ARTICLE IV.—*The North American Centropagidæ belonging to the Genera Osphranticum, Limnocalanus, and Epischura.** BY FREDERICK WILLIAM SCHACHT, B. S.

INTRODUCTION.

In Article III. of this Bulletin the writer discussed the North American species of *Diaptomus*, and in the present paper, in furtherance of the same purpose, the genera *Osphranticum*, *Limnocalanus*, and *Epischura* are treated. In the introduction to the former article was given a short account of the work of writers on the *Entomostraca* now included in the family *Centropagidæ*, especially those genera found in North America. No reference is made there to the genera *Heterocope* and *Eurytemora*, since at that time I regarded the presence of these two genera in North America as rather doubtful.

The only statement that *Heterocope* was ever found on this side of the Atlantic is made by Cragin ('83)†. After an enumeration of the genera of fresh-water *Copepoda* he says: "Of these eleven genera, four—*Diaptomus*, *Limnocalanus*, *Cyclops*, and *Canthocamptus*—have been recorded as common to the Old World and the New. I add *Heterocope* on the authority of my friend, Mr. William Patten, who informs me that a species is common in Watertown, Massachusetts." This evidence is not sufficient to justify the treatment of the genus in this paper.

In regard to *Eurytemora* (=*Temora*=*Temorella*) I was perhaps overhasty in my conclusions, but it being now too late to remedy the omission, the following statements must suffice. In his "Final Report" Herrick ('84) notes the occurrence of *Temora affinis* Poppe in the rivers flowing into the Gulf of Mexico as well as in the brackish waters into which these rivers flow. In the "Crustacea of Alabama" ('87) he notes, under the name of *Temorella affinis*, a species which according to his statement is the same. The figures of

*This paper was accepted by the Faculty of the University of Illinois June 1, 1898, as a thesis for the degree of Master of Science in Zoölogy.

†The parenthetical figures in the text of this paper refer usually to the bibliography of Article III., which is, however, supplemented by an additional list appended to this discussion.

the species in question differ, however, so considerably in these two articles that, as Schmeil ('98) says, nothing certain can be said of this species until Herrick declares himself as to which of the two sets of drawings are correct. Schmeil regards Herrick's form as possibly a new species. The recent discovery of a new species of this genus, *Eurytemora herdmani* I. C. Thompson and A. Scott, in the St. Lawrence River and Gulf removes all doubt as to the presence of the genus in American waters.*

Of the three genera treated in this paper, *Osphranticum*, containing a single species, and *Epischura*, containing three†, are, so far as now known, confined strictly to North America and are strictly fresh-water in their habitat. *Osphranticum* is ordinarily found in shallow or stagnant lakes and ponds (Forbes) or in running water (Herrick), while *Epischura* occurs, as a rule, in deep clear lakes. The genus *Limnocalanus* is peculiar in its habitat. One of the two species, *L. sinensis* Poppe, from China, is, so far as known, a strictly fresh-water form, while the other, *L. macrurus* Sars, although found as yet in America in fresh water only, occurs in Europe and Asia in both fresh- and salt-water lakes and in the ocean. Since there are only these two species known, it was thought best to treat both in this paper. *L. grimaldii* de Guerne is regarded by the writer as a synonym of *L. macrurus* Sars‡, for reasons given in the discussion of the latter species.

A brief discussion of the structural similarities and differences indicative of the relationships of the genera *Osphranticum*, *Limnocalanus*, *Diaptomus*, and *Epischura* may properly precede this paper, special attention being given to characters which are regarded as of generic or specific value.

Giesbrecht, in his "Monograph" ('92), gives special rank to the structure of the first pair of antennæ as a distinguish-

*See "On the Plankton collected continuously during two Traverses of the North Atlantic in the Summer of 1897; with Descriptions of New Copepoda; and an Appendix on Dredging in Puget Sound." By W. A. Herdman, I. C. Thompson, and Andrew Scott. Trans. Liverpool Biol. Soc., Vol. XII. (1897), p. 79.

†*E. fluviatilis* Herrick is not considered one of these.

‡The *Zoologisches Centralblatt* (Jahrg., III., pp. 481–483) contains a review of an article by N. Zograf entitled "Essai d'Explication de l'origine de la Faune des lacs de la Russie d'Europe" in which a reference occurs to *L. macronyx* G. O. S. This is probably an error, since it is the only reference to a species of that name which I have been able to find.

ing character in the *Copepoda*. If this be taken as a basis of classification here, *Osphranticum*, with its 23-segmented antennæ, would form a group by itself, while *Limnocalanus*, *Diaptomus*, and *Epischura*, with their 25-segmented antennæ would constitute another group.

