XXV.—THE CRUSTACEA OF THE FRESH WATERS OF THE UNITED STATES.

By Sidney I. Smith.

A—SYNOPSIS OF THE HIGHER FRESH-WATER CRUSTACEA OF THE NORTHERN UNITED STATES.

The following synopsis is intended to include all the species of decapod and tetradecapod *Crustacea* known to inhabit the fresh waters of the Northern United States east of the Mississippi River. It has been limited to this particular region, because there has been at hand no material of any importance from other parts of the country, and because very few species have been described from localities outside of the region included. I should, perhaps, except from this statement the numerous species of *Astacidæ*, but these have been so recently monographed by Professor Hagen that it seems needless to repeat an account of them here. The fresh-water *Crustacea* are of great economic importance as food for very many, if not all, our fresh-water food-fishes; and on this account, as well as for purely scientific reasons, I hope this imperfect synopsis will be of service to all those interested in the subject, and trust it will hasten the preparation of a more complete work, including all the species of the United States.

I am indebted to Mr. Oscar Harger for the descriptions of the species of *Asellus* and *Asellopsis*.

MACRURA.

Family Astacidæ.

The following list of the species of this family I have compiled largely from Dr. Hagen's most valuable work,* to which the reader is referred for the full account of the species. The crawfishes of all the eastern part of the United States belong to the genus *Cambarus*, but the species appear to be quite numerous, and are difficult to distinguish without careful study.

Cambarus acutus Girard.

Proceedings Academy Nat. Sci. Philadelphia, vol. vi, p. 91, 1853; Hagen, op. cit., p. 35, pl. 1, figs. 1–5; pl. 2, figs. 106–127; pl. 3, figs. 143, 144.

This species, one of the largest of our crawfishes, has an extensive

* Illustrated Catalogue Museum Comp. Zool., No. 3; Monograph of the North American Astacidæ, 1870.

range, being found from New York State south to Louisiana, and northwest to Indiana and Illinois.

According to Dr. Abbott,* this species frequents running streams which have masses of vegetation growing in them; the animal resting upon the plants, usually near the surface of the water.

CAMBARUS AFFINIS Erichson.

Astacus affinis Say, Journal Academy Nat. Sci. Philadelphia, vol. i, p. 168, 1817.
Cambarus affinis Erichson, Archiv für Naturgeschichte, xii, 1846, p. 96; Hagen, op. cit., p. 60, pl. 1, figs. 19-22, 84, 85; pl. 3, fig. 152; pl. 5.

Dr. Hagen knew this species only from the Middle States and Maryland. According to Dr. Abbott, in the paper previously referred to, this is *the* river-species in the vicinity of Philadelphia. He says, "We have been able to find it, as yet, only in the Delaware River, usually frequenting the rocky bed, but also in fewer numbers on the mud-bottomed portions of the river. They are usually found resting under flat stones, well out from the banks of the stream, where the water is of considerable depth. Wherever the vegetation is dense, we have failed to find them; nor have we seen anything to indicate that it is a burrowing species."

CAMBARUS VIRILIS Hagen.

Op. cit., p. 63, pl. 1, figs. 23-28; pl. 2, figs. 128-132; pl. 3, fig. 155; pl. 8.

Canada West; Lake Winnipeg; Saskatchewan and Red River of the North; Ohio; Illinois; Iowa; Lake Superior; Missouri; Texas.

CAMBARUS PLACIDUS Hagen.

Op. cit., p. 65, pl. 1, figs. 76-79; pl. 3, fig. 158.

Illinois; Tennessee; Texas.

CAMBARUS JUVENILIS Hagen.

Op. cit., p. 66, pl. 1, figs. 29-33; pl. 3, fig. 157.

Kentucky River; Osage River, Missouri.

CAMBARUS PROPINQUUS Girard.

Loc. cit., p. 88; Hagen, op. cit., p. 67, pl. 1, figs. 34-38; pl. 3, fig. 158.

I have examined specimens of this species from as far east as Montreal, and Dr. Hagen records it from Northern New York to Lake Superior. It dwells in Cayuga Lake, New York; and Professor Verrill has found it in a lake at Madison, Wis.

It was found in abundance in the stomach of *Menobranchus lateralis*, at Ecorse, Mich., by Mr. J. W. Milner.

A crawfish, found in the valley of the Saint John's and Aroostook Rivers in Maine and New Brunswick, is most likely this species; but I have never had specimens for examination.

*American Naturalist, vol. vii, p. 80, February, 1873.

CAMBARUS OBSCURUS Hagen.

Op. cit., p. 69, pl. 1, figs. 72–75; pl. 3, fig. 154.

Genesee River, New York.

CAMBARUS RUSTICUS Girard.

Loc. cit., p. 88; Hagen, op. cit., p. 71, pl. 1, figs. 80–83; pl. 3, fig. 161.

Ohio; Lake Superior.

CAMBARUS IMMUNIS Hagen.

Op. cit., p. 71, pl. 1, figs. 101, 102; pl. 3, fig. 160; pl. 8.

North Carolina; Alabama; Illinois.

CAMBARUS BARTONII Erichson.

Astacus Bartonii Fabricius, Supplementum Entomologiæ Systematicæ, p. 407, 1798; Say, loc. cit., p. 167.

Cambarus Bartonii Erichson, loc. cit., p. 97; Hagen, op. cit., p. 75, pl. 1, figs. 47–50; pl. 2, figs. 135–139; pl. 3, fig. 166.

Cambarus montanus, Diogenes, pusillus, and *longulus* (?) Girard, loc. cit., pp. 88, 90.

This seems to be the commonest species in the Northern States. It is found in Vermont and Massachusetts, in the tributaries of Lake Champlain and Hudson River, and extends west to Lake Superior and south to New Jersey, Maryland, and Kentucky.

Professor Verrill has collected it under stones in cold brooks in Northern New York, and in McKean County, Pennsylvania; but, according to Dr. Abbott, it is, in the vicinity of Trenton, N. J., a burrowing species. He says, "The burrows, so far as we have observed them, have all been in the banks of the smaller streams and meadow-ditches, (and occasionally a colony of burrows in the river-bank, where peculiarly favorable,) a little below the usual water-line." It occurs in Mammoth Cave with *C. pellucidus.*

CAMBARUS ROBUSTUS Girard.

Loc. cit., p. 90; Hagen, op. cit., p. 80, pl. 3, fig. 156.

Western New York.

CAMBARUS OBESUS Hagen.

Op. cit., p. 81, pl. 1, figs. 39–42; pl. 3, fig. 163; pl. 9.

Virginia; Illinois; Lake Michigan; Arkansas; New Orleans.

CAMBARUS PELLUCIDUS Erichson.

Astacus pellucidus Tellkampf, Müller's Archiv, 1844, p. 383, (*teste* authors.)

Cambarus pellucidus Erichson, loc. cit., p. 95; Hagen, op. cit., p. 55, pl. 1, figs. 68–71; pl. 3, fig. 148; pl. 6; Packard, American Naturalist, vol. v, p. 50, fig. 131, 1871; Hagen, American Naturalist, vol. vi, p. 494, 1872; Packard, Fifth Annual Report Peabody Academy of Science, Salem, p. 94, 1873.

Orconectes pellucidus and *inermis* Cope, American Naturalist, vol. vi, p. 419, fig. 116, 1872; Third and Fourth Annual Reports of the Geological Survey of Indiana, p. 173, 1872.

This is the blind species of Mammoth Cave, Kentucky, and Wyandotte Cave, Indiana. It is a fact worthy of notice that *C. Bartonii* occurs in Mammoth Cave with well-developed eyes.

Family PALÆMONIDÆ.

PALÆMON OHIONIS, *sp. nov.*

Carapax smooth, stout, and considerably swollen; the antennal and hepatic spines acute and of nearly equal size. Rostrum short, reaching scarcely to the tips of the antennal scales; its height in the middle about a third of the length, with a very high and arched lamellar crest above, not extending back of the middle of the carapax, and armed with ten to twelve slender teeth, of which the two or three posterior are back of the bases of the ocular peduncles, and more separated from each other than the anterior ones; inferior edge arcuate and armed with two or three teeth; the terminal third or fourth unarmed and directed slightly upward to the acute tip. Antennal scale about two-fifths as broad as long; the edges nearly parallel; the tip broad, subtruncate.

First pair of legs smooth and slender, the carpus, in large specimens, reaching beyond the tips of the antennal scales; merus and carpus subequal in length; hand very slender, about half as long as the carpus; fingers not quite half as long as the whole hand, cylindrical, armed with a few fascicles of setæ. Second pair of legs slender, either equal or somewhat unequal on the two sides; the ischium, merus, and carpus subequal in length; the carpus, in full-grown specimens, reaching much beyond the tips of the antennal scales, cylindrical, tapering proximally, and armed with scattering spinules, or short hairs; hand considerably longer than the carpus, slender; the basal portion of the propodus slightly swollen, nearly cylindrical, and armed with minute spinules; the fingers much shorter than the basal portion of the propodus, slender, not gaping, nearly straight, and armed with a few fascicles of short setiform hairs. Succeeding legs increasing slightly in length posteriorly; all of them with short, strongly-curved dactyli, and reaching slightly beyond the tips of the antennal scales.

