Bulletin of the Michigan Fish Commission

No. 5.

ON THE

CYCLOPIDÆ AND CALANIDÆ OF LAKE ST. CLAIR,

LAKE MICHIGAN, AND CERTAIN OF THE INLAND LAKES OF MICHIGAN.

By C. Dwight Marsh,

Professor of Biology in Ripon College.

Results of a Biological Examination of Lake St. Clair Undertaken For the State Board of Fish Commissioners in the Summer of 1893 under the Supervision of J. E. Reighard, and of Similar Work in the Summer of 1894, in the Vicinity of Charlevoix under the Supervision of H. B. Ward.

LANSING:
ROBERT SMITH & CO., STATE PRINTERS AND BINDERS,
1895.

ON THE CYCLOPIDÆ AND CALANIDÆ OF LAKE ST. CLAIR, LAKE MICHIGAN, AND CERTAIN OF THE INLAND LAKES OF MICHIGAN.

From the standpoint of the pisciculturist, perhaps no class of animals outside the fishes themselves is so important and interesting as the entomostraca. It is a well known fact that these minute crustacea form the entire food material of the young of some of our most important food fishes, and in many cases form a large part of the food of the adults.

They are universally distributed. Every stream, lake, pond, and pool has its population of these minute creatures. Moreover they are present in some places in enormous numbers. In the deeper waters of our lakes the surface waters to a depth of about thirty feet fairly swarm with copepods. In limnetic collections there are always present some *Cladocera*, but the great bulk of the material in any lake will consist of two or three species of *Diaptomus* and as many of *Cyclops*.

Inasmuch as the occurrence and abundance of animals is largely dependent on their food supply, it will be seen that an accurate and thorough knowledge of entomostraca is of fundamental importance, if we would have an exact knowledge of the conditions controlling our fish.

The material on which this paper is based was obtained from the following sources.

1. Collections made by Professor Reighard in certain lakes in southern Michigan in the summers of 1891 and 1893.
2. Collections made by Professor Reighard in the northern part of Lake Michigan in the spring of 1893.
3. Collections made by Professor Reighard during the biological examination of Lake St. Clair in the summer of 1893. This involved a very large number of collections in the months of July and August, and its results probably give us a very accurate knowledge of the copepod fauna of Lake St. Clair in the summer season. In connection with this work a few collections were also made in the Detroit river and in Lake Erie.
4. Collections made in July and August 1894 in connection with the scientific work of the Michigan Fish Commission at Charlevoix. This involved a careful examination of Round Lake and Pine Lake, collections in Lake Michigan and the lakes on Beaver Island, and cursory examinations of the small lakes in the neighborhood of Charlevoix.

5. Collections made by Dr. R. H. Ward in September, 1894, in Emmet and Cheboygan Counties, along the "Inland Route."

Inasmuch as these collections were made for the most part, in the summer season, and more especial attention was paid to the larger bodies of water, the results of the examination cannot be considered as giving us a complete knowledge of the fauna of the State. A more careful examination of the smaller lakes and of the stagnant pools would doubtless add some species to the list. Yet the number of those species would be small, and for the larger bodies of water the list as given in this paper is probably very nearly complete.

This becomes evident when one remembers how nearly identical are the faunæ of the deeper waters of our lakes. To such an extent is this true that one can prophesy quite exactly what species will be found in a collection from any of the lakes of this latitude. The collections from the deeper water will almost invariably give the following species:—*Diaptomus oregonensis*, *Cyclops brevispinosus*, *C. Leuckarti and C. fluviatilis*. *C. albidus* and *C. serrulatus* may be present, but belong more properly to the littoral fauna. In the larger lakes, in addition to this list we may find *Epischura lacustris*. *Diaptomus sicilis*, *D. Ashlandi*, *D. minutus*, and *Limnocalanus macrurus* are not commonly found except in the Great Lakes and in the bodies of water in direct connection with them; in the Great Lakes, too, *C. pulchellus* takes the place which *C. brevispinosus* holds in the smaller lakes.

D. Reighardi is the only new species which I have found in the Michigan collections. As I have already remarked in a former paper ('93 p. 192) the species of *Diaptomus* are, in some cases, quite limited in their distribution, and apparently *Diaptomus* is much more susceptible to the influences of its environment than is *Cyclops*. Very little is known of the life histories of the species of *Diaptomus*, and it is possible that a more complete knowledge may lead to a reduction of the number of species. But, so far as I can see, all the forms described vary within comparatively narrow limits, and there is no evidence whatever to lead us to question the separation of the forms.

I have indicated, in the accompanying chart, the distribution of the species. It has not seemed necessary to indicate the character of the individual collections in Lake St. Clair and Lake Michigan as no particular significance is attached to such facts.

The sketch maps will show most of the localities where the collections were made.

It is interesting to note the greater richness of the copepod faunæ of our lakes as compared with those of the continent of Europe. Zacharias finds seven species of copepods belonging to the *Cyclopidæ* and *Calanidæ* in the Plöner See. In Lake Michigan there are nine, and that includes no littoral species; in the lakes on the Beaver Island there are eight, in Pine Lake nine, in Round Lake eleven, in Intermediate Lake eleven, and in Lake St. Clair sixteen. The large number in Lake St. Clair is probably explained by the fact that, being very shallow, it has the species of the smaller bodies of water and of the stagnant pools, and in addition, because of its connection with the Great Lakes, has also their limnetic species.

Table of occurrence of Cyclopidæ and Calanidæ.

	Lake near Baldwin.	Bear Lake, Charlevoix County.	Beaver Island, North Lake.	Beaver Island, South Lake.	Black or Round Lake, Emmet County.	Burt Lake, Cheboygan County.	Carp Lake, Emmet County.	Crooked Lake, Emmet County.	Detroit River.	Dodge Creek, Cheboygan County.	Lake Erie.	Indian River, Cheboygan County.	Intermediate Lake, Antrim County.	Long Lake, Genesee County.	Long Lake, Ionia County.	Lake Michigan.	Mullet Lake, Cheboygan County.	Pickerel Lake, Emmet County.	Pigeon River, Cheboygan County.	Pine Lake, Charlevoix County.	Round Lake, Charlevoix County.	Lake St. Clair.	Susan Lake.	Twenty-sixth Lake.	Twin Lakes, Charlevoix County.
Diaptomus sicilis									+							+				+		+			
" Ashlandi									+							+				+	+	+			
" minutus		+				+		+	+			+				+	+			+	+	+			
" Reighardi			+					+					+												
" oregonensis		+		+		+		+			+	+	+	+	+	+	+	+		+	+	+		+	+
Epischura lacustris		+		+			+	+			+	+		+	+	+	+			+	+	+			
Limnocalanus macrurus									+							+						+			
Cyclops ater													+								+	+	+	+	
" brevispinosus	+	+	+	+	+		+	+	+		+		+								+	+	+		
" pulchellus						+			+		+	+				+				+	+	+			
" parcus																						+			
" Leuckarti		+		+	+	+	+	+			+	+	+		+	+	+	+		+	+	+			+
" fuscus													+												
" albidus			+	+	+		+			+			+					+	+		+	+	+	+	+
" fluviatilis		+		+		+	+	+			+		+		+	+	+			+	+	+		+	+
" serrulatus	+	+	+	+	+		+	+	+	+		+	+					+	+		+	+	+	+	+
" phaleratus													+						+			+		+	
" bicolor				+									+									+			

Pine Lake is peculiarly poor in its number of species. This is strikingly apparent when we compare it with Intermediate Lake. Pine Lake was very thoroughly examined, and it is likely that we are acquainted with all the species occurring there, and yet the number is only eight. All the collections from Intermediate Lake were made in one day by a party which went down from Charlevoix and remained only a few hours, and yet the number of different forms is eleven. Intermediate Lake seems to be an unusually rich collecting ground, for with the exception of Lake St. Clair and Round Lake, no other lake shows such a large number of species, and both Lake St. Clair and Round Lake have been very thoroughly explored. Moreover, in the case of Round Lake, several of the species may be considered as immigrants from Lake Michigan.

In general it may be said that the copepod fauna of Michigan does not differ materially from that of Wisconsin, which I have already described in a former report. (Marsh '93.) This is only what one would expect because of the very wide distribution of the species, as already noted. (Marsh '93, p. 191.)

Inasmuch as many of the species have been imperfectly described, it has seemed best to me in preparing this paper to devote some space to more detailed descriptions, and particularly to furnish some figures in addition to those already published, and in this way to supplement the work of preceding papers.

The literature of the *Copepoda* is so scattered that it is very difficult for any one except a specialist to make determinations of species that are at all satisfactory. Without doubt this fact has deterred many from attempting any study of the *Copepoda*. Much valuable work in regard to the distribution of species might be done by amateur investigators if there were any work giving brief directions by which the species might be determined with a fair degree of accuracy. This lack, with the advice of Professor Reighard, I have attempted to supply in the present paper. Preceding the notes on *Diaptomus* and *Cyclops*, I have given a brief synopsis of the species of those genera. These synopses, which, with some modifications, are like those in my paper on the copepods of Wisconsin, are intended simply to furnish a means of recognizing the species by some of their most obvious characters. While the first six plates may be considered as supplementing the work of my Wisconsin paper, I have thought best, in order to aid in the identification of species to add the seventh, which repeats some of the figures of the former paper. I think that by means of the synopses and plates, any one who has the patience to make the necessary dissections, will be able without much difficulty to identify our species of *Cyclops* and *Diaptomus*, at least as far as adult forms are concerned.

I have included in the synopses some species which have not yet been found in Michigan, but which have been reported from Wisconsin, and will, doubtless, after a more thorough exploration, be included in the Michigan fauna.

FAMILY CALANIDÆ.—GENUS DIAPTOMUS WESTWOOD.

KEY TO SPECIES OF DIAPTOMUS FROM CHARACTERISTICS OF THE MALE.

Antepenultimate joint of antenna without appendage,
- Fifth feet nearly equal in length, ---------- *oregonensis.*
- Left fifth foot shorter than right,
  - Inner ramus of left fifth foot about equal in length to first joint of outer ramus, terminal hook of right foot not markedly angular, ---------- *pallidus.*
  - Inner ramus of left fifth foot about twice as long as first joint of outer ramus, terminal hook of right foot with an abrupt angle at about midway of its length, *Reighardi.*

Antepenultimate joint of antenna with hyaline lamella, ---- *leptopus.*

Antepenultimate joint of antenna with appendage,
- Appendage short and blunt,
  - Left fifth foot hardly reaching end of basal joint of right, lateral spine of terminal joint of right foot weak, reaching about to end of joint, species large, occurring only in spring, ---------- *sanguineus.*
  - Left fifth foot reaching to about one-third the length of the terminal joint of the right, lateral spine of terminal joint large, reaching to nearly one-half the length of the terminal hook, ---------- *Birgei.*
- Appendage as long or longer than the penultimate joint,
  - Terminal hook of right fifth foot broad, lateral spine minute, ---- ---------- *minutus.*
  - Terminal hook falciform,
    - Lateral spine nearer outer extremity of joint, ------- *sicilis.*
    - Lateral spine stout, nearer base of joint, ---------- *Ashlandi.*

DIAPTOMUS SICILIS Forbes.