Osphranticum seems to be the most primitive of the American *Centropagidæ*, the fifth legs especially being less differentiated than in any of the other genera. This is particularly true of the female, in which all of the legs are biramose, each ramus consisting of three segments. In the male the left fifth leg is similar to the preceding legs, but the right one has a two-segmented outer ramus, the second segment being apparently formed by the coalescence of the second and third segments. In both sexes the inner rami of all the pairs of legs are alike.

Limnocalanus apparently approaches most closely to *Osphranticum*, the fifth pair of legs of the female being very similar in general structure to those of *Osphranticum*, as is perhaps most strikingly illustrated in the case of *L. macrurus* Sars and *O. labronectum* Forbes. In *Limnocalanus* both rami of the four anterior pairs of legs in both sexes are three-segmented and but slightly modified, as are also those of the fifth pair of legs of the female; but in the latter the second segment of the outer ramus is produced on the inner margin into a hook-like process, as in *Osphranticum*. The inner rami of the fifth pair of legs of the male are still three-segmented and similar to those of the preceding legs, but the outer rami are modified and are two-, or indistinctly three-, segmented.

Diaptomus is perhaps next in respect to modification. In this genus all the legs are biramose, but the first pair consists of a three-segmented outer, and a two-segmented inner, ramus. The following three pairs have both rami three-segmented. In the female the fifth pair of legs has a two- or, more rarely, three-segmented outer ramus, and a one- or, occasionally, two-segmented inner ramus. In the male the inner ramus is one- or, rarely, two-segmented, while the outer ramus of the right leg is three-segmented and that of the left leg two-segmented.

In *Epischura*, as in the other three genera, the cephalothorax is six-segmented. All of the swimming legs have a three-segmented outer, but a one-segmented inner, ramus. In the female the inner ramus has entirely disappeared in the fifth pair of legs, and the outer ramus is two-segmented. In the male also the fifth pair of legs are without inner rami, and the outer ramus of the right leg is two- or three-segmented, that of the left leg three-segmented. A peculiarity of this genus is the modification of the abdomen of the male into a clasping organ. The abdomen of the female is also modified in at least one species (*lacustris*).

So much for the relationships indicated by the structures considered. According to the above, *Osphranticum* must be regarded as the most primitive form, *Epischura* as the most modified, and *Limnocalanus* and *Diaptomus* as occupying an intermediate position. I think that the mass of characters will support this statement, although there are other characters which would lead one to doubt somewhat its correctness. For example, in *Osphranticum* and *Diaptomus* the females carry the eggs in an egg-sac, while in *Limnocalanus* and *Epischura* they do not. In *Osphranticum*, *Diaptomus*, and *Epischura* the spermatophore persists for some time; but I have not seen a single female *Limnocalanus* with a spermatophore, although according to Giesbrecht the fertilization by means of a spermatophore is about the only characteristic which all *Copepoda* have in common.*

The material at my command for the preparation of this paper has been complete; that is to say, I have had specimens of all the known species of the genera treated, and access to the most recent literature. The collections examined belong in great part to the Illinois State Laboratory of Natural History, in part to Prof. Frank Smith, of the University of Illinois, and in part to myself. The following localities are represented: Norway, the Caspian Sea, Lake Sitai and the Whangpoo River in China, Newfoundland, and the States

* "The sexually mature individuals are to some extent so transformed by parasitism that unless the fertilization by means of spermatophores be excepted they seem to have no characteristic common to all which would at the same time distinguish the order *Copepoda* from the other orders of *Entomostraca*." (Giesbrecht, '92, p. 40.)

of Illinois, Indiana, Ohio, Michigan, Washington, Oregon, Montana, Wyoming, Idaho, and Nevada.