Fourth and fifth segments of the abdomen produced at the posterior lateral angle, which is rounded in the fourth segment and acutely angular in the fifth. Sixth segment only a little longer than the fifth. Telson narrow, considerably shorter than the inner lamellæ of the appendages of the sixth segment, tapering regularly to the acutely triangular tip, which is armed each side with two slender spines and numerous long plumose setæ; the dorsal surface armed with two pairs of short spines.

Two specimens give the following measurements:

	Male.	Female.
	mm.	*mm.*
Length from tip of rostrum to extremity of telson	51.0	80.0
Length of carapax from orbit to middle of posterior margin	12.0	22.0
Breadth of carapax	7.8	14.0
Length of rostrum from its tip to base of ocular peduncles	8.2	13.5
Length of basal scale of antenna	8.4	32.0
Length of first pair of legs	16.0	8.3
Length of merus in first pair of legs	4.2	10.0

	mm.	mm.
Length of carpus in first pair of legs	4.5	4.7
Length of hand in first pair of legs	2.6	52.0-45.6
Length of second pair of legs	22.0	10.5- 9.6
Length of merus in second pair of legs	5.0	11.0- 9.8
Length of carpus in second pair of legs	4.2	16.4-13.6
Length of hand in second pair of legs	6.0	6.6- 6.1
Length of dactylus in second pair of legs	3.2	10.5- 9.6

The only specimens which I have seen were obtained by Prof. F. H. Bradley from the Ohio River at Cannelton, Ind., where he tells me it is taken for food.

PALÆMONETES EXILIPES Stimpson. (Plate I, fig. 1.)

Annals Lyceum Nat. Hist. New York, vol. x, p. 130, 1871.

Carapax smooth and the spines of the anterior border slender and acute. Rostrum nearly straight, scarcely reaching the tips of the antennal scales, and as long as the carapax from the bases of the ocular peduncles to the middle of the posterior margin; the dorsal crest slightly raised a little behind the bases of the ocular peduncles, and serrated with seven or eight equidistant, slender, and acute teeth, of which the second is directly above or slightly in front of the bases of the ocular peduncles; the tip unarmed, slender, and acute; the inferior edge armed with one or two teeth. Outer flagellum of the antennula much longer than the inner, and its secondary branch, which does not reach the middle of the flagellum, having only the terminal third free. Antennal scale broadest distally and evenly rounded at the tip.

First pair of legs slender, just reaching to the tips of the antennal scales; carpus a little longer than the merus, slightly thickened distally; hand nearly naked, scarcely thicker than the carpus and only half as long; fingers as long as the basal portion of the propodus. Second pair of legs slender; carpus nearly twice as long as the merus, slightly thickened distally; hand slightly thicker than the carpus, and nearly two-thirds as long; fingers slender, nearly naked, and a little shorter than the basal portion of the propodus; third, fourth, and fifth pairs of legs increasing successively in length, the fifth pair reaching to the tip of the rostrum.

Sixth segment of the abdomen slender, a little longer than the fourth and fifth together. Telson tapering regularly to the extremity, which is quite broad, but terminates in a slender and acute tip, each side of which there is a long and stout spine, and at each lateral angle a shorter one, while between the inner spines there are two long plumose setæ, arising from the under side and reaching beyond the tips of the long spines; each lateral margin armed with two short spines, one near the extremity, and another about three-fourths of the way from the base to the tip.

Two specimens, the first from Sandusky Bay, the second from Ecorse, Mich., give the following measurements:

	mm.	mm.
Length from tip of rostrum to tip of telson	30.0	32.0
Length of carapax from orbit to middle of posterior border	5.8	6.5

	mm.	mm.
Breadth of carapax	4.0	4.2
Length of rostrum from tip to base of ocular peduncle	5.8	6.4
Length of basal scale of antenna	5.4	5.6

I have seen only half a dozen specimens, which agree very closely with each other. All but one of them have seven teeth on the upper edge of the rostrum and two below, while this one has eight above and one below.

Collected by Mr. J. W. Milner at Ecorse, Mich., and in a grassy arm of Sandusky Bay, Lake Erie, known as the "Black Channel."

As Stimpson's specimens were from Somerville, S. C., and his description differed considerably from the Lake Erie specimens, I supposed, at the time the above description was written, that the northern specimens represented a distinct species. Since the manuscript was in the hands of the printer, however, I have received a large series of specimens collected by Dr. Edward Palmer in fresh-water streams in Florida, which evidently belong to Stimpson's species, and at the same time show that the Lake Erie specimens are undoubtedly of the same species. Most of the Florida specimens, like those from Lake Erie, differ from Stimpson's description in having the rostrum not longer than the antennal scales, but in a few of them it is very slightly longer, so that they agree well with the description.

Family PENÆIDÆ.

PENÆUS BRASILIENSIS Latreille.

Noûveau Dictionnaire d'Histoire Naturelle, vol. xxv, p. 154, (*teste* Edwards;) Edwards, Hist. Nat. des Crustacés, vol. ii, p. 414; Gibbes, On the Carcinological Collections of the United States, Proceedings American Association, 3d meeting, p. 170, 1850; Stimpson, Annals Lyceum Nat. Hist. New York, vol. x, p. 132, 1871; von Martens, Ueber Cubanische Crustaceen, Archiv für Naturgeschichte, 1872, vol. xxxviii, p. 140.

This is perhaps more properly a marine than a fresh-water species; but as it ascends fresh-water streams for long distances, it should be included in the present list. Dr. Stimpson says, "It was found in the Croton River at Sing Sing, N. Y., by Professor Baird, and by myself in a fresh-water creek near Somers' Point, N. J." It is common on the coast of the Southern States, and extends south to Brazil.

SCHIZOPODA.

Family MYSIDÆ.

MYSIS RELICTA Lovén. (Plate I, fig. 2.)

Om några i Vettern och Venern fauna Crustaceer, Öfversight af Vetenskaps Akademiens Förhandlingar, Stockholm, xviii, 1861, p. 285; Smith, American Journal of Science, 3d series, vol. ii, pp. 374, 452, 1871; and Preliminary Report on Dredging in Lake Superior, in Report of Secretary of War, vol. ii, Report of Chief of Engineers, p. 1022, 1871.

Mysis oculata, var. *relicta*, G. O. Sars, Histoire Naturelle des Crustacés d'Eau Douce de Norvège, 1e livraison, p. 14, plates 1–3, 1867.

Mysis diluvianus Stimpson, MSS.; Hoy, Transactions Wisconsin Academy, vol. i, p. 100, 1872, (no description.)

In this country, this species was first found in the stomachs of the white-fish. Subsequently, it was dredged in Lake Michigan by Drs. Hoy and Stimpson, in 40 to 50 fathoms, off Racine. In Lake Superior, I found it in a large number of the dredgings. It was brought up with sand and mud from 12 to 14 fathoms among the Slate Islands; from 4 to 6 fathoms in the cove at the eastern end of Saint Ignace; from 8 and 13 fathoms, with *Cladophora*, &c., on the south side of the same island; and in many of the hauls from 72 to 148 fathoms. Mr. Milner also dredged it, in 1872, in 60 fathoms, off Outer Island. It apparently furnishes a large part of the food of the white-fish in many parts of the lakes. Nine-tenths of the contents of the stomachs of white-fish taken at Outer Island were made up of *Mysis*.

I have carefully compared American with European specimens, and with the beautiful figures given by Dr. G. O. Sars, in his elaborate work on the Fresh-Water Crustacea of Norway, and am still unable to detect any characters by which to distinguish them. The form and ornamentation of the appendages seem to be exactly the same throughout, and the habits appear to be the same in the Scandinavian lakes and in Lake Superior. This species is also very closely allied to *Mysis oculata* Kroyer, a marine species found on the coasts of Labrador and Greenland. Lovén points out this close affinity, and regards it, together with the occurrence with it in the Scandinavian lakes of *Gammaracanthus loricatus* Bate, *Pontiporeia affinis* Lindström, and *Idotea entomon* Fabricius, all of which he regarded as specifically identical with previously-known marine forms, as evidence that the lakes where it is found were formerly filled with salt-water; that they had been cut off from the sea by the elevation of the Scandinavian peninsula; and that the differences between these species of the lakes and their allies of the neighboring ocean have been brought about by gradual changes in the habitats of the lake-species. Dr. Sars adopts Lovén's view as to the origin of these species in the Scandinavian lakes; regards the fresh-water *Mysis* as only a variety of the marine form; and considers, with good reason, the *Gammaracanthus* as a distinct variety of the marine species. He also points out the interesting fact that the slight differences (principally in the form of the telson) which distinguish the fresh-water from the marine form of the *Mysis* are exactly such as distinguish immature from adult individuals of the marine form, and are such differences as might have been brought about by a slight retardation of development, caused by the gradual change from a marine to a less congenial fresh-water habitat. Dr. Sars gives the Gulf of Bothnia as a habitat of the fresh-water variety, so that it is apparently not wholly confined to the fresh waters, but, like the *Pontoporeia affinis*, lives also in the somewhat brackish waters of the Baltic.