Plate VII, figs. 1 and 11.

1882. *D. sicilis* Forbes, p. 645, pl. VIII, figs. 9 and 20.
1884. " " Herrick, p. 142, pl. Q, fig. 18.
1889. " " DeGuerne and Richard, p. 23, figs. 13 and 14, pl. II, fig. 13.
1891. " " Forbes, p. 702, pl. 1, fig. 6.
1893. " " Marsh, p. 197, pl. III, figs. 8 and 10.

D. sicilis is found everywhere in the Great Lakes, in Lake St. Clair and in the Detroit River. It is also found in Pine Lake, and very likely occurs in other bodies of water having direct connection with the Great Lakes.

I do not know of its occurrence in bodies of water away from the Great Lakes, except in Green Lake (Marsh '91 and '93), and Lake Geneva (Forbes, '90), and both of these are deep-water lakes.

DIAPTOMUS ASHLANDI Marsh.

Plate VII, fig. 2.

1893. *D. Ashlandi* Marsh, p. 198, pl. III, figs. 11–13.

When I described this species in my paper on the *Cyclopidæ* and *Calanidæ* of Wisconsin, I knew of only two localities for it, Lake Supe-

rior and Lake Erie. It occurred in the collections from Lake St. Clair and the Detroit River, but not abundantly. In the Lake Michigan collections it was a common species, but not nearly so numerous as *D. minutus*. I found it in none of the smaller lakes except Round Lake and Pine Lake.

Diaptomus minutus Lilljeborg.

Plate VII, fig 3.

1889. *D. minutus* DeGuerne and Richard, (Lilljeborg) p. 50, pl. I, figs. 5, 6 and 14, pl. III, fig. 25.

1891. *D. sicilis var. imperfectus* Forbes, p. 703.

1891. " " Marsh, p. 212.

1893. " " Marsh, p. 199, pl. IV, figs. 1 to 3.

D. minutus is, perhaps, the most common of all the *Diaptomi* in the collections from Lake St. Clair and the Great Lakes. With *D. sicilis* and *D. Ashlandi* it forms the great bulk of the crustacea in the limnetic collections. While I have found it in one or two of the Wisconsin lakes, it, like the two preceding species, has not so far been found in any of the Michigan waters which do not have direct connection with the Great Lakes. The three species may be fairly considered as characteristic of the fauna of the Great Lakes.

It is with considerable hesitation that I have considered Forbes's *imperfectus* identical with *minutus*. One can not be certain of the identity of the two forms from the description given by Forbes, and yet from the localities which he gives for his variety, it seems very probable that the two are the same. He speaks of it as common in Lake Superior and Lake Michigan, and in some adjacent lakes, and in Lake Geneva. Inasmuch as *D. minutus* is so common in the Great Lakes it is not at all probable that it has been overlooked by so accurate an observer as Professor Forbes, and as he reports *imperfectus* as an abundant form, I think the probabilities are that *imperfectus* is a synonym of *minutus*.

Diaptomus oregonensis Lilljeborg.

Plate VII, fig. 5.

1889. *D. oregonensis* DeGuerne and Richard, (Lillj.) pl. II, fig. 5, pl. III, fig. 8.

1893. " " Marsh, p. 200, pl. IV, figs. 4 and 5.

D. oregonensis is the common limnetic species of the smaller lakes. It occurs in the Great Lakes, but not abundantly, while in the smaller bodies of water it usually forms the larger part of the limnetic fauna.

DIAPTOMUS REIGHARDI, *sp. nov.*

Plate I, figs. 1-4.

The first segment of the cephalothorax is considerably shorter than the second. The first two segments form nearly half the length of the cephalothorax. The last segment is armed behind with two very minute spines.

The first segment of the abdomen of the female is elongated, nearly equal in length to the remainder of the abdomen and the furca. It is dilated laterally and in front and bears two rather small lateral spines. The second segment is about one-third shorter than the third. The third segment is slightly shorter than the furca.

The antennae reach the end of the furca. The right antenna of the male is swollen anterior to the geniculating joint; the antepenultimate joint has no appendage.

The outer ramus of the fifth foot of the female is two-jointed. The third joint is represented by the customary two spines. The inner ramus is one-jointed; it is somewhat longer than the first joint of the outer ramus, and is armed at tip with minute setæ and two spines.

In the right fifth foot of the male the basal joint is quadrangular, about one-half longer than broad. The length of the first joint of the outer ramus is about equal to its width. The second joint is elongate, concave on its inner margin; at about one-third of its length there is a minute spine on its inner margin; the rather long lateral spine is situated at about two thirds of its length. The terminal hook has a single abrupt angle at about one-half its length. The inner ramus is one-jointed and equals in length the first joint of the outer ramus.

The left fifth foot of the male reaches a little beyond the middle of the second joint of the outer ramus. The basal joint is about as broad as long, and is somewhat shorter than the basal joint of the right foot. The first joint of the outer ramus is about as broad as long, its distal end considerably narrower than the proximal. The second joint is about twice as long as the first, and the tip is expanded into two finger-like processes, of which the outer is much the larger and is armed on its inner surface with a pad bearing minute setæ. The inner ramus extends to rather less than one-half the length of the second joint of the outer ramus.

Length of female, 1.1395 mm.; male, 1.0248 mm.

This species, which is nearly related to *D. oregonensis*, is yet readily distinguished by the characters of the male fifth foot. I found it in the collections from only three localities,—the North Lake on Beaver Island, Intermediate Lake, and Crooked Lake.

I have named this species in honor of Professor Reighard who has, directly and indirectly, done so much to increase our knowledge of lacustrine faunæ.

Genus EPISCHURA Forbes.

Plate II, figs. 1-6. Plate III, figs. 1-6.

Epischura lacustris Forbes.

1844. *Scopiophora vagans* Pickering, p. 62.
1882. *E. lacustris* Forbes, pp. 541 and 648, pl. VIII, figs. 15, 16, 21, 23, pl. IX, fig. 8.
1884. *E. lacustris* Herrick, p. 131, pl. Q, fig. 13.
1889. " " DeGuerne and Richard, p. 90, pl. IV, figs. 3, 9 and 10.
1891. " " Forbes, p. 704, pl. I, figs. 1–5; pl. II, fig. 7.
1893. " " Marsh, p. 200, pl. IV, fig. 6.

I have very little doubt that, as stated by Herrick ('84, p. 131), the *Scopiophora vagans* of Pickering is the same as *E. lacustris*. The statement in regard to the armature of the abdominal furcæ can apply to no other genus, and as only one species of *Epischura* has been found in the Great Lakes, there would seem to be little doubt as to the identity of Pickering's species. If then we follow the laws of priority as strictly as do some authors, we should throw out Forbes's name. But I cannot think it wise when a name has been so long incorporated in our literature, and is founded on an accurate and easily recognized description, to throw it aside in favor of a name accompanied by a description which, it is true, probably applies to this animal, but is manifestly inaccurate in some particulars, and may be in all.

It is not necessary to give a detailed description of this species, as that has already been done by other authors, but, as very few figures of it have been published, it has seemed best to me to draw quite a number in order that they may serve for comparison of this genus with others, and of the various species of *Epischura* with each other.

A few points in the anatomy, which have not been noted by others should be mentioned.

Forbes has recently ('93, p. 255) called attention to the fact that the fourth abdominal segment of the male is without a process, and that the fifth bears two processes.

The antennæ are 25-jointed. In the female, clavate sensory setæ are present on all segments except the 4th, 6th, 8th, 10th, 20th, 21st, 22d and 24th. The 8th and 11th segments have each a short spine. The left antenna of the male is like those of the female except that the sensory setæ are much longer, particularly on the basal segments. The right antenna of the male is 22-jointed, with a hinge between the 18th and 19th segments. The 19th segment is formed by the union of the 19th, 20th and 21st of the typical antenna, and the 20th by the union of the 22d and 23d.

The outer rami of the swimming feet are three-jointed, and the inner one-jointed. In all the feet the inner ramus bears five setæ. In the first foot the first and second joints of the outer ramus have each one external and one internal seta. The terminal joint has six setæ. In the second, third, and fourth feet, the first and second joints of the outer ramus have spines externally instead of setæ as in the first foot. The terminal joint has two short spines externally, a long terminal spine with its outer margin deeply serrate, and four setæ on the internal margin.

E. lacustris was a common species in the collections from Lake St. Clair, Lake Michigan, and many of the smaller lakes.

Genus LIMNOCALANUS Sars.

Limnocalanus macrurus Sars.

Plate IV, figs. 1 and 2, Plate V, figs. 1-5.

1863. *L. macrurus* Sars., pp. 228-229.
1882. " " Forbes, p. 648.
1886. *Centropages Grimaldi* DeGuerne, pp. 1–10.
1888. *L. macrurus* Nordqvist, pp. 31–37, pl. I, figs. 9–11; pl. II, figs. 1–5; pl. III, figs. 1–4.
1889. *L. macrurus* DeGuerne and Richard, p. 77, pl. IV, figs. 5, 11, and 12.
1891. *L. macrurus* var. *auctus* Forbes, p. 706.
1893. " " Marsh, p. 201, pl. IV, fig. 7.

For the description of *L. macrurus* we must depend largely upon the elaborate description and figures of Nordqvist.

Forbes ('91, p. 706) thinks that our form is sufficiently different from the European to rank as a distinct variety. When preparing my former paper ('93) it did not seem to me that there was good reason for establishing a new variety. Recently I have made a more careful examination of the details of its structure, using material from Detroit River, Lake Michigan, and Green Lake. So far as the specimens I have examined are concerned, the points of difference mentioned by Forbes ('91, p. 707) do not exist. It seems to me that the twenty-fifth antennal segment is clearly separated from the twenty-fourth, and not consolidated as stated by him. In all my specimens I find the hook like spines on the eighth and twelfth segments.

Nordqvist and Forbes are in agreement in regard to the terminal teeth of the mandible, but Forbes finds one seta instead of the two figured by Nordqvist; in this respect my observations confirm those of Forbes. The accessory spines have been evident in my preparations. It would seem then, that unless *L. macrurus* is susceptible of local variations—a highly improbable supposition—that Forbes's variety can not stand, for the only point of difference on which it rests is the existence of one seta on the mandible instead of two.

The second joint of the second maxillipede differs slightly from Nordqvist's figure, and I have accordingly figured it. (Pl. V, fig. 5.) The difference appears to me, however, unimportant.

It is impossible to tell whether our species may not differ from the European in the armature of the antenna, as that was not worked out in detail by Nordqvist. In regard to the sensory setæ, he simply states that they are present on some of the segments, but does not state their number. In the female, clavate sensory setæ are present on all joints except the 4th, 20th, 21st, 22d, and 24th. The setæ are distributed as follows: the first joint has three; there are two on the 2d, 3d, 5th, 7th, 9th, 10th, 11th 13th to 19th inclusive, and 22d to 24th inclusive; the 4th, 8th, 12th 20th,

and 21st have one seta; the 6th has none; the 25th has four setæ, one of which is plumose; the 8th and 12th have, in addition to the ordinary and sensory setæ a hook-like spine.

The left antenna of the male is armed like the female antenna.