Through the kindness of Professor Smith I was able to examine collections from Lake George and Lake James in Steuben County, Ind., in which I found specimens of *Epischura lacustris* and *Diaptomus oregonensis*. Mr. Chancey Juday, Curator of Collections, University of Indiana, kindly sent me collections from Tippecanoe Lake, Eagle Lake, and Turkey Lake, in Indiana, in which occurred *Epischura lacustris*, *Diaptomus sicilis*, *D. oregonensis*, and *D. siciloides*. I also acknowledge my indebtedness to Prof. G. O. Sars, who kindly furnished me with specimens of *Limnocalanus grimaldii*, thus enabling me to compare them with *L. macrurus*—also furnished by him to the Illinois State Laboratory of Natural History; to Herr S. A. Poppe, for specimens of *Limnocalanus sinensis*; to Professor Lillejeborg for *Epischura nevadensis*; and to Dr. C. A. Kofoid, Superintendent of the Illinois Biological Station at Havana, to whom I owe thanks for his many kindnesses during my stay at the Station in July, 1896, and while at the University.

No illustrations accompany this paper, since the species treated may be identified by figures already published.

OSPHRANTICUM Forbes.

Osphranticum, Forbes, '82a, p. 645.
*Potomoichetor**, Herrick, '82, p. 23.
Osphranticum, Herrick, '84, p. 134.
Osphranticum, Herrick, '87, p. 12.
Osphranticum, de Guerne et Richard, '89b, p. 149.
Osphranticum, Herrick and Turner, '95, p. 85.

Cephalothorax compact, six-segmented, the first two segments confluent above, the last segment produced into a bluntly-rounded lobe on each side. Abdomen (furca included) composed of five segments in the female, of six in the male. Furcal rami hairy on the inner margins; armed with five plumose setæ, the second from within the longest, and with a delicate smooth seta on the inner margin of the

*Spelled *Potamoichetor* in Herrick's subsequent references.

dorsal surface. First pair of antennæ 23-segmented; right male antenna geniculate between the 18th and 19th segments, and the 19th and 20th segments ankylosed. Second pair of antennæ, mandibles, and first, second, and third pairs of maxillæ as in *Diaptomus*, but stouter. All the swimming legs biramose, with three-segmented inner and outer rami; armed with stout setæ. In the female the legs of the fifth pair are alike, biramose, the rami three-segmented, the inner ramus the shorter. Fifth pair of legs of male biramose, dissimilar. Both rami of left leg three-segmented, the inner ramus the shorter. Outer ramus of right leg two-segmented, the inner three-segmented and like the inner ramus of the left leg. Egg-sac obovate.

Osphranticum labronectum Forbes.

Osphranticum labronectum, Forbes, '82, p. 645, Pl. VIII., Fig. 24, 28, 29; Pl. IX., Fig. 1, 2, 4, 5, 7, 9.
Potomoichetor fucosus*, Herrick, '82, p. 224, Pl. II., Fig. 12–14; Pl. III., Fig. 1–8, 13, 14.
Osphranticum labronectum, Herrick, '84, p. 134, Pl. Q2, Fig. 1–8, 13, 14.
Osphranticum labronectum, Herrick, '87, p. 12.
Osphranticum labronectum, de Guerne et Richard, 89b, p. 149, Fig. 1, 2.
Osphranticum labronectum, Herrick and Turner, '95, p. 86, Pl. XII., Fig. 1–8, 13, 14; Pl. LIX., Fig. 7, 8.

Of medium size, body compact, widest before the middle. Cephalothorax composed of six segments decreasing gradually in length from before backward; first two segments confluent above, the last segment slightly produced at the angles into bluntly-rounded points, but unarmed. Abdomen (furca included) composed of five segments, decreasing in length from before backward. Furcal rami, however, slightly longer than the preceding segment and about twice as long as wide; hairy on the inner margin and armed with five long plumose setæ of which the second from within is the broadest and longest, the middle one being next in length, and the other three subequal; dorsal surface of each ramus armed near the inner apical angle with a delicate smooth seta. Abdomen of male composed of six segments: the first shorter

*Spelled *Potamoichetor* in Herrick's subsequent references.

than any of the others except the fifth, which is the shortest; the second, third, and fourth segments decreasing in length in regular order; the second slightly shorter than the furcal rami, which are armed as in the female.

Antennæ 23-segmented, extending about to the end of the cephalothorax, or barely surpassing it. Right male antenna geniculate between the 18th and 19th segments; 19th and 20th segments ankylosed; six segments preceding the geniculation rather thickly swollen; penultimate segment produced at the inner apical angle into a broad bluntly-rounded process extending slightly beyond the end of the segment.