The occurrence, in Lake Michigan and Lake Superior, so far removed from the sea, of this *Mysis*, and other forms so nearly identical with marine species, is a fact of peculiar interest, which goes far toward

proving the marine origin of a part of the fauna of our great lakes. Dr. Stimpson,* in his first notice of his dredging in Lake Michigan, while regarding the *Mysis* as a new species, recognized its close affinity with "certain arctic forms," and supposes the same changes to have taken place in Lake Michigan as in the Scandinavian lakes. He says, "*Mysis* is a marine genus, many species of which occur in the colder parts of the North-Atlantic seas. One species, *M. relicta*, was found by Lovén in company with *Idothea entomon* and other marine *Crustacea* in the deep fresh-water lakes Wener and Wetter of Sweden, indicating that these basins were formerly filled with salt-water, and have been isolated from the sea by the elevatory movement of the Scandinavian peninsula, which is still going on. That the same thing has occurred in our own lakes is shown by the occurrence in their depths of the genus *Mysis*, notwithstanding the non-occurrence of marine shells in the Quaternary deposits on their shores. Kingston, on Lake Ontario, is, I believe, the highest point in the valley in which such shells have been found. Very probably, at the time when the sea had access to these basins, the communication was somewhat narrow and deep, and the influx of fresh water from the surrounding country was sufficient to occupy entirely the upper stratum, while the heavier sea-water remained at the bottom. After the basin had become separated from the ocean by the rise of the land, the bottom water must have become fresh by diffusion very slowly to allow of the gradual adaptation of the crustaceans to the change of element." In the entire absence of geological evidence of any oceanic connection with Lake Superior in recent geological times, the occurrence, in its otherwise strictly lacustrine fauna, of a very few forms of life showing close affinity with marine species, seems scarcely to warrant so positive an assumption of such a connection. At the time Lake Ontario was a part of the great Saint Lawrence Valley sea, there was, very likely, no insuperable barrier in the Niagara River to the upward migration of active swimming animals like *Mysis*, and some of the inhabitants of the upper lakes may have reached their present homes by this route, during the northward movement of the fauna, at the close of the Quaternary epoch. On the other hand, *Mysis relicta*, although originally derived from the strictly marine species *M. oculata*, may have existed long enough to have had the same history as some of the strictly fresh-water species, known to be common to Northern America and Northern Europe, since it has much the same geographical distribution. The investigation of the fauna of the lower lakes and Lake Champlain, and possibly of Lake Winnipeg, will throw much light upon these interesting questions, and it seems best to reserve any lengthy discussion of them until such investigations have been made.

Whether we should regard the fresh-water form of *Mysis* as a variety of *M. oculata* or as a distinct species, seems a matter of little import-

*On the Deep-Water Fauna of Lake Michigan, American Naturalist, vol. iv, p. 403, September, 1870.

ance, as long as we recognize the characters which distinguish them; but, as we know no truly intermediate forms, it is perhaps best for the present to regard it as a species.

In regard to the distribution and habits of this species in Europe, I translate the following remarks from Dr. Sars's great work. He says, "I have found it in Norway only in Lake Mjösen, the largest of our lakes. There, however, it is found in very great quantities, from shallow water (3 to 6 fathoms) to very great depths, (200 fathoms.) In Sweden, it seems to be much more widely diffused. Besides the two largest lakes of that country, Wener and Wetter, where it was first discovered, it has since been found in eight other Swedish lakes as well as in the Gulf of Bothnia. It has also recently been found by M. Malmgren in Lake Ladoga, the largest lake in Europe, as well as in many of the lakes of Finland. In habits, it seems to resemble the marine species. Like them, it generally lives collected together in great masses or in bands. It seems to prefer places where the bottom presents quite rapid inclinations; in such places, it is frequently found in great bands, swimming along the borders of these acclivities in the calm and elegant manner peculiar to the species of *Mysis*, making a digression only here and there to avoid some object which it fears. Its principal food seems to be composed of *Entomostraca*, with which these waters swarm. In the stomach of an individual, which I examined for the purpose, I discovered the remains of two or three species of *Cyclops*, a *Canthocamptus*, a *Bosmina*, a *Daphnia*, and a *Cypris*."

AMPHIPODA.

Family ORCHESTIDÆ.

HYALELLA, *gen. nov.*

First pair of maxillæ with rudimentary, very short, and uniarticulate palpi. Palpus of the maxillipeds composed of five segments; the terminal segment being slender and styliform, and the penultimate broad. Antennulæ, antennæ, and thoracic legs much as in *Hyale*. Telson short, stout, and entire.

This genus seems to be closely allied to *Hyale*, but differs from it and from the rest of the *Orchestidæ* in the palpus of maxillipeds, which has five instead of four segments, showing in this respect a remarkable approach toward the gammaroid group of *Amphipoda*. From *Hyale*, it differs also in the telson.

HYALELLA DENTATA, *sp. nov.* (Plate II, fig. 8, male, lateral view; fig. 9, female, lateral view; fig. 10, details.)

Body slightly compressed. First and second segments of the abdomen with the dorsal margin produced posteriorly into a well-marked spiniform tooth. Eyes nearly round, about equal in diameter to the thickness of the proximal segment of the peduncle of the antennula.

Peduncle of the antennula about as long as the head; the flagellum a little longer than the peduncle, and composed of seven to nine segments. Antennæ somewhat longer than the antennulæ; the two distal segments of the peduncle elongated and nearly equal; the flagellum usually but little longer than the flagellum of the antennula, and composed, usually, of eight to ten segments.

First pair of legs with the merus somewhat quadrate in outline; the ischium and carpus articulated on the two anterior margins, and reaching by, so as to touch each other; the postero-inferior angle being rounded and furnished with an area armed with numerous minute denticles, just below which there are a few slender setæ; the carpus much longer than broad, as long as the width of the first epimeron, somewhat triangular, and furnished with a line of setæ on each side near the distal extremity; the propodus slightly shorter than the carpus, a little less than half as broad as long; the lateral margins strongly curved, and armed with minute spinules; palmary margin transverse, nearly straight, and armed with a small tooth at the posterior angle; the dactylus very strongly curved, and its tip closing behind the posterior angle. Second pair of legs in the male greatly developed; the merus nearly quadrilateral, considerably longer than broad; the postero-inferior angle slightly rounded and armed somewhat as in the first pair; the carpus not longer than broad, with the posterior margin projecting into a process nearly as long as the merus and extending along the posterior margin of the propodus; the propodus very stout, about as long as the depth of the second epimeron; the breadth greatest distally, and a little less than the length; palmary margin slightly oblique, armed with a submarginal line of setæ; the middle portion a little arcuate, with an abrupt notch near the middle, and two slight emarginations near the postero-inferior angle; the dactylus stout, curved, and with the tip closing behind the angle of the propodus. In the female, the second pair of legs are slender and weak, and the carpus and hand are elongated and narrow; the propodus not broader than the merus, more than twice as long as broad; the postero-inferior angle produced distally, so that the nearly straight prehensile portion of the palmary margin forms less than a right angle with the posterior margin; the dactylus slightly curved and fitting closely the palmary margin; seventh pair of legs only slightly longer than the sixth, and with the basis broad, and its posterior margin serrate.

The infero-posterior angles of the three first segments of the abdomen a little less than right-angled, but only slightly produced. First pair of caudal stylets considerably longer than the second. Third pair short; the basal segments not reaching beyond the basal segments of the second pair, nearly as broad as long, and armed on the outside at the distal extremity with three or four stout spines; the terminal segment nearly as long as the basal, slender, tapering, and furnished

with a few slender setæ at tip. Telson stout, as long as broad; the posterior margin rounded and furnished each side with a slender seta.

Length from front of head to tip of telson, 4^{mm}.5 to 6^{mm}.5.]

Abundant in pools of stagnant water, New Haven, Conn. Also collected at Madison, Wis., by Professor Verrill; Madeline Island, Lake Superior, by Mr. J. W. Milner; at The Dalles, Oregon, by Mr. Oscar Harger; and in Lake Raymond and Birdwood Creek, Nebraska, by Messrs. Oscar Harger and T. M. Prudden, of the Yale College expedition of 1873; in the West Fork of the Des Moines River, Humboldt, Iowa, and at Salem, Mass., by Mr. Caleb Cooke; at Grand Rapids, Mich., and Bangor, Me., by Mr. N. Coleman; and at Norway, Me., by myself.

Since the above was in the hands of the printer, I have received numerous specimens of this species, collected at Lake Okeechobee, Florida, by Dr. Edward Palmer. In some of these specimens, the dorsal teeth upon the first and second segments of the abdomen are very small; and, in a very few specimens, they are wholly, or almost wholly, wanting.

The *Amphithoë azteeus* Saussure, (Mémoire sur divers Crustacés nouveaux du Mexique et des Antilles, p. 58, pl. 5, fig. 33, 1858,) from a reservoir at Vera Cruz, Mexico, although very badly described and figured from the male alone, has evidently no affinity with *Amphithoë* in any modern sense, undoubtedly belongs to this genus, and may be called *Hyalella azteca*. The discovery of the far southern range of our species renders it quite probable that it may prove to be synonymous with this species of Saussure.

Allorchestes Knickerbockeri of Bate, (Catalogue Amphipodus Crustacea British Museum, p. 36, pl. 6, fig. 1, 1862,) supposed to have come from the fresh waters of North America, belongs probably to this genus. It has the first and second segments of the abdomen armed dorsally as in our species, which it resembles considerably in several other respects, although the figures and description, indicated as made from the female only, represent the first pair of legs much like those of the second pair of the female of our species, while the second pair have very stout hands and resemble the second pair of legs of the male of our species. The palpus of the first pair of maxillæ, in Bate's species, is figured (perhaps incorrectly) as composed of two segments.

Family LYSIANASSIDÆ.

PONTOPOREIA HOYI, *sp. nov.* (Plate II, fig. 5.)