The right antenna of the male is 22-jointed, the 19-21 being united in one, and the 22d and 23d. The joint is between the 18th and 19th. The side of the 17th is produced into a blunt spine, and the 18th and 19th are armed on the inner margin with rows of minute spines. The number of the sensory setæ is the same as in the left antenna and in the antenna of the female, and not greater as stated by Nordqvist. In fact the differences in the armature of the right and left antennæ are only apparent, and are occasioned by the coalescence of the 19th–21st and the 22d and 23d joints.

It has seemed best to me to figure the swimming feet and describe them in some detail, in order to get a basis of comparison with similar forms.

In the first foot both the first and second basal joints are armed internally with a plumose seta. The first two joints of the exopodite have no external spines; the terminal joint has two external spines, two apical setæ—the outer spinulose on its outer margin—and three internal setæ. The terminal joint of the endopodite has one internal seta, two apical, and three internal.

The second, third and fourth feet have no seta on the second basal joint, and the first and second joints of the exopodite have each an external spine. In all the feet except the first there are groups of two or three minute spines at the bases of the spines of the exopodite.

The second and third feet are alike. The terminal joint of the exopodite has four internal setæ, and the terminal joint of the endopodite has two external setæ and four internal.

The fourth foot is like the second and third except that the terminal joint of the endopodite has three internal setæ. The fifth feet have no setæ on the basal joints. The second joint of the exopodite in the female is prolonged internally into a hook-like expansion. The exopodites of the male are two jointed, the terminal joints having a peculiar construction more easily understood from the figure than from any written description. The terminal joints of the endopodite in both male and female are armed with two external, two apical, and two internal setæ.

FAMILY CYCLOPIDÆ.—GENUS CYCLOPS MÜLLER.

KEY TO SPECIES OF CYCLOPS.

Antennæ 17-jointed,
  Fifth foot one-jointed, armed with one spine and two long setæ—a large species of dark color, ---------- *ater.*
  Fifth foot two-jointed,
    Second joint of fifth foot armed with seta and short spine,
      Terminal joint of outer branch of swimming feet armed externally with three spines,
        Furca of moderate length—occurring in pools, ---- *Americanus.*
        Furca elongated, outer furcal seta abbreviated to a short, thick spine—limnetic in habit, ---------- *brevispinosus.*

Terminal joint of outer ramus of swimming feet armed externally with two spines, ---------- *parcus.*
Second joint of fifth foot with two terminal setæ,
Furca short—occurring in pools, ---------- *navus.*
Furca elongated—limnetic in habit, ---------- *pulchellus.*
Second joint of fifth foot with one terminal and one lateral seta, ---------- *Leuckarti.*
Second joint of fifth foot with three setæ,
With clavate seta on twelfth antennal segment, inner margin of furca not beset with hairs, egg-sacs lying away from abdomen, ---------- *albidus.*
Sensory hair on twelfth antennal segment, inner margin of furca beset with hairs, egg-sacs close to abdomen, ---------- *fuscus.*
Antennæ 16-jointed, fifth foot three-jointed, ---------- *modestus.*
Antennæ 12-jointed, fifth foot one-jointed,
Furca variable in length, armed externally with a row of fine spines, ---------- *serrulatus.*
Furca short, without armature of spines—a small limnetic species, ---------- *fluviatilis.*
Antennæ 11-jointed,
Swimming feet 3-jointed, ---------- *phaleratus.*
Swimming feet 2-jointed, ---------- *bicolor.*
Antennæ 8-jointed, ---------- *fimbriatus.*

Cyclops ater Herrick.

Plate VI, figs. 1-4, 6, and 12.

1882. *C. ater* Herrick, p. 228, pl. III, figs. 9–12.
1884. " " " p. 145, pl. Q, figs. 9–12.
1887. " " " p. 14.

The cephalothorax is oval, nearly as broad as long, with the lateral angles produced caudally. The first segment equals two-thirds the total length of the cephalothorax.

The antennæ are 17-jointed, about as long as the cephalothorax, its segments having the typical armature of the *Cyclopidæ*. The last two segments have a smooth hyaline lamella, which in the last segment projects as a flat, blunt process beyond the end of the joint.

The abdomen is of moderate length, the last segment being armed posteriorly with a row of fine spines. The furca is rather more than twice as long as its width. The lateral spine is situated near the end. Of the terminal setæ, the outer is slightly shorter than the inner, the second is about twice as long as the outer, and the third about three times as long.

The swimming feet are armed as follows:

FIRST FOOT.

Outer br. ex. 3 spines.	Inner br. ex. 1 seta.
ap. 2 setæ.	ap. 1 spine, 1 seta.
in. 3 setæ.	in. 3 setæ.

SECOND AND THIRD FEET.

Outer br. ex. 3 spines.	Inner br. ex. 1 seta.
ap. 1 spine, 1 seta.	ap. 1 spine, 1 seta.
in. 4 setæ.	in. 3 setæ.

FOURTH FEET.

Outer br. ex. 2 spines.	Inner br. ex. 1 seta.
ap. 1 spine, 1 seta.	ap. 2 spines.
in. 4 setæ.	in. 2 setæ.

The fifth foot is one-jointed, and armed with a stout spine and two long setæ.

Average length 1. 77 mm.

A large, very robust form, of striking appearance because of its deep colors. The colors of the St. Clair specimens were as follows: antennæ, antennules, swimming feet and furcal setæ dark blue, almost black. The caudal margins of the cephalothorax have the same color. On each side of the abdomen, and extending to the ends of the furcæ is a strip of the same color but darker. Borders of the cephalothorax tinged with green. Oviducts white. The ovary is orange.

To the naked eye it resembles closely in form, size, and color an *Arrenurus* with which it is found associated. This may be a case of protective mimicry.

This species was originally described by Herrick in 1882, and is mentioned by him in his succeeding reports of 1884 and 1887, but has been noted by no other author. It was discovered by Professor Reighard in the St. Clair collections, and was worked out very thoroughly by him. It is from his notes that the above description is taken.

This seems to be a somewhat rare form in this region. I have found a few individuals in Rush Lake, Wisconsin, and in Michigan, besides in the St. Clair collections, have found it in Twenty-Sixth Lake, Intermediate Lake and Susan Lake. Where it occurs it is easily detected because of its large size and prominent colors. The specimens from Round Lake had more of the red color, so much so that this, on a superficial examination, seemed to be the most prominent color.

Cyclops brevispinosus Herrick.

Plate VII, fig. 12.

1884. *C. brevispinosus* Herrick, p. 148, pl. S, figs. 7–11.
1893. " " Marsh, p. 205, pl. IV, figs. 11 and 12.

C. brevispinosus occurred in the collections from Lake St. Clair, the Detroit river, Lake Erie, Susan Lake, Beaver Island, Intermediate Lake and Round Lake. I have found it in collections from Lake Superior and Lake Ontario, but, curiously, never in Lake Michigan collections.

Cyclops pulchellus Koch.

Plate VII, fig. 14.

1838. *C. pulchellus* Koch, H. 21, pl. 2.
1857. " *bicuspidatus* Claus, p. 209, pl. XI, figs. 6 and 7.
1863. " " " p. 101.
1863. " *pulchellus* Sars, p. 246.
1870. " *bicuspidatus* Heller, p. 71.
1872. " " Fric, p. 221, fig. 6.
1876. " " Hoek, p. 17, pl. I, figs. 7–11.
1880. " *pulchellus* Rehberg, p. 543.
1880. " *helgolandicus* Rehberg ('80a), p. 64, pl. IV, fig. 5.
1882. " *Thomasi* Forbes, p. 649, pl. IX, figs. 10, 11, and 16.
1883. " *pectinatus* Herrick, p. 499, pl. VII, figs. 25, 28.
1883. " *Thomasi* Cragin, p. 13, pl. III, figs. 1–13.
1884. " " Herrick, p. 151, pl. U, figs. 4, 5, 7, and 8.
1885. " *pulchellus* Daday, p. 220.
1886. " " Vosseler, p. 194, pl. V, figs. 19–28.
1890. " " Lande, p. 50, pl. XXI, figs. 146–155.
1891. " *Thomasi* Forbes, p. 707, pl. II, fig. 8.
1891. " *bicuspidatus* Brady, p. 13, pl. V, figs 1–5.
1891. " *Thomasi* Brady, p. 14, pl. VI, figs. 1–4.
1891. " *bicuspidatus* Schmeil, p. 27.
1891. " " Richard, p. 229, pl. VI, fig. 6.
1892. " " Schmeil, p. 75, pl. II, figs. 1–3.
1893. " *Thomasi* Forbes, p. 249, pl. XXXIX, figs. 9–12, pl. XL, fig. 13.
1893. " *pulchellus* Marsh, p. 207, pl. IV, figs. 18–19.

C. pulchellus is the common *Cyclops* of the Great Lakes. It occurs sometimes in smaller bodies of water, but in the collections from Michigan I have not found it from any of the small lakes except Pine Lake and Round Lake.

According to Forbes ('82 b) *C. pulchellus* and the *Diaptomi* form the greater part of the food of the young white fish.

Cyclops parcus Herrick.

1882. *C. parcus* Herrick, p. 229, pl. VI, figs. 12–15.
1884. " " p. 148, pl. R, fig. 22.
1893. " " Marsh, p. 208, pl. IV, fig. 16, pl. V, fig. 1.

I have found *C. parcus* only in the collections from Lake St. Clair.

Cyclops leuckarti Sars.

Plate VII, fig. 15.

1863. *C. Leuckarti* Sars, p. 239.
1874. " *simplex* Poggenpol, p. 70, pl. XV, figs. 1–3.
1875. " *tenuicornis* Uljanin, p. 30, pl. IX, figs. 12 and 13.
1876. " *Leeuwenhoekii* Hoek, p. 19, pl. III, figs. 1–12.
1880. " *simplex* Rehberg, p. 542.
1884. " " Herrick, p. 150.

1884. *C. oithonoides* Herrick, p. 150, pl. S, figs. 2–6.
1885. " *Leuckarti* Daday, p. 218.
1885. " *simplex* Daday, p. 236.
1885. " *pectinatus* Daday, p. 223, pl. I, figs. 7–13.
1886. " *simplex* Vosseler, p. 193, pl. IV, figs. 15–17.
1887. " " Herrick, p. 17, pl. VII, fig. 1, a-j.
1890. " " Thallwitz, p. 79.
1890. " " Lande, p. 55, pl. XVI, figs. 42–45; pl. XVII, figs. 46–50.
1891. " *Leuckarti* Schmeil, p. 25.
1891. " *edax* Forbes, p. 709, pl. III, fig. 15; pl. IV, figs. 16–19.
1891. " *Scourfeldi* Brady (?) p. 10, pl. IV, figs. 1–8.
1891. " *Leuckarti* Richard, p. 230, pl. VI, fig. 20.
1892. " " Schmeil, p. 57, pl. III. figs. 1–8.
1893. " " Marsh, p. 209, pl. IV, fig. 17; pl. V, figs. 2–6.

I have no doubt that, as stated by Schmeil, *C. Leuckarti* Claus and *C. Leuckarti* Sars are identical, and that possibly by strict laws of priority Claus should be given as authority for the name. Yet, as the description by Claus is not only imperfect, but in many respects inaccurate and misleading, I have preferred to retain the designation of *C. Leuckarti* Sars. Other points in the synonomy are discussed in Schmeil '92 and Marsh '93.