Fifth pair of legs of male biramose. Second basal segment of right leg armed above the middle of the outer margin with a delicate hair slanting upward. First segment of outer ramus slightly longer than the width at the base, irregularly trapezoidal, the outer margin forming the longest side; armed at the outer apical angle with a stout spine about as long as the segment itself and provided on each margin with a narrow hyaline lamella; just within this, another very minute spine. Second segment irregular in form, the proximal third subquadrate, about as wide as the preceding segment, produced at the inner apical angle in the form of a rather large cushion-like pad sparsely covered with delicate hairs; distal two thirds subquadrate, about half as wide as the proximal third, provided on the inner margin with delicate hairs, and armed a short distance above the middle of the outer margin with two spines, one large and one small, similar to those on the preceding segment; apex of segment armed with three spines fully as long as the segment itself, the outer two straight, the inner curved inward slightly, and each of them provided with a hyaline lamella, the edges of which seem to be plumose. Just posterior to the inner apical seta is a short slender spine.

First segment of inner ramus of right leg irregular in form, about as long as wide, provided on the inner margin with a few fine hairs. Second segment slightly wider than the preceding, barrel-shaped, and slightly longer than wide; provided on the inner margin with a few fine hairs, and at the

outer apical angle with a long delicate plumose seta. Third segment slightly narrower than the second; margins sulcate, armed with six subequal plumose setæ similar to the seta on the preceding segment, of which three are apical, two are on the outer margin, and one is on the inner. The setæ are so placed as to form two groups of three each.

Basal segments of left fifth leg like those of right leg. First segment of outer ramus similar to the corresponding segment of the outer ramus of the right leg and similarly armed, but not quite so broad. Second segment subquadrate, about one and a half times as long as wide; outer apical angle armed as in the preceding segment; inner margin provided with a few delicate hairs. Third segment considerably narrower than the second and slightly shorter; armed at the apex with two lamellate setæ and a short sharp spine. Inner ramus like that of right leg.

Fifth pair of legs of female biramose. Second basal segment provided on the outer margin, a short distance above the middle, with a delicate hair slanting upward. First segment of outer ramus subquadrate, slightly broader than long; armed at the outer distal angle with a long lamellate spine, and on each side of this with a very minute smooth spine. Second segment somewhat shorter and narrower than the preceding; armed at the outer distal angle like the first segment, except that the inner of the small spines is wanting; inner apical angle produced into a long, moderately stout lamellate hook, shaped about like the blade of a pruning knife; both margins provided with a few fine hairs. Third segment slightly longer than the second, about twice as long as wide; armed at the outer apical angle with a plumosely lamellate spine almost as long as the segment itself, and at the apex with two similar subequal spines (about twice the length of the lamellate spine) and a short smooth spine; outer margin provided with a few long fine hairs; inner margin sulcate and armed with four slender subequal plumose setæ about as long as the segment.

Inner ramus of fifth leg of female three-segmented, the first segment irregular in shape, with a somewhat projecting

inner apical angle. Second segment subquadrate, about one and a half times as long as wide; armed at the outer apical angle with a plumose spine almost twice as long as the segment, and on the inner margin with a few fine hairs. Third segment slightly longer and narrower than the preceding; irregularly triangular, with sulcate margins and truncate apex; armed on the outer margin with two long, slender, plumose setæ, at the apex with two similar setæ and a short smooth spine, and on the inner margin with one seta similar to those already mentioned and one shorter lamellate seta, and provided on the upper half with a few fine hairs.

Length of female, 1.703 mm.; that of male, 1.362 mm.

The above description was prepared from specimens collected in the summer of 1896 at the Illinois Biological Station, at Havana, Ill.; from type specimens; and from other State Laboratory material collected at various times and places, mostly in Illinois.

The single species of this exclusively North American genus was first described by Herrick in a paper read before the Minnesota Academy of Sciences in 1879, but which, owing to a fire, was not published until 1882. The description then appeared, under the name *Potomoichetor fucosus*, in the Tenth Annual Report of the Geological and Natural History Survey of Minnesota (Herrick '82). This Report was not distributed, however, until after the August number of the "American Naturalist" appeared, which contained the description of *Osphranticum labronectum* by Forbes ('82).