Pontoporeia affinis Smith, American Journal of Science, 3d series, vol. ii, p. 452, 1871; and Preliminary Report on Dredging in Lake Superior, p. 1022, 1871.

Gammarus Hoyi Stimpson, MSS., (full-grown male form.)

Gammarus brevistylis Stimpson, MSS., (female.)

On first examining specimens of this species, obtained in Lake Superior in 1871, I regarded them as specifically identical with the *Pontoporeia affinis* of the Scandinavian lakes and the Baltic. A subsequent

and more minute comparison has, however, revealed some differences, which are apparently constant. In the form and proportions of the segments of the thorax and abdomen, in the size and form of the eyes, in the minute details of antennulæ, antennæ, and mouth appendages, I can detect no differences by which it would be possible to distinguish specimens taken in Lake Superior from those sent from Lake Wetter, or from the beautiful figures of the Scandinavian species given by Sars.* In the first pair of legs, however, the propodus in the American species is proportionately a very little shorter than in the European, and the palmary margin is less oblique—that is, it is not so nearly parallel with the posterior margin; the posterior margin is somewhat shorter, and furnished with fewer hairs; and there are usually two small and slender spines on the palmary margin near the tip of the closed dactylus, while in the European species there are no real spines upon the palmary margin, but only slender setiform hairs. In both the European and American species, there is a very thin and narrow lamellar edge, extending nearly the whole length of the palmary margin. The dactylus is apparently a little longer and more slender in the European species. The obliquity of the palmary margin, and its armature near the posterior angle, seem to be always characteristic of the American species. In young specimens, however, there is often but one spine, while in larger ones there are often three. In the third and fourth pairs of legs of the American species, the dactylus is usually armed on the inside, a little way from the tip, with two setiform hairs, while in the European species there is only one. Some young specimens of the American species, however, agree with the European in having but one hair upon the dactylus, while large ones often have three, and in the full-grown male from Lake Michigan, mentioned farther on, there are even four.

The most remarkable differences are in the peculiar, elongated, papilliform appendages upon the sternal portion of the thoracic segments. In the European species, Dr. G. O. Sars describes and figures an elongated and slender process depending from the middle of the sternum of several of the thoracic segments; and in the single specimen which I have examined, there are three of these processes, one each on the second, third, and fourth segments. Dr. Sars, who has studied the living animals very carefully, does not suggest what may be the use of the appendages, or whether they ever vary in number or position in different specimens. In specimens from Lake Superior, there are usually seven of these appendages, one upon the second and two each upon the third, fourth, and fifth segments. In form and size, these appendages do not differ, except that in alcoholic specimens they seem to be a little longer in the American species. In some specimens of the American species, the appendage upon the second segment is wholly wanting, and in two specimens examined carefully there was only a single median

* Histoire Naturelle des Crustacés d'Eau Douce de Norvège, p. 82, pl. 7, figs. 10–25; pl. 8, figs. 1–5, 1867.

one upon the third segment. In the absence of all knowledge of the nature and use of these appendages, it seems useless to speculate on their importance as distinctive characters. In a species of *Pontoporeia* from the Gulf of Saint Lawrence, which I suppose to be the *P. affinis* of Kroyer, there are no such appendages on any of the thoracic segments. This fact, together with the variation noticed in the specimens from Lake Superior, would seem to indicate that these appendages are not of so much importance as might at first be supposed.

This species was found in great abundance in the dredgings in Lake Superior in 1871, and occurred in every haul from 4 to 160 fathoms. It was also dredged by Mr. J. W. Milner in Lake Superior in 1872, in 60 fathoms off Outer Island. It is common in the stomach of the white-fish from Lakes Superior and Michigan, and probably also from the lower lakes. All the specimens dredged in Lake Superior were taken in August and the early part of September, and none of the females were carrying eggs during that time. Females carrying eggs were dredged by Dr. Stimpson, in Lake Michigan, in 40 to 60 fathoms, off Racine, Wis., June 24, 1870, and with them the adult male form with long antennulæ and antennæ. This peculiar form of the adult male, corresponding perfectly with the same form of the European species figured and described by Dr. Sars, I have not been able to find among the numerous specimens from Lake Superior. A single specimen of this form of the male was, however, sent to me by Dr. Stimpson under the manuscript name of *Gammarus Hoyi*, while two specimens of the female were sent as *Gammarus brevistylis*. These are undoubtedly the same as the *Gammarius Hoyi* and *brevistilus* mentioned, without description, by Dr. P. R. Hoy, (*loc. cit.*)

PONTIPOREIA FILICORNIS, sp. nov.

Gammarus filicornis Stimpson, MSS.

Male.—Outline of the head very much as in *P. affinis*. Eyes about as large as in that species, slightly elongated, black. Peduncle of the antennula reaching nearly to the distal end of the penultimate segment of the peduncle of the antenna, about as long as the head and the first segment of the thorax together; first segment large and thickened; second half as long as the first; third slightly more than half as long as the second. Flagellum greatly elongated and very slender, reaching nearly to the tip of the abdomen, and composed of thirty-three segments, of which the proximal are longer than broad, while they increase in length distally, until, near the tip, they are many times longer than broad, and exceedingly slender. The upper side of the flagellum is nearly naked, only the alternate segments being furnished with two minute setæ near the distal extremity, while the under side of each segment is armed distally with minute setæ, and most of the segments with one or several clavate (olifactory) papillæ, and many of the segments have in addition a peculiar transparent, shallow, bell-shaped ap-

pendage, raised on a very slender peduncle. Secondary flagellum reaching to the fourth segment of the primary, and composed of four segments, of which the terminal one is very short. Penultimate segment of the peduncle of the antenna about as long as the first segment of the peduncle of the antennula; ultimate segment slightly shorter; penultimate and antepenultimate segments furnished with long, plumose hairs below and several fascicles of short, setiform hairs above. Flagellum much longer than the flagellum of the antennula, very slender, and composed of about fifty very elongated and somewhat flattened segments, which have about the same proportions as in the flagellum of the antennula, and are furnished with the same kinds of appendages.

Epimera of almost exactly the same proportions and form as in *P. affinis*, and the first four margined with plumose hairs in the same way. First pair of legs very nearly like those of *P. affinis;* the palmary margin even slightly more longitudinal than in that species, continuous with the posterior margin, and armed with two small obtuse spines near the tip of the closed dactylus in addition to the setiform hairs. Second pair of legs of the same form as in *P. affinis*, except that the palmary margin is slightly concave and a little oblique in a proximal direction; the posterior margin furnished with fascicles of setiform hairs, as in that species, and armed close to the palmary margin with three or four small obtuse spines. Third and fourth pairs of legs like those of *P. affinis*, except that the dactyli have each three setiform hairs near the tip, being in this as in several other respects nearer *P. Hoyi*. Fifth and sixth pairs of legs almost exactly as in *P. affinis*, except the posterior margin of the propodus in the sixth pair is armed with three pairs of small spines. Seventh pair of legs having a few small spines on the propodus, but otherwise as in *P. affinis*.

Lateral margins of the first, second, and third segments of the abdomen with the angles rounded; lateral margin of the third segment furnished with a line of several submarginal, plumose setæ near the anterior angle, and behind them armed with five large and acute spines directed backward, of which four are in pairs near the middle of the margin, and one alone near the posterior angle; the posterior edges of the lateral expansions of all three of the segments furnished with a few, widely separated, plumose hairs. Peduncles of the first and second pairs of caudal stylets reaching to about the same point, a little beyond the extremity of the sixth segment of the abdomen; the outer rami slightly longer than the inner, and those of the second pair of stylets only a little shorter than those of the first. Rami of the posterior caudal stylets longer than in *P. affinis;* the outer ramus rather more than twice as long as the peduncle, narrow, and tapering to an obtuse tip, both edges furnished with long plumose hairs, and the outer edge with a sharp spine at the base of each hair. Telson slightly longer than broad, cleft half-way to the base, and each lobe tipped with two short spinules and a plumose seta. There are two of the peculiar papilliform

appendages on the sternum of the third, fourth, and fifth segments of the thorax, as in *P. Hoyi*, but apparently none upon the second.

Length from the front of the head to the tip of the telson, 6 mm.

Of this species, I have seen but a single specimen, which was dredged with the last species in Lake Michigan, in 40 to 60 fathoms, off Racine, by Dr. Stimpson, from whom it was received under the manuscript name of *Gammarus filicornis*.

This species differs remarkably from all the heretofore-known species of *Pontoporeinæ*, in the excessive elongation of the flagella of the antennulæ and antennæ, a character which might be regarded by some naturalists as of generic value. The very close agreement with *P. affinis* and *Hoyi* in all other parts of the animal, however, seems to indicate a very close affinity with those species, especially the latter; and as this one peculiarity is very likely only a sexual character of the old males of the species, I retain the species in the genus. The mouth-appendages seem to agree perfectly with those of the species just mentioned. The singular armature of the lateral margins of the third segment of the abdomen is not peculiar to this species, but is almost exactly repeated in *P. affinis*, *P. Hoyi*, and the marine species, already mentioned, from the Gulf of Saint Lawrence, and is probably common to the genus, although it seems to have been overlooked till now.

Family GAMMARIDÆ.

GAMMARUS LIMNÆUS Smith. (Plate II, fig. 6, lateral view; fig. 7, dorsal view.)

Gammarus lacustris Smith, American Journal of Science, 3d series, vol. ii, p. 453, 1871; and Preliminary Report on Dredging in Lake Superior, p. 1023, 1871.