As would be expected, this species was distributed almost universally in the waters examined.

Cyclops fuscus Jurine.

Plate VI, figs. 5, 7 and 11.

1820. *Monoculus quadricornis fuscus* Jurine, p. 47, pl. II, fig. 2.
1841. *C. signatus* Koch, H 21, pl. VIII.
1850. " *quadricornis var. c* Baird, p. 203, pl. XXIV, fig. 5.
1857. " *coronatus* Claus, p. 29, pl. I, fig. 5, and pl. II, figs. 1–11.
1863. " " " p. 97, pl. II, fig. 16; pl. X, fig. 1.
1863. " *signatus* Sars, p. 242.
1863. " *coronatus* Lubbock, p. 199.
1870. " " Heller, p. 71.
1872. " " Fric, p. 218, fig. 12.
1876. " " Hoek, p. 12.
1878. " *signatus* Brady, p. 100, pl. XVII, figs. 4–12.
1882. " *tenuicornis* Herrick, p. 227, pl. V, fig. 14; pl. VI, figs. 1–11, and 20.
1884. " *tenuicornis* Herrick, p. 153, pl. R, fig. 16; pl. Q', figs. 8–11, and 20.
1885. " *signatus* Daday, p. 208.
1886. " " Vosseler, p. 189, pl. IV, figs. 6–10.
1888. " *fuscus* Sostariç, p. 58.
1890. " *signatus* Thallwitz, p. 79.
1890. " " Lande, p. 33, pl. XV, figs. 1–12.
1891. " " Brady, p. 6, pl. 2, fig. 5.
1891. " *fuscus* Richard, p. 223, pl. VI, fig. 6.
1891. " " Schmeil, p. 22.
1892. " " " p. 123, pl. I, figs. 1–7b; pl. IV, fig. 2.
1893. " *signatus* Marsh, p. 211.

In my paper on the Wisconsin *Cyclopidæ* and *Calanidæ* ('93), agreeing with Herrick and Brady, I expressed my belief that the two forms here called *fuscus* and *albidus*, the *coronatus* and *tenuicornis* of Claus, belonged to the same species, *fuscus* being the more mature form. Since writing that paper I have examined a large number of specimens from widely separated localities, and I must acknowledge that I was wrong, and that, as stated by Schmeil ('92), the two forms must be considered distinct, for I have been utterly unable to find the connecting forms. The points of difference, as stated so elaborately by Schmeil, hold good for the American specimens. *C. fuscus* has a sensory hair on the twelfth antennal segment, the hyaline lamella of the 17th segment deeply notched, the third segment of the antennule short, the inner borders of the furca thickly beset with hairs, and the egg sacs lie close to the abdomen, while *C. albidus* has a clavate seta on the twelfth antennal segment, the membrane of the 17th segment serrate or smooth, the inner borders of the furca either without hairs or with only fine hairs, and the egg sacs lie separated from the abdomen. These characters, with the greater size of *C. fuscus*, serve to distinguish the species, while the less evident characters mentioned by Schmeil are easily demonstrated.

One characteristic not mentioned by Schmeil I have found constantly in my specimens. The larger of the two terminal spines of the endopodite of the fourth foot, instead of being serrated on its edges as is customary in all the spines of the swimming feet, is beset on its inner margin with long, rather irregular teeth, as shown in the plate. (Plate VI, fig. 7.) If this peculiarity exists in the European forms, it would seem probable that it would have been noted by some observer, but I have nowhere seen an account of it. It may serve then to indicate a slight variation from the European type.

I have found *C. fuscus* in the Michigan collections from only one locality, Intermediate Lake. I have found it in several Wisconsin localities, though nowhere abundantly, and it is probable that it occurs in other localities in Michigan.

Cyclops albidus Jurine.

Plate VI, figs. 8–10.

1820. *Monoculus quadricornis albidus* Jurine, pp. 44 and 47, pl. II, figs. 10 and 11; pl. III, fig. 24.
1841. *C. annulicornis* Koch, H 21, pl. VI.
1850. " *quadricornis* var. *b* Baird, p. 202, pl. XXIV, fig. 4.
1857. " *tenuicornis* Claus, p. 31, pl. III, figs. 1–11.
1857. " *pennatus* Claus, p. 35, pl. III, figs. 12–17.
1863. " *tenuicornis* Claus, p. 99, pl. I, fig. 3; pl. II, fig. 17; pl. IV, fig. 5.
1863. " *tenuicornis* Sars, p. 242.
1863. " *annulicornis* Sars, p. 243.
1863. " *tenuicornis* Lubbock, p. 202.
1870. " *tenuicornis* Heller, p. 71.
1872. " " Fric, p. 219, fig. 12.
1874. " *Clausii* Poggenpol, p. 70, pl. XV, figs. 4–14.
1875. " *signatus* Uljanin, p. 29, pl. IX, figs. 6–11; pl XI, fig. 8.
1876. " " Hoek, p. 12, pl. I, figs. 1–4.

1878. *C. tenuicornis* Brady, p. 102, pl. XVII, figs. 1–10.
1882. " " Herrick.
1883. " " Cragin, p. 3, pl. II, figs. 1–14.
1883. " *signatus* var. *fasciacornis* Cragin, p. 2, pl. II, fig. 15.
1884. " *tenuicornis* var. *a* Herrick, p. 153, pl. Q^4, figs. 1–7.
1885. " " Daday, p. 211.
1886. " " Vosseler, p. 189, pl. IV, figs. 6–10.
1888. " *albidus* Sostariç, pl. I, figs. 3, 4 and 12.
1890. " *tenuicornis* Thallwitz, p. 79.
1890. " " Lande, p. 36, pl. XVI, figs. 22–32.
1891. " *gyrinus* Forbes, p. 707, pl. II, fig. 9; pl. III, fig. 14.
1891. " *albidus* Schmeil, p. 23.
1891. " *annulicornis* and *tenuicornis* Richard, pp. 224–226.
1892. " *albidus* Schmeil, p. 128, pl. I, figs. 8–14b; pl. IV, fig. 2.
1893. " *signatus* Marsh, p. 211, pl. V, figs. 7–9.

Schmeil states that the antennæ of *C. albidus* are armed with crowns of spines as in the case of *C. fuscus*. This seems to be rarely true in our forms. Although I have examined with great care large numbers of mature females, it is only in very few specimens that I have found this peculiar armature. The membrane of the terminal antennal segment is ordinarily serrate. The common form corresponds to the *annulicornis* of Sars and Richard, which, according to Schmeil, Richard now allows to be a variety of *albidus*. The distinguishing characteristic of *annulicornis* is the rudimentary seta of the inner margin of the terminal segment of the endopodite of the fourth foot. This is represented in most of my specimens only by a minute spine. (Pl. VI, fig. 9.) In two individuals I have found in place of this minute spine a short seta. (Pl. VI, fig. 8.) In these two specimens the circlets of spines were present on the 8th, 9th, 10th, 12th, 13th, and 14th segments. It was this form evidently that Cragin called *C. tenuicornis* ('83 pl. II, figs. 1–14), as is shown very clearly by the figures of the fourth foot and antennule, although he did not figure the circlets of spines on the antennal segments. *C. signatus* var. *fasciacornis* Cragin, it is not possible to identify with certainty, although it seems probable that it is *albidus*. *C. gyrinus* Forbes does not have the antennal circlets of spines, but does have a short seta instead of a minute spine on the fourth foot, thus agreeing with Cragin's figures of *C. tenuicornis*. This would seem to be intermediate between the two forms I have seen. It is difficult in such a case to tell just where the limits of species should be drawn, for we are entirely ignorant of the life histories of the forms, and it is certain that the *Cyclopidæ* have wide limits of variation. It seems to me safer, for the present, at least, to consider such minute differences as varietal, and not to increase the number of species.

C. albidus is not very abundant, but occurred in many of the St. Clair collections, and in some of those from other points in Michigan. It is a universally distributed species, but does not occur in great numbers.

Cyclops fluviatilis Herrick.

1882. *C. fluviatilis* Herrick, p. 231, pl. VII, figs. 1–9.
1883. " *magnoctavus* Cragin, p. 5, pl. II, figs 14–23.
1884. " *fluviatilis* Herrick, p. 159, pl. Q^5, figs. 1–9.
1887. " " Herrick, p. 15.

1891. *C. magnoctavus* Brady, p. 19, figs. 1–4.
1893. " *fluviatilis* Marsh, p. 214, pl. V, figs. 14 and 15; pl. VI, fig. 1.

C. fluviatilis occurs in most of the limnetic collections in all except the smallest bodies of water.

CYCLOPS SERRULATUS Fischer.

1851. *C. serrulatus* Fischer, p. 423, pl. X, figs. 22, 23, 26–31.
1853. " " Lilljeborg, p. 158, pl. XV, fig. 12.
1857. " " Claus, p. 36, figs. 1–3.
1863. " " Sars, p. 254.
1863. " " Claus, p. 101, pl. I, figs. 1 and 2; pl. IV, fig. 12; pl. XI, fig. 3.
1863. " " Lubbock, p. 197.
1870. " " Heller, p. 72.
1872. " " Fric, p. 222, fig. 18.
1875. " " Uljanin, p. 34, pl. VIII, figs. 1–8.
1878. " " Brady, p. 109, pl. XXII, figs. 1–6.
1878. " " var. *montanus* Brady, p. 110, pl, XXII, figs. 7–14.
1880. " *agilis* Rehberg, p. 545.
1882. " " Forbes, p. 649.
1882. " *serrulatus* Herrick, p. 230, pl. V, figs. 1–5; pl. VII, fig. 10.
1883. " *pectinifer* Cragin, p. 6, pl. IV, figs. 1–7.
1884. " *serrulatus* Herrick, p. 157, pl. O, figs. 17–19.
1884. " " var. *elegans* Herrick, p. 158.
1885. " *agilis* Daday, p. 240.
1886. " " Vosseler, p. 190, pl. V, figs. 29–31.
1890. " " Thallwitz, p. 79.
1890. " " Lande, p. 60, pl. XVII, fig. 69; pl. XVIII, figs. 70–80.
1891. " *serrulatus* Schmeil, p. 29.
1891. " " Richard, p. 234, pl. VI, figs. 6–12.
1891. " *agilis* Forbes, p. 710.
1892. " *serrulatus* Schmeil, p. 141, pl. V, figs. 6–12.
1893. " " Marsh, p. 215, pl. VI, figs. 2–5.

This well known species occurs everywhere in Michigan waters and with the same variations in structure which I have noted in the collections made in Wisconsin. (Marsh '93, pp. 215–216.)

CYCLOPS PHALERATUS Koch.

