secondaries subequal, thick and stout, with summits more broadly rounded and more strongly exsert than those of the remaining thin and slender septa; sides coarsely granulated, edges of the higher cycles regularly crenately dentate. Pali granular, present before all the septa but those of the last cycle, excepting in the most mature forms, where they may be lacking before a part of the fourth as well as before all of the fifth cycle of septa. Columella papillose, well developed.

In polishing down the base of the coral, the rings marking the existence of previous outer walls are clearly seen. In one specimen no less than eight appear, showing the growth of the coral and its relation to the development of its septa.

The individuals of this form generally occur alone attached to some shell, but occasionally they are found in clusters, being in close contact with one another at their sides or the outer edge of their bases.

Dimensions.—Height of largest specimen, 4 mm.; breadth of calice, 11 mm.

Geological horizon—Miocene, Chesapeake formation.

Locality.—Carters Landing, James River, and Yorktown, Virginia.

Collections.—U. S. National Museum (type); Wagner Free Institute of Science; Johns Hopkins University.

Family OCULINIDÆ (part) Edwards and Haime.

Genus ASTROHELIA Edwards and Haime.

ASTROHELIA PALMATA (Goldfuss).

1826–1833. *Madrepora palmata* GOLDFUSS, Petrefacta Germaniæ, Pt. 1, p. 23, pl. XXX, figs. 6, *a*, *b*.

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