Eyes small, slightly elongated. Antennulæ about as long as the thorax; first segment of the peduncle about as long as the second and third together; flagellum about twice as long as the peduncle, composed of about twenty-five elongated segments, furnished with few and minute setæ, or hairs; secondary flagellum short, scarcely, if at all, longer than the terminal segment of the peduncle, composed of two to four segments, of which the terminal one is very short. Antennæ as long as, or a little shorter than, the antennulæ; ultimate and penultimate segments of the peduncle nearly equal in length, naked above, and furnished with a few short hairs, or setæ, arranged in three or four small fascicles; flagellum considerably shorter, to nearly as long as the peduncle, composed of about twelve segments, furnished with a few short hairs.

Legs of the first pair in the male with the carpus short, triangular; the propodus a little less than twice as long as broad, much narrowed distally; the palmary margin slightly concave in outline, continuous with the posterior margin, with a narrow lamellar edge, and furnished with a few long hairs and with two long, obtuse spines near the middle, and

three or four smaller ones on each side near the tip of the closed dactylus; the posterior margin beyond the tip of the dactylus with a few hairs and several small, obtuse spines; dactylus strongly curved and one-half as long as the propodus. In the female, the propodus is considerably smaller and proportionally shorter than in the male; the palmary margin is without the lamellar edge and without spines, except two or three long ones near the tip of the closed dactylus; and the posterior margin is armed with several shorter spines and quite numerous hairs arranged in several fascicles. Legs of the second pair in the male with the carpus a little longer than in the first pair; the propodus as long as in the first pair, slightly broadest distally, but the edges nearly parallel, and only slightly convex in outline; the palmary margin a little oblique, concave in the middle, with a broader lamellar edge than in the first pair, and armed on the outer side with a long, stout, and obtuse spine near the middle, two or three smaller ones on each side—usually two on the outer side and three on the inside—at the tip of the closed dactylus, a few short hairs along the base of the lamellar margin, and a fascicle of long hairs at the base of the median spine; the posterior margin with about six fascicles of hairs. In the female, the carpus and hand are considerably smaller than in the male; the carpus is proportionally much more elongated than in the male, and fully as broad as the propodus; the propodus is narrow, twice as long as broad, the edges nearly parallel, the palmary margin without the lamellar edge and without the spine in the middle, straight, and very nearly transverse.

Fourth and fifth segments of the abdomen rounded above, and each armed with three fascicles of a very few small spines. Sixth segment with a fascicle of two or three spines each side, but no median fascicle. Inferior lateral margin of the first segment rounded, of the second and third produced posteriorly into an acute angle. Outer rami of the posterior caudal stylets narrow, with two or three stout spines on the proximal two-thirds of the outer edge; the inner edge without spines, and both edges furnished with long hairs; the terminal segment short, tapering, and the edges, as well as the tip, furnished with long hairs. Inner rami narrow, not quite as long as the basal portion of the outer; both edges furnished with long hairs, as in the outer rami, and the inner edge with two or three spines. Divisions of the telson about as long as the peduncles of the posterior caudal stylets, and tipped with two or three short spines and a few hairs.

Length, from the front of the head to the tip of the telson, 15^{mm} to 20^{mm}.

Color in life, uniform obscure dark brownish-green, without spots or markings of any kind.

Dredged in Lake Superior in abundance among *Cladophora*, in 8 to 13 fathoms, on the south side of Saint Ignace Island; also at Simmons's Harbor, on the north shore, in 13 to 15 fathoms; and among the Slate Islands in 4 to 6 and 12 to 14 fathoms; taken also from the stomachs of trout caught in brooks near Marquette, Mich. It is probably com-

mon in most or all the tributaries of Lake Superior, and very likely of many other of our nothern lakes and rivers.* The European species alluded to below is said, by Dr. G. O. Sars, to be the food of a variety of trout (*Salmo punctatus*) found among the higher mountains of Norway, and our species probably serves a similar purpose in the waters which it inhabits.

This species is very closely allied to the *Gammarus neglectus* of G. O. Sars,† which inhabits the lakes of Norway, and is apparently much like it in habits. Our species differs from the European in some minor details, and is undoubtedly entitled to be considered a distinct species.

The name *lacustris*, which I first gave to this species, is pre-occupied as a synonym of the European species just mentioned.

GAMMARUS FASCIATUS Say.

Journal Academy Nat. Sci. Philadelphia, vol. i, p. 374, 1817; (?)Bate, Catalogue Amphipodous Crustacea British Museum, p. 210, pl. 37, fig. 6, 1862.

Secondary flagellum of the antennulæ as long as the second segment of the peduncle, and composed of five or six segments. Antennæ furnished with many more, and much longer hairs than in the last species.

First pair of legs in the male much as in the last species; the palmary margin of the propodus armed with the stout spine on the middle of the inner side, and with two or three smaller spines near the tip of the closed dactylus much as in that species, but there are no spines on posterior margin proper. In the female, the propodus is only slightly narrowed distally, and the palmary margin is not nearly so oblique as in the male, or as in the same part of the female of the last species; the posterior margin furnished with several fascicles of hairs, but without spines, except a cluster near the tip of the closed dactylus. Second pair of legs in the male very much as in the last species, but there are three or four spines on each side—usually four on the outside and three on the inside—near the tip of the closed dactylus. In the female, the second pair of legs are very much as in the female of the last species; but the carpus and propodus are not quite so elongated.

Fourth and fifth segments of the abdomen slightly angulated dorsally at the posterior margin, and each armed with three fascicles of spines considerably larger than those in the last species, and the median fascicle on each segment raised on a distinct protuberance. Sixth segment with a median and lateral fascicles of spines. Outer rami of the posterior caudal stylets with the terminal segment very narrow, styliform, and without lateral hairs. Inner rami with usually one or two spines

* Since the above was written, I have examined specimens of this species, collected by Hayden's expedition in 1873, in Colorado, from a cool spring, Fire-Hole Basin; and very large specimens from an elevation of 9,000 feet, near Long's Peak. It was also collected the same year by Dr. Coues, while on the Northern Boundary Commission.

† Histoire Naturelle des Crustacés d'Eau Douce de Norvège, 1e livraison, p. 46, pl. 4, 5; pl. 6, fig. 1-20.

on the inner edge. Divisions of the telson with a spine and one or two hairs on the outer edge as well as a few spines and hairs at the tip.

Length, from the front of the head to the tip of the telson, 10^{mm} to 15^{mm}.

This species is probably common throughout the Northern States. It is abundant in the fresh-water streams and ponds about New Haven, Conn.; Say's specimens were from near Philadelphia; Professor Verrill has collected it at Eastport, Me.; Mr. N. Coleman, at Grand Rapids, Mich.; and Mr. J. W. Milner has found it in abundance at Ecorse, Mich. Specimens collected at Madison, Wis., by Professor Verrill, and at Waukegan, Ill., by Mr. Milner, are considerably larger than usual, and differ slightly in the number of spines upon the hands, but apparently belong to this species.

Fragments of a *Gammarus* from the stomachs of shad taken in the Delaware River appear to belong to this species.

? GAMMARUS MINUS Say.

Journal Academy Nat. Sci. Philadelphia, vol. i, p. 376, 1818; Bate, Catalogue Amphipodous Crustacea British Museum, p. 221, 1862.

I have not yet been able to rediscover this species, which is very likely not a true *Gammarus*, and, as it seems to have given rise to much confusion, I quote the original description: "Body whitish, with a few pale fulvous lateral spots; eyes reniform, blackish, placed at the exterior base of the superior antennæ; superior antennæ obviously longer than the inferior ones; seta [secondary flagellum] short, attaining the tip of the second articulation of the terminal joint [flagellum;] terminal joint with about twelve articulations. Length, three-twentieths of an inch, [nearly 4^{mm}.] Found in brooks under stones, and may be readily discovered by taking a stone out of the water, and inspecting its inferior surface."

According to Bate, specimens sent to the British Museum as this species by Say, agree in no way with the description, and are described by Bate as a species of *Allorchestes*,* although he quotes the "*Gammarus minimus* Say," of White's List of Crustacea in the British Museum under *Gammarus minus*, while White must have had the same specimens which afterward became the types of the new species of "*Allorchestes*." The *Gammarus minus* of DeKay (Natural History of New York, p. 37, pl. 9, fig. 29) is made up principally of Say's original description; but he apparently had before him some other species, (probably small specimens of *G. fasciatus*,) from which the rude attempt at a figure given in his work may have originated.

CRANGONYX GRACILIS Smith.

American Journal of Science, 3d series, vol. ii, p. 453, 1871; and Preliminary Report on Dredging in Lake Superior, p. 1022, 1871.

♀ *Female.*—Eyes slightly elongated, composed of a few black facets.

* *A. Knickerbockeri.* See p. 647.

Antennulæ slightly more than half as long as the rest of the animal; first and second segments of the peduncle subequal, ultimate segment two-thirds as long as the penultimate; flagellum in full-grown specimens about once and a half as long as the peduncle, and composed of about twenty segments; secondary flagellum about as long as the basal segment of the primary flagellum, slender, and composed of only two segments, the terminal one very short. Antennæ only about half as long as the antennulæ; ultimate and penultimate segments of the peduncle elongated, subequal in length; flagellum a little shorter than the peduncle, composed of seven or eight segments. Legs of the first and second pairs subequal.