1838. *C. phaleratus* Koch, H 21, pl. IX.
1851. " *canthocarpoides* Fischer, p. 426, pl. X, figs. 24, 25, 32–38.
1853. " " Lilljeborg, p. 208.
1857. " " Claus, p. 37, pl. I, figs. 6–10.
1863. " " " p. 102, pl. IV, figs. 1–4.
1863. " " Lubbock, p. 202.
1863. " *phaleratus* Sars, p. 255.
1872. " *canthocarpoides* Fric, p. 223, fig. 19.
1874. " *lascivus* Poggenpol, p. 72, pl. XV. figs. 22–24; pl. XVI, figs. 7 and 8.
1875. " *phaleratus* Uljanin, p. 38, pl. IX, figs. 1–5.
1878. " " Brady, p. 116, pl. XXIII, figs. 7–13.
1882. " *adolescens* Herrick, p. 231, pl. VI, figs. 15–20.

1883. *C. perarmatus* Cragin, p. 7, pl. I, figs. 9–18.
1884. " *phaleratus* Herrick, p. 161, pl. R, figs. 6–10.
1885. " " Daday, p. 252.
1887. " " Herrick, p. 14, pl. VII, figs. 2, a–d.
1888. " " Sostariç, p. 74, pl. II, figs. 21–22.
1890. " " Lande, p. 75. pl. XX, figs. 126–136.
1891. " " Schmeil, p. 36.
1891. " " Brady, p. 25, pl. IX, fig. 2.
1891. " " Richard, p. 238, pl. VI, fig. 12.
1892. " " Schmeil, p. 170, pl. VIII, figs. 1–11.
1893. " " Marsh, p. 216, pl. VI. figs. 6 and 7.

I have found *C. phaleratus* in the collections from only three localities,—Lake St. Clair, Intermediate Lake, and Twenty-sixth Lake. Very little attention, however, was paid in the collections to the smaller lakes and stagnant pools, and it is probable that in such localities it occurs generally distributed through the State.

Cyclops bicolor Sars.

Plate I, figs. 5–7.

1863. *C. bicolor* Sars, p. 253.
1880. " *diaphanus* Rehberg, p. 547.
1884. " " Herrick, p. 160, pl. R, fig. 12.
1885. " " Daday, p. 246.
1885. " *brevisetosus* Daday, p. 255, pl. III, figs. 3, 5 and 10.
1887. " *diaphanus* Herrick, p. 16, pl. VII, figs. 3 a–e.
1888. " " Lande. p. 67, pl. 18, figs. 91–98.
1891. " *bicolor* Schmeil, p. 34.
1891. " *diaphanus* Richard, p. 236, pl. VI, fig. 26.
1892. " *bicolor* Schmeil, p. 118, pl. VI, figs. 6–13.
1893. " " Marsh, p. 217.

I have found *C. bicolor* in the collections from three of the Michigan lakes—Lake St. Clair, Intermediate Lake, and South Lake on Beaver Island. Doubtless more thorough collections from small lakes and stagnant pools would furnish other localities, though this species seems to be nowhere very abundant. I have found, in a collection from a lake in northern Wisconsin, an egg-bearing female with ten-jointed antennæ, the fourth and fifth joints of the eleven-jointed variety being united in one. Unless this specimen should be considered a monstrosity, we would infer that this species can reproduce in either the ten or eleven-jointed stage.

I have added to the synonomy as previously given *C. brevisetosus* Daday. I do not feel certain of the identity of the two forms, and yet it seems to me probable that they are the same. I can not read the Hungarian, but from the Latin synopsis and the figures I can not help thinking that *brevisetosus* is the same as *bicolor*. The points of difference are the following. The furca of *brevisetosus* is longer than in typical *bicolor*. The armature of the swimming feet does not correspond to Daday's description, but the one figure which he gives of a swimming foot closely resembles the structure of *bicolor*, and does not correspond to his own description. The antennæ of *brevisetosus* are ten-jointed, but they correspond exactly to the structure of my ten-jointed specimen of *bicolor*. In all other respects the descriptions agree.

BIBLIOGRAPHY.

Although the list of papers consulted is very nearly the same as that of my paper on the Wisconsin *Cyclopidæ* and *Calanidæ*, I have though it best to insert it in this paper for convenience of reference. I have not had the opportunity of seeing the original paper of Poggenpol, nor the papers of Sostariç and Thallwitz, and the quotations from those authors are taken from Schmeil. In all other cases I have personally verified the references.

BAIRD, W.:

'50. Natural History of the British Entomostraca. Ray Soc., Lond.

BRADY, G. S.:

'78. Monograph of the free and semi-parasitic Copepoda of the British Islands, 3 vols., Ray Soc., Lond.

'91. Revision of the British Species of Fresh-water Cyclopidæ and Calanidæ.
Natural History Transactions of Northumberland, Durham and Newcastle-upon-Tyne, Vol. XI, part 1.

CLAUS, C.:

'57. Das Genus Cyclops u. s. einheimische Arten.
Archiv. fur Naturgeschichte, XXIII, 1 Bd., pp. 1–40.

'63. Die freilebenden Copepoden mit besonderer Berücksichtigung der Fauna Deutschlands, der Nordsee und des Mittelmeeres. Leipzig.

CRAGIN, F. W.:

'83. A Contribution to the History of the Fresh-water Copepoda. Trans. Kans. Acad. Sci., Vol. VIII.

DADAY, Jeno.:

'85. Monographia Eucopepodorum liberorum in Hungaria hucusque repertorum.
A. M. tudományos Académia által a Vitéz-alapból.

DEKAY, J. E.:

'44. Zoology of N. Y., VI, Crustacea.

FISCHER, S.:

'51–'53. Beiträge zur Kenntniss der in der Umgegend von St. Petersburg sich findenden Cyclopiden. (und Fortsetzung).
Bull. Soc., Imp., Moscow.

FORBES, S. A.:

'82*a*. On Some Entomostraca of Lake Michigan and Adjacent Waters.
Amer. Naturalist, Vol. XVI, pp. 537–542, and 640–649.

'82*b*. The First Food of the Common Whitefish. Rep. U. S. Com. Fish and Fisheries for 1881, pp. 771–782.

'91. On Some Lake Superior Entomostraca. Rep. U. S. Com. Fish and Fisheries, 1887, pp. 701–718.

'93. A Preliminary Report on the Aquatic Invertebrate Fauna of the Yellowstone National Park, Wyoming, and of the Flathead Region of Montana. Bull. U. S. Fish Com. for 1891, pp. 209-258.

FRIC, A.:

'72. Die Krustenthiere Böhmens. Archiv der naturwiss. Landesdurchforschg. von Böhmen., II Bd., IV Abth., pp. 203–269.

DeGuerne and Richard.:
'89. Révision des Calanides d'eau douce. Mem. de la Soc. Zool. de France, Vol. II.

DeGuerne, J.:
'86. Description du *Centropages Grimaldii*, Copépode nouveau du Golf de Finlande. Bull. Soc. Zool. de France, XI.

Heller, C.:
'70. Untersuchungen über die Crustaceen Tyrols.
Berichte des medic. naturw. Vereins in Innsbruck. 1 Jhrg. pp. 67–96.

Herrick, C. L.:
'82. Cyclopidæ of Minn. with Notes on other Copepods.
10th Ann. Rep. Geol. and Nat. Hist. Sur. Minn. pp. 221–235.
'83. Heterogenetic Development in Diaptomus.
Amer. Nat. Vol. XVII, pp. 381–389, 499–505.
'84. A final report on the Crustacea of Minnesota included in the Orders Cladocera and Copepoda.
12th Ann. Rep. Geol. and Nat. Hist. Sur. Minn.
'87. Contribution to the Fauna of the Gulf of Mexico and the South.
Mem. of Denison Sci. Assoc. Vol. 1, No. 1.

Hoek, P. P. C.:
'76. De Vrijlevende Zoetwater—Copepoden der Niederlandsche Fauna.
Tijdsch. d. Nederl. Dierkund. Vereenig III.

Jurine, L.:
'20. Histoire des Monocles qui se trouvent aux environs de Genève.

Koch, C. L.:
'35, 41. Deutschlands Crustaceen, Myriapoden und Arachniden.

Lande, Adam.:
'90. Materyjaly do Fauny Skorupiaków Widlonogich Królestwa Polskiego. Widlonogi Swobodnie Zyjace I. Rodzina Cyclopy. Warsaw.

Lilljeborg, W.:
'53. De Crustaceis ex ordinibus tribus; Cladocera, Ostracoda, et Copepoda in Scania occurrentibus.

Marsh, C. Dwight:
'91. On the Deep Water Crustacea of Green Lake.
Wis. Acad. Sci. Arts and Letters, Vol. VIII, pp. 211–213.
'93. On the Cyclopidæ and Calanidæ of Central Wisconsin.
Wis. Acad. Sci., Arts and Letters, Vol. IX, pp. 189–224.

Nordqvist, Osc.:
'88. Die Calaniden Finlands. Bidrag till Kännedom af Finlands Naturoch Folk, heft 47.

Poggenpol, M. J.:
'74. List of the Copepoda, Cladocera, and Ostracoda of the Environs of Moscow. (In Russian.) Trans. in Cragin '83.

Rehberg, H.:
'80. Beitrag zur Kenntniss der freilebenden Süsswasser Copepoden.
Abh. d. Natur. Ver. zu Bremen, Bd. VI, pp. 533–554.
'80*a*. Weitere Bemerk. über d. freileb. Süssw. Copepoden.
Abh. d. Natur. Ver. zu Bremen, Bd. VII, Hft. 1, pp. 61–67.

RICHARD, Jul.:
'91. Recherches sur le Système glandulaire et sur le Système nerveux des Copépodes libres d'eau douce, suivie d'une Révision des Espèces de ce Groupe qui vivent en France. Annales des Sciences naturelles, Zoologie. T 12, pp. 113–270.
SARS, G. O.:
'63. Oversigt af de indenlandske Ferskvandscopepoder. Forhandlinger i Videnskabs-Selskabet i Christiana. 1862.
SCHMEIL, Otto:
'91. Beiträge zur Kenntniss der freilebenden Süsswasser Copepoden Deutschlands mit besonderer Berücksichtigung der Cyclopiden. Zeitschr. f. Naturwis. 64 Bd. 1 and 2 Hft.
'92. Deutschlands freilebende Süsswasser-Copepoden. 1. Theil: Cyclopidae. Bib. Zool. Heft 2.
SOSTARIC.
'88. Beiträge zur Kenntniss. (?)
THALLWITZ.
'90. Entomostraken. (?)
ULJANIN, W. N.
'75. Crustacea of Turkestan. Part I. (In Russian.)
VOSSELER, J.
'86. Die freilebenden Copepoden Württembergs und angrenzender Gegenden. Jahreshefte des Ver. für Vaterl. Naturkunde in Württ. 1886.

EXPLANATION OF PLATES.

PLATE I.

Fig. 1. *Diaptomus Reighardi*—fifth feet of female x 340.
2. " " abdomen of male x 195.
3. " " fifth feet of male x 223.
4. " " abdomen of female x 190.
5. *Cyclops bicolor*—abdomen of female x 269.
6. " " antenna of female x 333.
7. " " 10-jointed antenna of female x 325.

PLATE II.

Fig. 1. *Epischura lacustris*—antenna of female x 113.
2. " " right antenna of male x 113.
3. " " antennule x 113a.
4. " " mandible and palpus x 217.
5. " " second maxillipede x 217.
6. " " first maxillipede x 217.

PLATE III.