De Guerne and Richard, in their "Revision" ('89b), publish the best figures of this species. Although not strictly correct in every particular, the omissions are of minor importance, as may be seen by the following enumeration of them. In the fifth legs of the female the hair on the second basal segment, the small spines at the outer apical angles of the segments of the outer ramus, the hairs on the outer margins of these segments, and the lamella of the hook at the inner apical angle of the second segment of this ramus are not figured. The third segment of the inner ramus is not quite correct. Here the hairs on the inner margin, the

lamella on the upper spine of this margin, and the small spine on the apex of the segment are all omitted. In the figures of the fifth pair of legs of the male, the small spines at the outer apical angles of the segments of both outer rami, the spine at the inner apical angle of the last segment of the right outer ramus, and the hairs on the inner margin of the first segment of both inner rami are wanting.

Although this species is widely distributed,—having been found in Alabama, Illinois, Minnesota, Oregon, and Wyoming,—no differences sufficient to establish even a new variety have been found in specimens from these localities so widely separated and so varied in character. Herrick, in his papers, states that all the specimens examined by him, from Alabama to Minnesota, had 24-segmented antennæ. Forbes found the antennæ 23-segmented, de Guerne and Richard, who examined specimens sent to Poppe by Forbes, agreed with him, and the writer also found the antennæ of all the specimens he examined to be 23-segmented. The specimens collected by Dr. Forbes in April, 1877, and described in 1882, were uniform pale brown; those collected by the writer at Havana, Ill., in July, 1896, were hyaline or opalescent white; while a single male found in June, 1897, at Urbana, Ill., in a temporary pool, was bright scarlet throughout, and hardly to be distinguished from the specimens of *D. sanguineus* among which it was found. Herrick has found *Osphranticum* in "estuaries of running water," and says that according to his observations it prefers such localities. The writer's observations tend to confirm Forbes's statement that it prefers swamps and pools, or at least quiet or stagnant water. At the Biological Station at Havana, during the summer of 1896, a single specimen was captured in the Illinois River, in midstream, while in Quiver Lake, in a mat formed of *Ceratophyllum* and *Lemna* in a stagnant portion near shore (substation C), they were comparatively numerous, though not occurring in any such numbers as either *Diaptomus* or *Cyclops*. In fact, in none of the collections examined were they at all common.

Prof. Forbes, in connection with the original description,

makes a remark in regard to the "steady movement in the water," and this is all, to my knowledge, that has been said about the habits of *Osphranticum*. The following statements, gathered from observation of a number of specimens kept for some time in a large flat dish may therefore be of interest. Their movements in the water are very different from the short jerky springs of *Cyclops*, and they differ also from those of *Diaptomus* in that they are more regular. The motions of these three genera might perhaps be expressed by telegraphic symbols as follows: *Cyclops*, – – – – – – – –; *Diaptomus*, – —— – —— – —— – ——; and *Osphranticum*, ———— ———— ————. *Osphranticum* swims equally well on the dorsal or ventral surface, seeming, however, to prefer the former position. As in *Diaptomus*, the anterior end is elevated in swimming, and the antennæ are actively employed. Sometimes it will turn backward somersaults, going over and over in the water, but I have seen this done only when individuals were swimming on the back. When startled they would dart to the bottom, hide for an instant under a bit of debris, and then make another dash, repeating the performance until they deemed themselves out of danger.

Since *O. labronectum* is the only species known, no key will be required.

LIMNOCALANUS G. O. SARS.

Limnocalanus, Sars, '62, p. 226.
Centropages, de Guerne, '86, pp. 276–285.

Body long and narrow, the front armed with two hook-like processes. Cephalothorax widest at the middle, composed of six well-defined segments; last thoracic segment not produced laterally but slightly projecting posteriorly and armed on each side with a minute blunt spine. Abdomen slender; in the female composed (furca included) of four (*macrurus*) or five (*sinensis*) segments. Furcal rami very long; hairy on the inner margin; armed with five stout plumose setæ (the second from within the longest), and one slender seta (plumose in *sinensis*), shorter than the rest, on the dorsal surface,

near the inner margin and opposite the outermost of the other setæ.

First pair of antennæ shorter than the body, 25-segmented, the last segment very small. Right male antenna geniculate between the 18th and 19th segments, each of which is armed with a hyaline lamina. Outer ramus of second pair of antennæ seven-segmented* and armed with very long setæ. Mandibles produced at the inferior extremity into nine teeth, of which the outer two are longer than the rest, the inner two slender and setiform; palpus long and narrow, three-segmented, the last two segments very short, outer ramus small, armed with long setæ. First pair of maxillæ about as in *Diaptomus*. Second pair of maxillæ robust, eight-segmented, the last segment produced into long stout claws; margins otherwise sparsely hairy; the falcate apex bare or armed with very small dense spines. Maxillipeds seven-segmented, much elongated and narrow, directed forward, and armed with numerous long setæ.