Propodus in the first pair of legs nearly quadrate in outline, a little longer than broad; palmary margin nearly straight, with a few small submarginal spines, each furnished with a cilium a little way from the tip; a similar stout spine near the posterior angle, and just at the angle itself two short, stout, obtuse, and serrated spines; dactylus stout, slightly curved, and armed with a slight tooth on the inside a little way from the tip, and with a slender, setiform hair near the middle of the outer margin. Propodus in the second pair more elongated than in the first; the palmary margin somewhat oblique, and without the short spines just at the posterior angle, but otherwise armed much as in the first pair. Fifth, sixth, and seventh pairs of legs subequal in length; posterior pair slightly longest; their squamiform basal segments with the posterior margin serrate, and both margins armed with small spines.

Postero-lateral angles of the first, second, and third segments of the abdomen produced and terminating in a small tooth. Posterior caudal stylets reaching to the tips of the penultimate; the outer rami nearly twice as long as the peduncle, and armed with a few slender spines; the inner rami rudimentary, very minute, shorter than the diameter of the outer, and wholly unarmed. Telson scarcely as long as the bases of the posterior caudal stylets, slightly broader than long, and the posterior margin with a triangular emargination, either side of which the extremity is truncate, and armed with three spines. Length, 6^{mm} to 7^{mm}.

Male.—The largest males seen from Lake Superior are considerably smaller than the females, being about 5^{mm} in length, and more slender. In the first pair of legs, the palmary margin of the propodus is slightly oblique, and armed each side with a submarginal row of about eleven stout and obtuse spines, which are nearly equidistant from one another except at the posterior angle, where about five of them are crowded together, most of the spines with a notch and cilium a little way from the tip. In the second pair of legs the propodus is proportionally shorter than in the female, and increases considerably in breadth distally, while the palmary margin is much more oblique, slightly arcuate, and armed each side with a row of about fifteen spines like those on the first pair, but not so much crowded together at the posterior angle. In other respects, the males resemble the females.

Dredged in Lake Superior, in company with *Gammarus limnæus*, among *Cladophora*, in eight to thirteen fathoms, on the south side of Saint Ignace Island.

The incubatory lamellæ of the female are very large, projecting much beyond the epimera of the anterior legs, as in *C. recurvatus* Grube, (Archiv für Naturgeschichte, vol. xxxii, p. 410, pl. 10, fig. 1,) which our species much resembles in the form of the antennulæ, antennæ, anterior legs, &c., while it differs much in the posterior caudal stylets and in the form of the telson.

A single specimen of a male *Crangonyx*, collected by Mr. J. W. Milner in an estuary of Lake Huron, belongs apparently to this species, but is very much larger, being 14^{mm} in length, so that it is quite probable that the specimens from Lake Superior are all young. This large specimen, however, agrees in all essential features with the smaller ones.

CRANGONYX VITREUS Packard.

? ? *Stygobromus vitreus* Cope, American Naturalist, vol. vi, p. 422, 1872; Third and Fourth Annual Reports of the Geological Survey of Indiana, p. 181, 1872.

Crangonyx vitreus Packard, Fifth Annual Report of the Peabody Academy of Science, Salem, p. 95, 1873.

Dr. Packard's specimens were from three different wells in Orleans, Ind., and were collected by M. N. Elrod, who says that many of them were in and on buckets that had been in the bottom of the well for several days. Professor Cope's specimens were from Mammoth Cave, Kentucky, but are described in such an unintelligible manner that it is very doubtful whether they belong to the same species, or even genus, as Dr. Packard's specimens. I have, however, followed Dr. Packard in quoting Professor Cope's name as a synonym.

CRANGONYX TENUIS, *sp. nov.*

A slender, elongated species, with very low epimera, resembling more in form the species of *Niphagus* than the typical species of *Crangonyx*.

Eyes not observable in alcoholic specimens. Secondary flagellum of the antennulæ very small, composed of two segments, of which the terminal is very short.

First and second pairs of legs differing but little in the two sexes. First pair stouter than the second, and with the palmary margin of the propodus much more oblique; the palmary margin of the propodus of both pairs, and in both sexes, armed each side with a series of stout, obtuse spines, with a notch and a cilium near the tip.

First three segments of the abdomen longer than the last three of the thorax; fourth, fifth, and sixth together scarcely longer than the third. Caudal stylets all extending to about the same point. First pair with the rami subequal, scarcely half as long as the peduncle. Peduncle in the second pair reaching a little beyond the peduncle of the first pair; the rami very unequal, the outer only half as long as the inner. Posterior pair scarcely as long as the telson; the single terminal segment very

small, and tipped with four or five setiform spinules. Telson two-thirds as broad as long, tapering very slightly toward the entire and slightly arcuate posterior margin, which is armed with about ten slender spinules.

In the largest male seen, 13^{mm}.5 in length, (excluding the antennæ,) the antennulæ are about 5^{mm} long; the flagellum being twice as long as the peduncle, and composed of about twenty-two segments, while the antennæ are stout, fully 6^{mm} long, and the flagellum as long as the peduncle, and composed of fifteen segments. All the females and most of the males which I have seen are much smaller, being 6^{mm} to 8^{mm} in length, and in these the antennulæ are longer than the antennæ; and the flagellum of the antennulæ is composed of sixteen to nineteen segments, while that of the antennæ has only eight to ten.

The only specimens which I have seen were found in wells at Middletown, Conn., and were sent to me by Mr. G. Brown Goode.

ISOPODA.

Family ASELLIDÆ.

ASELLUS COMMUNIS Say. (Plate I, fig. 4.)

Journal Academy Nat. Sci. Philadelphia, vol. i, p. 427, 1818; Edwards, Hist. Nat. des Crust., vol. iii, p. 147, 1840; DeKay, Nat. Hist. New York, Crust., p. 49, 1844. *A. vulgaris?* Gould, Invertebrata of Massachusetts, p. 337, 1841.

Head with the anterior margin nearly straight; external angles obliquely truncated; sides nearly parallel, with a small, prominent lobe at the posterior angle; hinder margin somewhat rounded and shorter than the anterior margin of the first thoracic segment. Eyes near the middle of the lateral margin, oval, convex, with many facets. Basal segment of the antennulæ cylindrical, much larger than the next two, which are, however, well marked as peduncular segments; flagellum nearly equaling the peduncle of the antennæ. Antennæ with three short basal segments, which are together about equal in length to the fourth; last peduncular segment equal in length to the third and fourth together; flagellum much longer than the peduncle, extending, when bent backward, about to the base of the abdomen. Both antennæ and antennulæ with scattered hairs, which are larger and stouter on the peduncular segments.

Thoracic segments increasing in breadth posteriorly; all behind the first segment with the anterior angle produced and gradually turning more and more backward in the posterior segments. Epimera becoming conspicuous on the posterior segments, which have their lateral borders emarginate and the posterior angles rounded. Pleon (abdomen) suborbicular, slightly excavated at the insertion of the caudal stylets and obtusely pointed between them, ciliate along the entire margin, as are the head and the lateral borders of the thoracic segments.

Mandibles with conspicuous triarticulate palpi, of which the first seg-

ment is clavate; the second on the external side gibbous, and furnished beyond the middle with a tuft of bristly hairs; the third slender and tapering, finely and regularly ciliate along the external side, the cilia rather suddenly increasing in length at the apex. First segment of palpus of the maxilliped short; second with the exterior margin nearly straight, interior strongly rounded and densely hairy; third subtriangular, the external margin being nearly straight, the internal much curved and converging toward the outer, the distal articulation of the segment being less than half the length of its proximal articulation; fourth segment clavate; fifth less than half the length of the fourth.

First pair of thoracic legs in the male strongly chelate; the propodus much enlarged and subglobular, with a prominent acute tooth, and a smaller lobe on its palmary margin; dactylus with a tubercle at the base, an emargination near the middle, and a small acute spine at the end; carpus small and triangular. In the remaining pairs of legs, the carpus and propodus are of about equal length and movably articulated; the posterior three are much larger than the others; and the fourth pair has a spiny tubercle on the propodus.

First abdominal segment in the males furnished with two pairs of appendages; the outer pair composed, on each side, of a small subquadrate plate, to the extremity of which is articulated another somewhat larger plate of similar shape. The inner or upper pair composed of a robust, suboval basal portion on each side, bearing at its extremity two rami; the inner ramus irregular in shape, cylindrical, bent, and tapering to a blunt extremity; outer ramus biarticulate; proximal segment short, expanding distally, and bearing a small, obtusely ovate plate, which is ciliate near the extremity. The corresponding segment in the female bears a pair of short narrow plates, which meet each other along their inner, straight margins, and are obliquely rounded and ciliate at their extremity. Outer plates of the next pair of abdominal appendages thickened, and forming an operculum for the branchiæ. These opercular plates, as taken together, are orbicular in outline, and broadly truncated at the end. Each plate is divided by a slightly oblique suture into two unequal portions; the distal portion being about twice as large as the proximal.

Posterior pleopoda, or caudal stylets, flattened, ciliate; proximal segments expanded from the base, obliquely truncated at the extremity; rami narrowly ovate, pointed, the inner about twice as long as the outer. The flattening of these appendages is more conspicuous in the adult males.

Length, excluding antennæ and caudal stylets, 15^{mm}; breadth, 5^{mm}.

Above brown, spotted, and mottled with yellowish.

This species is common under stones in streams and pools about New Haven, Conn. It is mentioned by Dr. Gould as common in Massachusetts in similar situations, and by Mr. Say in the neighborhood of Philadelphia. It has also been collected, by Mr. N. Coleman, at Grand Rapids, Mich.