Fig. 1. *Epischura lacustris*—first foot x 217.
2. " " second foot x 153.
3. " " fifth foot of female x 217.
4. " " fifth foot of male x 153.
5. " " abdomen of female x 113.
6. " " abdomen of male x 113.

PLATE IV.

Fig. 1. *L. macrurus*—right antenna of male x 275.
2. " " left antenna of male x 275.

PLATE V.

Fig. 1. *L. macrurus*—first foot x 275.
2. " " second foot x 275.
3. " " fifth foot of female x 275.
4. " " fifth foot of male x 275.
5. " " second and third joints of second maxillipede x 275.

PLATE VI.

Fig. 1. *Cyclops ater*—abdomen of male x 146.
2. " " receptaculum seminis x 113.
3. " " fourth foot x 113.
4. " " 11th, 12th, and 13th antennal segments of female x 113.
5. " *fuscus*—terminal joints of female antenna x 217.
6. " *ater*—terminal joints of female antenna x 217.
7. " *fuscus*—terminal joint of endopodite of fourth foot x 217.
8. " *albidus*—terminal joint of endopodite of fourth foot x 280.
9. " " terminal joint of endopodite of fourth foot x 280.
10. " " antennule x 217.
11. " *fuscus*—antennule, first three joints x 217.
12. " *ater*—outline of cephalothorax of female x 108.

PLATE VII.

Fig. 1. *Diaptomus sicilis*—fifth feet of male x 140.
2. " *Ashlandi*—fifth feet of male x 140.
3. " *minutus*—fifth feet of male x 140.
4. " " fifth foot of female x 250.
5. " *oregonensis*—fifth feet of male x 140.
6. " *pallidus*—fifth feet of male x 200.
7. " *leptopus*—fifth feet of male x 138.
8. " *sanguineus*—fifth feet of male x 138.
9. " *Birgei*—fifth feet of male x 136.
10. " *sanguineus*—terminal joints of male antenna x 136.
11. " *sicilis*—terminal joints of male antenna x 136.
12. *Cyclops brevispinosus*—fifth foot x 250.
13. " *modestus*—fifth foot x 250.
14. " *pulchellus*—fifth foot x 250.
15. " *Leuckarti*—fifth foot x 250.

PLATE VIII.

Sketch map of Lake St. Clair and vicinity, showing collecting stations.

PLATE IX.

Sketch map of Charlevoix and vicinity showing collecting stations.

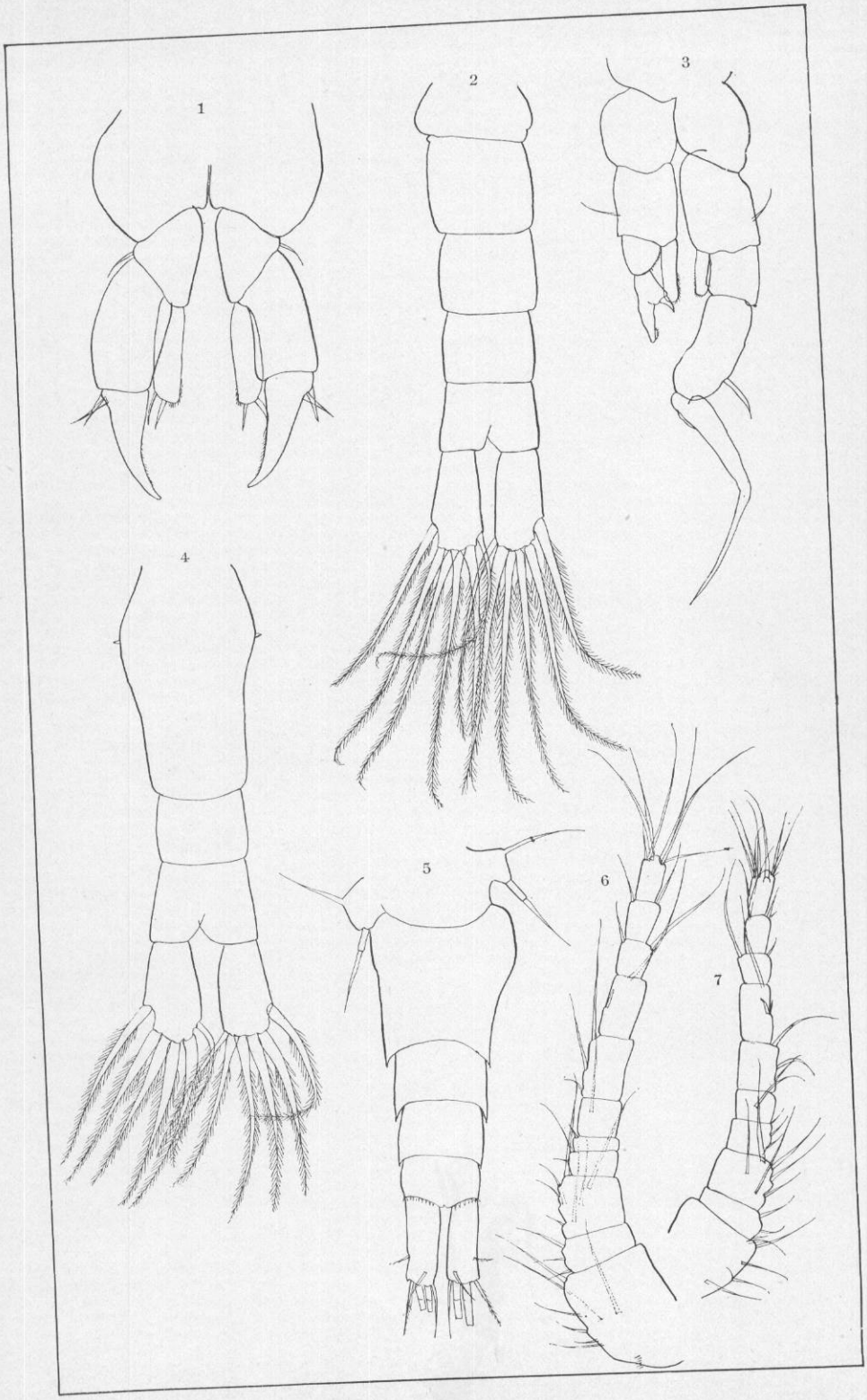

PLATE I.

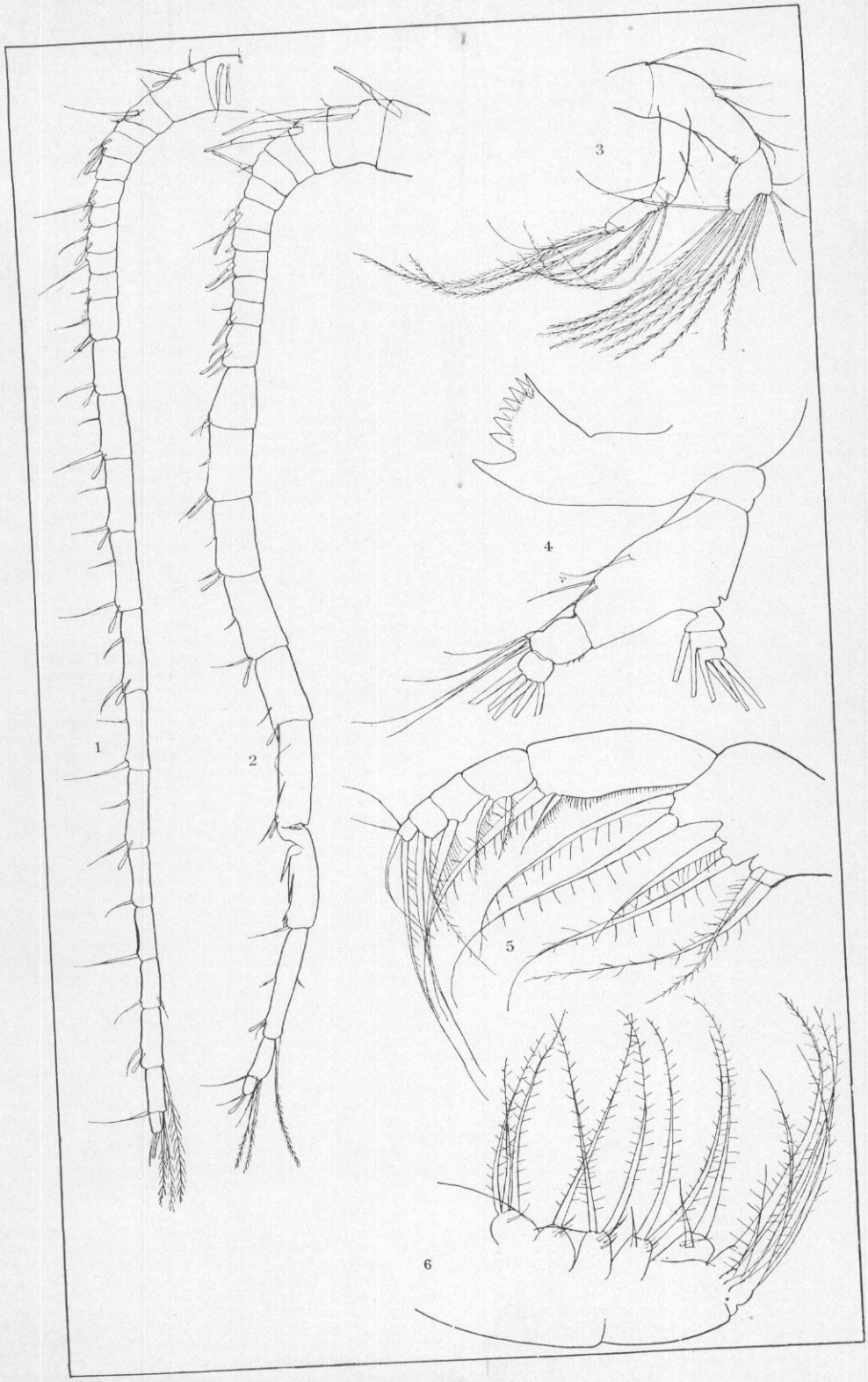

PLATE II.

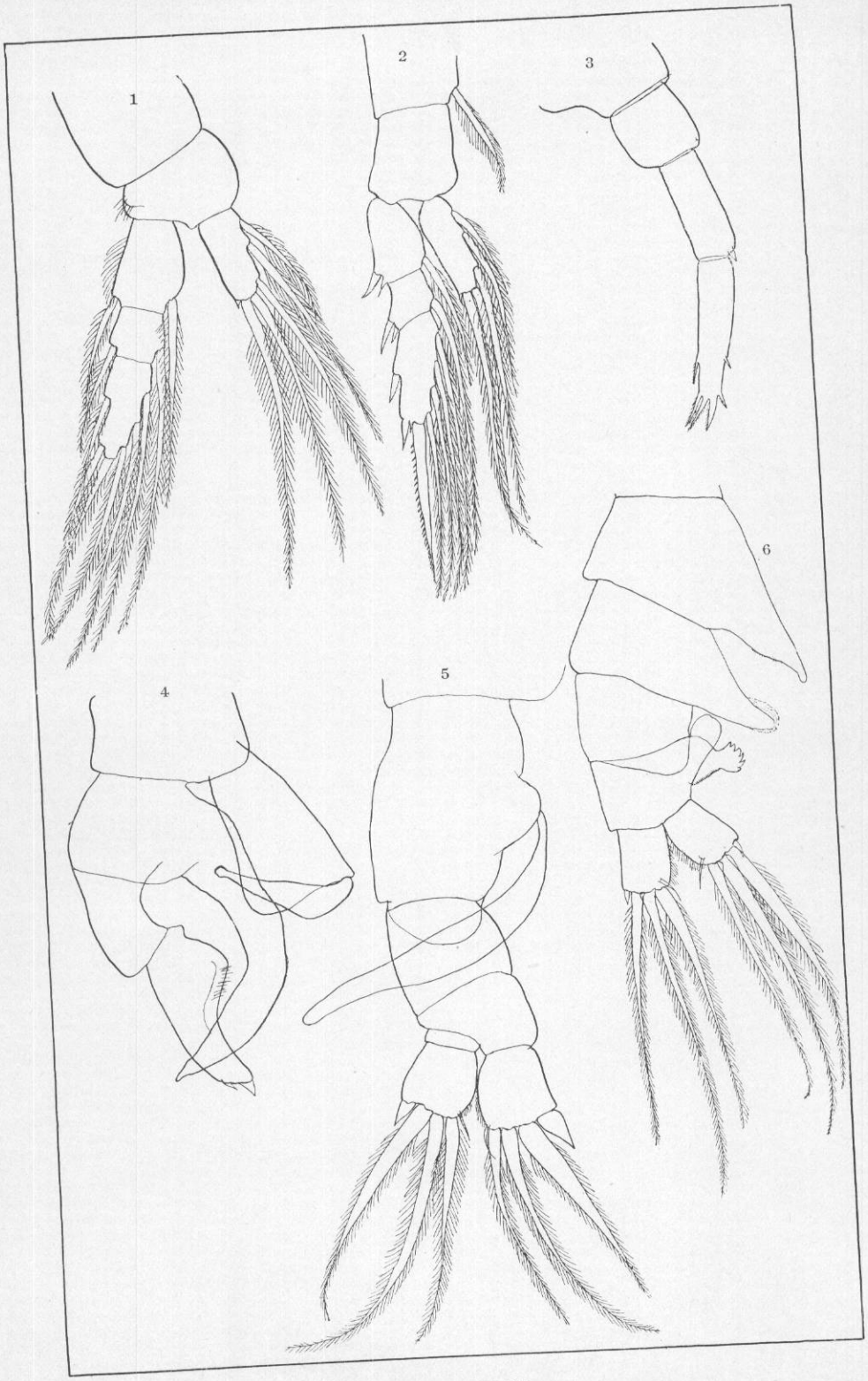

PLATE III.

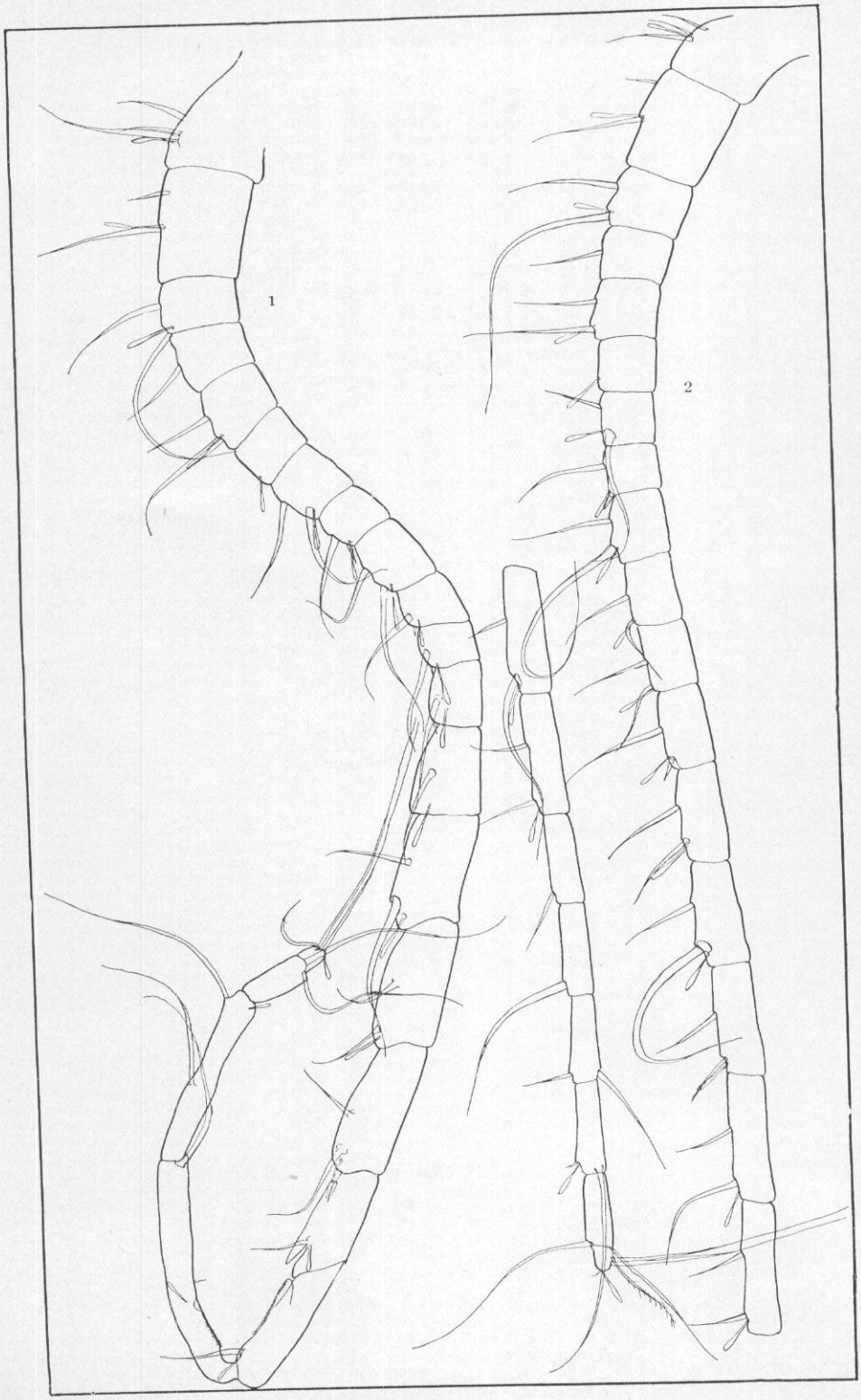

PLATE IV.

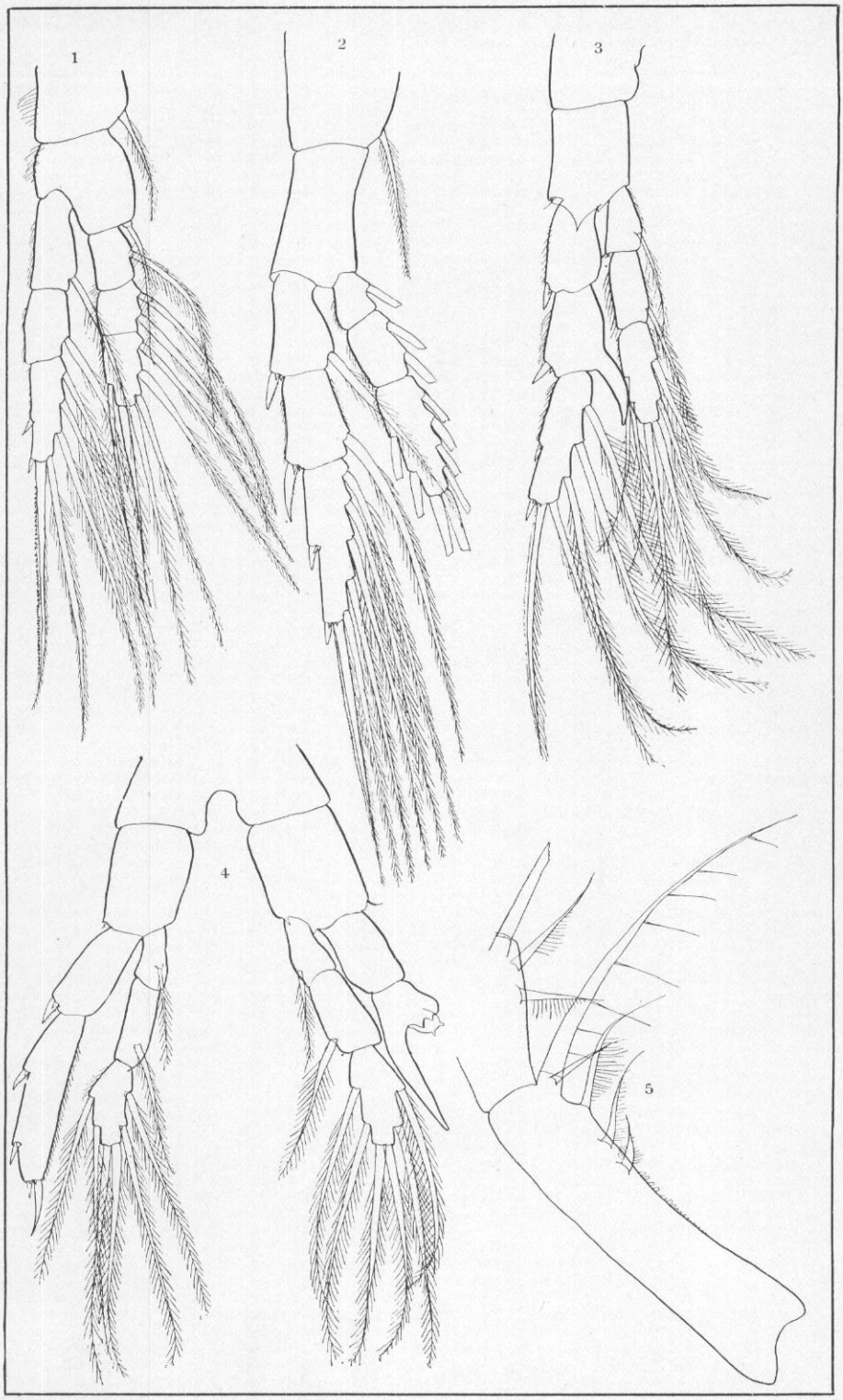

PLATE V.