ASELLOPSIS Harger.

American Journal of Science, 3d series, vol. vii, p. 601, 1874.

The genus *Asellopsis*, which was proposed for the reception of *Asellus tenax* Smith, differs from the genus *Asellus* in the *absence of mandibular palpi*. The presence of these palpi has been heretofore regarded as characteristic of the family to which both the genera undoubtedly belong.

ASELLOPSIS TENAX Harger. (Plate I, fig. 3.)

Asellus tenax Smith, American Journal of Science, 3d series, vol. ii, p. 453, 1871; and Preliminary Report on Dredging in Lake Superior, p. 1023, 1871.

Anterior margin of the head broad, excavated for the bases of the antennulæ; external angles rounded; margin expanded with a large, rounded sinus on a line with the eyes; behind this the margin expands into a rounded lobe. The posterior margin of the head is broad and rounded behind, adapted to the first thoracic segment. Eyes of more than twenty facets, considerably within the margin of the head, oval or somewhat reniform. Antennæ about half as long as the body, separated from each other at the base by about half their diameter; first three segments shorter than broad, of about equal length, successively decreasing in diameter; fourth segment as long as the first three, cylindrical; fifth or last peduncular segment as long as the third and fourth together, slender, slightly clavate; flagellum of about thirty segments. Immediately exterior to the base of the antenna is a prominent tubercle, tipped with a few short bristles. Antennulæ with the basal segments large and swollen, about equal in diameter to the fourth segment of the antennæ; second segment slender, slightly clavate, about attaining the end of the third segment of the antennæ; third or last peduncular segment small and slender, less than half the length of the second and similar to the segments of the flagellum, which are usually five in number, the second being longest.

First thoracic segment concave forward, as is also the second in a less degree; third about straight posteriorly; last four slightly curved in the opposite direction. Pleon narrowed posteriorly, obtusely rounded at the end. The margins of all the segments, as well as the pleon and the head, are ciliate; the cilia being more abundant along the external margins of the segments.

Left mandible with two dentigerous lamellæ; molar process truncated nearly at right angles; right mandible with a single dentigerous lamella; the molar process obliquely truncated. Palpus of the maxilliped with the first segment short, nearly cylindrical; second segment suborbicular, with about five cilia along the external margin and twenty along the internal. Cilia much fewer than in *A. communis;* third segment truncate-oval in outline, somewhat broader than long, ciliate; fourth segment cylindrical, or somewhat clavate, less than half the diameter of the third; fifth or last segment about half as long as the penultimate.

First pair of thoracic legs chelate; carpus small, triangular, and closely united with the propodus, which is thickened in the male, with a broad, low tubercle on the inner margin a little above the base; dactylus more than half as long as the propodus, its palmary edge armed with spines, of which the distal ones are the larger, and at the end with a large spine; carpus and propodus in the remaining six pairs of legs of about equal length, movably articulated, and armed with acute spines along their posterior edges; dactylus much less than half as long as the propodus, armed with spines along the posterior margin, and biunguiculate at tip. Three proximal segments similar in all the legs, the first being longest, and the third short and triangular, or quadrant-shaped.

The first abdominal segment is furnished, in the males, with two pairs of appendages, of which the outer is composed of a small oval plate, with a few articulated spines along the inner border, and articulated at its extremity with a larger and longer plate, which is expanded along its outer border, and ciliate along its exterior and distal margin. The inner or upper pair of appendages consists, on each side, of a robust quadrate plate, to the distal margin of which two biarticulate rami are attached. The inner ramus has its proximal segment short, much expanded, but not in the form of a hook, as in *A. aquaticus* as figured by Sars;* its terminal segment is pear-shaped, as in that species. The outer ramus has its proximal segment also expanded and triangular; the distal segment quadrate and ciliate externally and distally. The corresponding abdominal segment, in the females, with a single pair of plates, which are subquadrant-shaped but broader than long, with their inner margins straight and meeting each other on the median line. Outer plates of the next pair of abdominal appendages thickened, and forming an operculum covering the remaining branchial plates. These opercular plates are semi-ovate, truncated at the extremity, straight on the inner side, and meet along the median line. They are each divided into two very unequal portions by a suture, running from near the end of the inner straight margin, diagonally across the plate, to a point on the outer curved margin about one-third of the way from the base to the apex; the distal portion is thus much the smaller.

Posterior pleopoda, or caudal stylets, slender; proximal segment somewhat larger than the fourth segment of the antennæ, cylindrical, as are the two rami, of which the outer is only half as long as the inner.

Length, excluding antennæ and caudal stylets, 8^{mm} to 13^{mm}.

Color above dark-fuscous, spotted, and mottled with yellowish.

Common among *Cladophora*, in 8 to 13 fathoms, on the south side of the island of Saint Ignace, also in 4 to 6 fathoms at the eastern end of that island, and in 6 to 8 fathoms among the Slate Islands in Lake Superior; and since collected by Mr. J. W. Milner on algæ drifted into nets, 30 fathoms, Thunder Bay, Lake Huron.

* Histoire Naturelle des Crustacés d'Eau Douce de Norvège, 1e livraison, pl. x, fig. 6, 1867.

Mr. Milner has also collected at Ecorse, Mich., on the Detroit River, specimens probably of this species, but differing from the form above described as follows: The flagellum of the antennulæ contains one or two more segments. The lateral portions of the head and segments of the body, especially in fully adult specimens, are expanded so that the outline of the animal is a broader oval. The open sinus in the lateral margin of the head is a narrow incision, rounded at the bottom, but with the sides sometimes meeting. The propodus in the first pair of legs is nearly as much enlarged in the males as in *A. communis*, and is armed on its palmary margin with three acute teeth, of which the middle one is the largest.

I propose the variety-name *dilata* for this form, although inclined to regard it as the more typical form of the species, which was, however, first described from the less perfectly developed specimens found in Lake Superior.

CÆCIDOTEA STYGIA Packard.

American Naturalist, vol. v, p. 751, figs. 132, 133, 1871; Fifth Annual Report Peabody Academy of Science, Salem, p. 95, 1873.

Cæcidotea microcephala Cope, American Naturalist, vol. vi, p. 411, figs. 109, 110, p. 419, 1872, and reprinted in Third and Fourth Annual Reports of the Geological Survey of Indiana, p. 163, 1872, (*teste* Packard;) Smith, American Naturalist, vol. vii, p. 244, 1873.

Found in Mammoth Cave, Kentucky; Wyandotte Cave, Indiana; and from wells at Orleans, Ind.

I have had no specimens of this species for examination, but, as Professor Packard suggests in his last paper, it is evidently very closely allied to *Asellus*, and has no affinity with *Idotea*. Professor Packard was at first misled by having only a single specimen and that one having lost the caudal stylets. Professor Cope figures and describes his specimens as having external "egg-sacs" attached to the tip of the abdomen. These egg-sacs undoubtedly really belonged to some *Entomostracan*, and probably to the parasite of the blind fish from the same cave. Professor Packard says they were the caudal stylets mistaken for egg-sacs by Professor Cope, but this seems impossible, as they are figured and described as short, broad sacs filled with spherical bodies.

B—THE CRUSTACEAN PARASITES OF THE FRESH-WATER FISHES OF THE UNITED STATES.

Scarcely anything has as yet been published upon the crustacean parasites infesting our fresh-water fishes, and the principal object of the following partial synopsis is to call attention to the subject, and furnish a basis for future investigation, which is of special practical importance to all those engaged in raising fishes confined in ponds or other restricted areas.

The few species here enumerated are doubtless only a small fraction

of those which really prey upon our common fishes. The species are usually not conspicuous, and are very likely to be overlooked by ordinary observers. The Lernæans, which include the commonest and by far the most injurious species, may be attached to any part of the fish, and should be specially looked for upon the gills and about the gill-openings and throat. It is important that specimens should be collected in large numbers for study. For this purpose, they should be preserved, while quite fresh, in small bottles of alcohol or other strong spirit.

Family ARGULIDÆ.

ARGULUS CATOSTOMI Dana and Herrick.

American Journal of Science, 1st series, vol. xxx, p. 388, 1836, and vol. xxxi, p. 297, plate, 1837.

Parasitic on the "sucker," a species of *Catostomus*, in Mill River, near New Haven, Conn., in both fresh and brackish water.

Argulus Funduli Kroyer, (Bidrag til Kundskab om Snyltekrebsene, p. 20, pl. 2, fig. 1, 1863,) should, perhaps, be included in this list, as it is described as found upon *Fundulus limbatus* Kroyer, from New Orleans, but it is not stated whether from salt or fresh water.

Family CALIGIDÆ.

LEPEOPHTHEIRUS SALMONIS Kroyer.

Caligus Salmonis Kroyer, Naturhistorisk Tidsskrift, vol. i, p. 622, 1837, vol. ii p. 13, 18, pl. 6, fig. 7, 1838; Edwards, Hist. Nat. des Crustacés, vol. iii, p. 455; Steenstrup and Lütken, Bidrag til Kundskab om det aabne Havs Snyltekrebs og Lernæer, p. 15, 1861.

Caligus vespa Edwards, op. cit., vol. iii, p. 456.

Lepeoptheirus Stromii Baird, British Entomostraca, p. 274, pl. 32, figs. 8, 9, 1850.