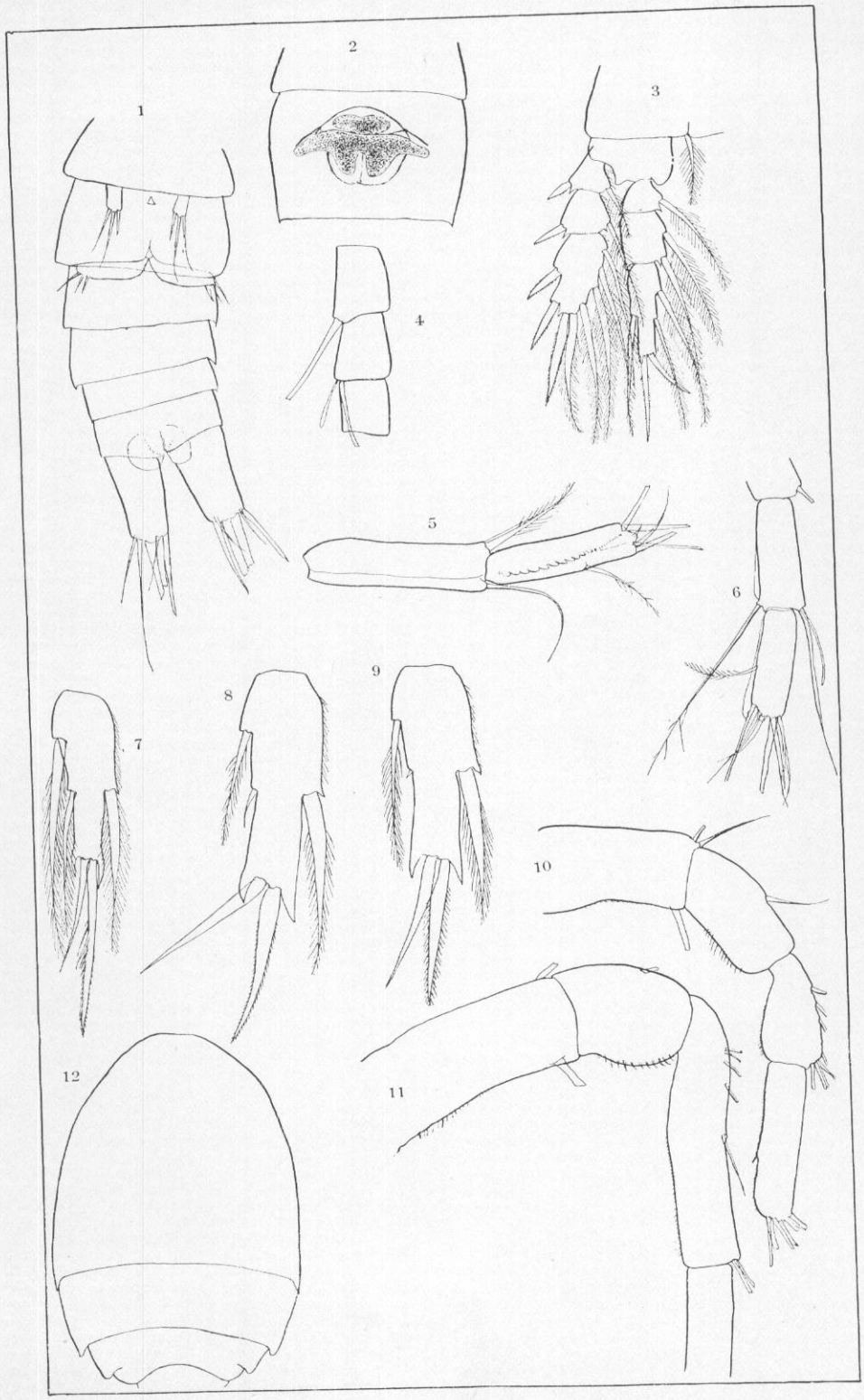

PLATE VI.

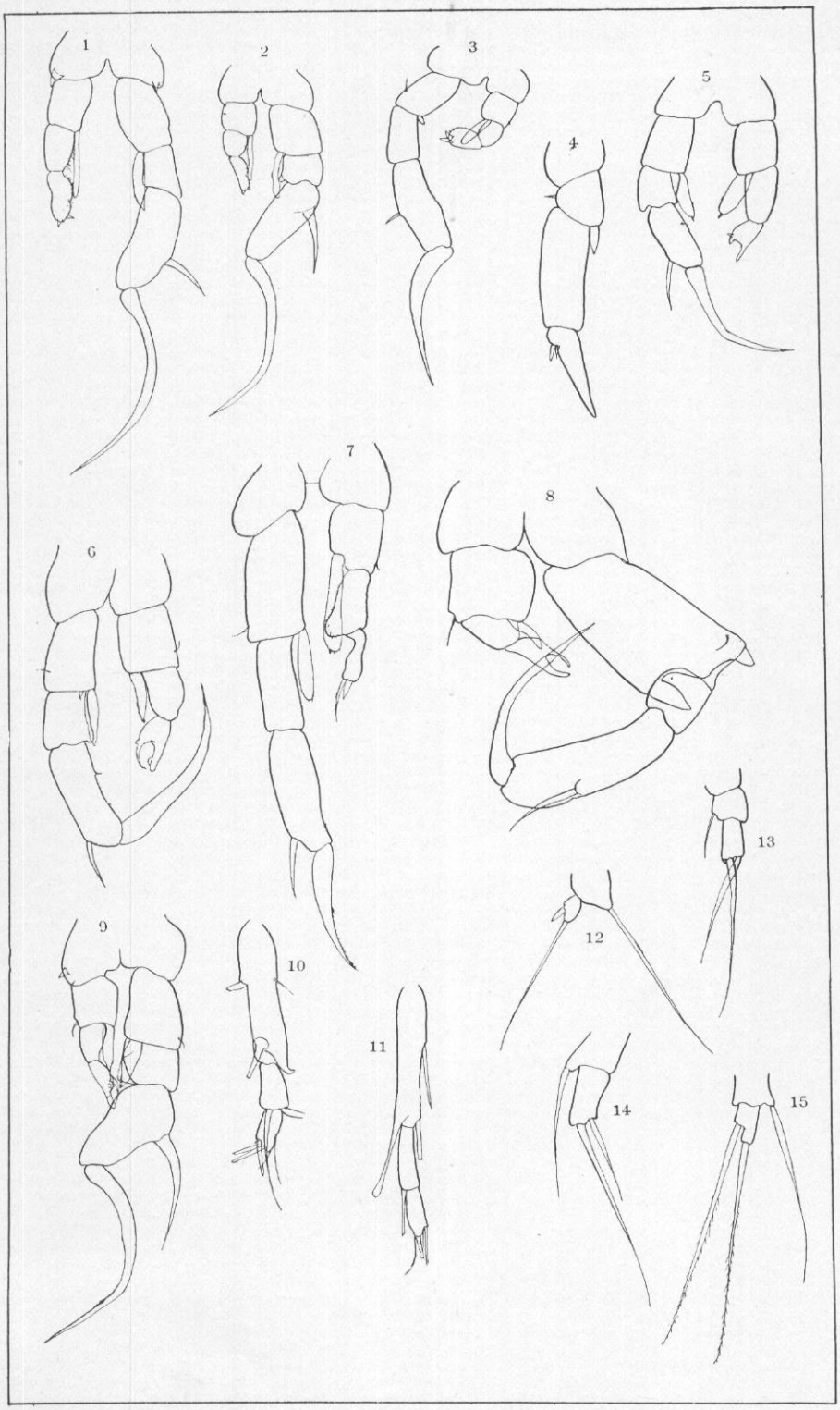

PLATE VII.

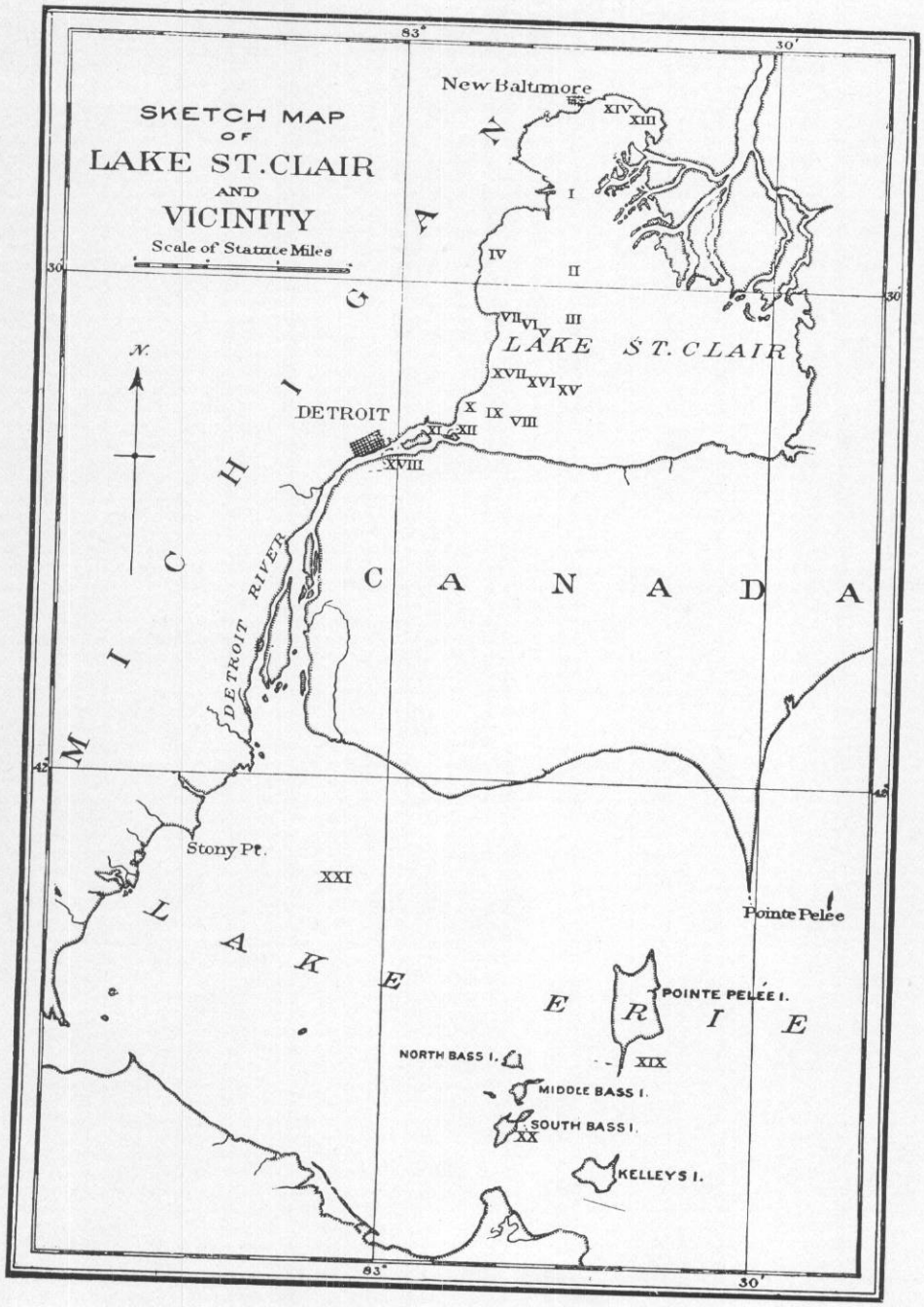
SKETCH MAP
OF
LAKE ST. CLAIR
AND
VICINITY
Scale of Statute Miles
83°
30′
New Baltimore
CANADA
LAKE ST. CLAIR
N.
DETROIT
MICHIGAN
DETROIT RIVER
CANADA
Stony Pt.
LAKE ERIE
Pointe Pelée
POINTE PELÉE I.
NORTH BASS I.
MIDDLE BASS I.
SOUTH BASS I.
KELLEYS I.
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII
XIII
XIV
XV
XVI
XVII
XVIII
XIX
XX
XXI
42°

PLATE VIII.