Lepeoptheirus Salmonis Kroyer, Bidrag til Kundskab om Snyltekrebsene, p. 137, pl. 17, fig. 1, in Naturhistorisk Tidsskrift, III, vol. ii, 1863.

Parasitic on the salmon of our eastern coast and of Europe. It is perhaps more properly a marine than a fresh-water species, but is carried by the salmon far up the fresh water rivers.

Ergasilus Funduli Kroyer, (Bidrag til Kundskab om Snyltekrebsene, pp. 228, 238, pl. 11, fig. 1, 1863,) from *Fundulus limbatus* Kroyer, from New Orleans, is perhaps to be added to this list.

Family LERNÆOPODIDÆ.

ACHTHERES PIMELODI Kroyer.

Bidrag til Kundskab om Snyltekrebsene, pp. 272, 275, pl. 17, fig. 5, 1863.

Upon a specimen of *Pimelodus maculatus*, from Cincinnati, according to Kroyer, from whose work I translate the following diagnosis: "Arms, by which the animal is attached, much longer than the head, slender, nearly straight; bulla (the extremity of the united arms) very small, sessile. Body annulated into five segments, and marked with two dorsal, longitudinal sulcations. External ovaries equaling or exceeding the

length of the animal, slender, linear, provided with about twenty series of eggs longitudinally, and two, or at the most three, transversely."

ACHTHERES LACÆ Kroyer.

Op. cit., pp. 274, 275, pl. 17, fig. 6, 1863

This species is described by Kroyer from a "North-American species of perch, (*Perca Laca,*)" and should probably be included in this list. The following is a translation of the diagnosis: "Arms, by which the animal is attached, scarcely or a little longer than the head, stout, arcuate; bulla distinctly petiolate. Body neither annulated nor longitudinally sulcated; external ovaries much shorter than the animal, about equaling the body; stout, obclavate, filled with about twelve series of eggs longitudinally, and transversely, with four anteriorly, three in the middle, and two posteriorly."

LERNÆOPODA FONTINALIS, *sp. nov.* (Plate III, fig. 12, lateral and dorsal views; figs. 13 and 14, details.)

Female.—Head nearly as long as the body, and longer than broad. Body, short and thick, not very much longer than broad. Prehensile hooks (fig. 14, *a*) stout, nearly half as long as the head, with a small papilliform process on the inside of the penultimate segment; terminal segment rather slender, tapering, straight to near the tip, which is suddenly curved backward, and terminating in an acute point. Arms by which the animal is attached nearly or quite as long as the body; bulla with an elongated petiole, and broadly expanded at the extremity; ova-sacs as long as or a little longer than the body, with three or four series of eggs transversely, and ten to twenty longitudinally.

Entire length, from mouth to extremities of ova-sacs, 5^{mm}; diameter of body, $1^{mm}.5$; length of ova-sacs, 2^{mm}; diameter of ova-sacs, $0^{mm}.75$.

This species is apparently allied to the *L. carpionis* of Kroyer, (op. cit., p. 277, pl. 14, fig. 4,) and seems to belong to this genus as understood by Kroyer. In our species, the antennulæ (fig. 13, *c*) are very short and small processes, not reaching beyond the mouth. The antennæ (fig. 13, *d*) are large, and extend as far forward as the mouth, and each one is divided at the extremity into three lobes, of which the median lobe is again minutely bilobed, or obscurely forcipulate, while the lateral ones (dorsal and ventral in relation to the animal) are armed with numerous minute hooks, and on the outer side, just below the tip, there is another similar lobe armed with minute hooks. The palpi-like appendages (fig. 13, *b*) on each, just below the mouth, are each tipped with three papilla-like lobes. The mandibles (fig. 14, *b*) are each armed with four stout distal and three much smaller proximal teeth.

Found upon the brook-trout, (*Salmo fontinalis,*) at Norway, Me., in the trout-breeding establishment of Mr. A. B. Crockett. The specimens were all attached to the gills, and were apparently the cause of the

death of the fish on which they were found. It is probably a common and widely-distributed species.

I have considerable hesitation in referring this and the next species to the genus *Lernæopoda*, which is usually restricted to parasites of marine or partially marine fishes. Our species certainly do not agree generically with the typical species of *Achtheres*, described and figured by Nordmann, while they seem to agree very well with species of *Lernæopoda* described by Kroyer. It is possible our species may belong to *Basanistes*, but in all external characters they seem to differ widely. In fact, the species of this group have many of them been so poorly described that it is very difficult to make out what the characters of genera really are. The European species, upon which most of the genera are based, need careful revision.

LERNÆOPODA SISCOWET, *sp. nov.* (Plate III, fig. 15, fig. 16, details.)

Female.—Head not more than half as long as the body. Body short, but little longer than wide, semi-annulated by three or four obscure constrictions on the ventral side, and the posterior extremity extending only slightly beyond the bases of the ova-sacs. Prehensile maxillipeds fig. 16, *b*) proportionally smaller than in the last species; the penultimate segment with a process upon the inside terminated by two small, papilla-like appendages, (fig. 16, *b'*;) the terminal segment regularly curved from the base to the acute tip, and armed on the under side near the tip with a spinous prominence. Arms about as long or considerably longer than the body, slender, nearly straight; bulla with a distinct petiole and a broadly-expanded margin. Ova-sacs longer than the head and body together, linear, with twenty to thirty longitudinal and about four transverse series of eggs.

The antennulæ are a little longer than in the last species, and the antennæ and palpi are quite similar to the antennæ and palpi of that species. The mandible, (fig. 16, *a*,) on one side, at least, is broad toward the base, and is armed with four stout distal, and one, or possibly two, small proximal teeth.

Entire length of a specimen, from mouth to extremities of ova-sacs, 13^{mm}; length of body, 5^{mm}; diameter of body, 3^{mm}.2; length of ova-sacs, 8^{mm}.3; diameter of ova-sacs, 1^{mm}.2.

This species was found upon the siscowet (*Salmo siscowet*) at Outer Island, Lake Superior, by Mr. J. W. Milner.

LERNÆOPODA (?) COREGONI, *sp. nov.* (Plate III, fig. 17.)

Head more elongated than in the preceding species. Body elongated and with some obscure indications of annulation, due perhaps to contraction in alcoholic specimens. The prehensile maxillipeds (fig. 17, *a*) reaching nearly as far forward as the mouth; the basal portion very stout; the terminal portion slender, cylindrical, flexible, and armed at the extremity with a minute, strongly-curved hook, (fig. 17, *a'*.) Arms slender, but shorter than the body; the bulla with

a short but distinct petiole. Ova sacs nearly as long as or considerably longer than the body, linear, with three or four transverse and eighteen to thirty-five longitudinal series of eggs.

The antennulæ are much longer than in the species just described, extending fully as far forward as the mouth. The antennæ are proportionally rather larger than in either of the species here described, but are similar to them in structure. The palpi are small, and each one is terminated by two minute, papilla-like appendages. The mandibles (fig. 17, *b*, *c*) each have four stout distal teeth, besides a smaller terminal one, which is nearly obsolete on one mandible and conspicuous on the other, and three small proximal teeth on one and two on the other.

Entire length of a specimen, from mouth to extremities of ova-sacs, 13^{mm}; length of body, $5^{mm}.5$; diameter of body, $1^{mm}.8$; length of ova-sacs, 6^{mm}; diameter of ova-sacs, 1^{mm}.

Found by Mr. J. W. Milner on the white-fish (*Coregonus albus*) at Ecorse, Mich., and at Outer Island, Lake Superior.

This species is probably not a true *Lernæopoda*, and is perhaps the representative of an undescribed genus.

CAULOXENUS STYGIUS Cope.

Proceedings Academy Nat. Sci. Philadelphia, 1871, p. 297; American Naturalist vol. vi, pp. 420, 412, figs. 111–113, 1872, and reprinted in Third and Fourth Annual Reports of the Geological Survey of Indiana, pp. 175, 164, 1872; Packard Fifth Annual Report Peabody Academy of Science, Salem, p. 94, 1873.

This is a peculiar lernæan, described by Professor Cope as parasitic on the blind fish (*Amblyopsis*) of Wyandotte Cave, Indiana; also from a cave in Bradford, Orleans County, Ind., according to Professor Packard. According to Professor Cope, it is allied to *Achtheres* and *Lernæopoda*, although the arms by which the animal is attached are united for their whole length, and it is stated that it "is not a sucker or devourer of its host, but must feed on the substances which are caught by the blind fish and crushed between its teeth"!

Family LERNÆOCERIDÆ.

LERNÆOCERA CRUCIATA Lesueur.

Lerneocera cruciata Lesueur, Journal Academy Nat. Sci. Philadelphia, vol. iii, 286, pl. 11, fig. 4, 1824; Edwards, Hist. Nat. des Crustacés, vol. iii, p 527.
Lernea cruciata DeKay, Nat. Hist. of New York, Crustacea, p. 59, 1844.

On *Centrarchus æneus* in Lake Erie, according to Lesueur.

LERNÆOCERA CATOSTOMI Kroyer.

Bidrag til Kundskab om Snyltekrebsene, p. 321, pl. 18, fig. 4, 1863.

Described by Kroyer as found in the Mississippi River, at Saint Louis, on *Catostomus macrolepidotus*, and so is very likely to be found much farther north and east.

Another species is described by Kroyer, (*L. Pomotidis*, op. cit., p. 323, pl. 15, fig. 5,) from a species of *Pomotis* taken at New Orleans.