All the swimming legs biramose. Both rami of the four anterior pairs of legs three-segmented, the inner shorter than the outer.

Outer ramus of fifth pair of legs of female three-segmented; armed within, on the second segment, with a very strong, curved, hook-like process. Inner ramus as in the other legs.

Outer ramus of right fifth leg of male two- (*sinensis*) or indistinctly three- (*macrurus*) segmented, the second segment produced into a stout hook-like process. Outer ramus of left fifth leg two-segmented, the second segment armed with a slender digitiform process. Inner rami three-segmented, alike, and similar to those of the preceding pair (*macrurus*), or differing from one another (*sinensis*). Eye single, near the lower margin of the head.

This genus was established by Dr. Sars in 1862 to receive

*The parts of the generic description referring to the structure of the second pair of antennæ, the mandibles, maxillæ, maxillipeds, and the swimming legs are compiled from Sars ('62 and '97), Nordqvist ('88), and de Guerne and Richard ('89b). In regard to the second pair of antennæ of *macrurus* the writers mentioned state that the outer ramus is seven-segmented, and Nordqvist says further that the suture between the second and third segments is indistinct, and figures the antenna with six segments. Sars ('97) says of *grimaldii* that the outer ramus is six-segmented and so figures it. After careful examination, I find no difference in the second pair of antennæ of *macrurus* and *grimaldii*, the segmentation being equally distinct, each of the four spines between the second and last segments marking a segment.

a fresh-water centropagid closely resembling the marine genus *Calanus*, and until 1889 *L. macrurus* was the only representative known. In that year Poppe described (de Guerne et Richard, '89b) a new species, *L. sinensis*, from China. The latter, so far as now known, is a purely fresh-water form, and *L. macrurus* was at first so regarded, but in Asiatic and European countries it has been found to occur in both fresh and salt water,—in America it has as yet been found only in fresh water,—and further search may show that *L. sinensis*, too, is common to both. *L. macrurus* is the only American representative of the genus, but it was deemed best to include *sinensis* in this paper, thus making the revision of the genera treated complete.

As already stated, the genus is represented by only two species, *macrurus* and *sinensis*. The former is common to America, Europe, and Asia, having been found in the river Jana (in East Siberia), in the Caspian Sea, in the Arctic Ocean, in the lakes of northern Norway, Sweden, and Finland, and in the deeper northern lakes of North America; the latter, *sinensis*, has been found only in eastern China.

Marsh, in his "Limnetic Crustacea of Green Lake" ('97), records some observations on the habits of *Limnocalanus*, and states that it is repelled by bright light and high temperatures, and hence performs diurnal migrations which are more pronounced in cold weather. It seems to have two periods of maximum occurrence, May and November, but is found at all times, although never very abundantly. In March and April most of the individuals are immature.

To my knowledge *Limnocalanus* has never been found with an egg-sac, differing in this respect from *Osphranticum* and *Diaptomus* but agreeing with *Epischura*. The spermatophore, a slender tubular structure, adheres to the female for a considerable time after attachment.

From a practical and economic standpoint *Limnocalanus* is of importance as contributing to the first food of *Coregonus clupeiformis* (Forbes '83a), of *Labidesthes sicculus**, and probably of other lake fishes.

*See Forbes "On the Food Relations of Fresh-water Fishes: a Summary and Discussion." Bull. Ill. State Lab. Nat. Hist., Vol. II., Art. VIII., p. 532. 1885.

Since there are only two species of *Limnocalanus* known, the key is naturally very simple, and only the most striking differences are used.

KEY TO THE SPECIES OF LIMNOCALANUS.

Based on the Characters of the Female.

1 (2). Hook-like process at inner apical angle of second segment of outer ramus of fifth leg armed for the entire length of both margins with fine symmetrical teeth. Outer apical angle of same segment armed with a stout serrate spine. Second basal segment without plumose seta at outer apical angle. *macrurus.*

2 (1). Hook-like process at inner apical angle of second segment of outer ramus of fifth leg armed on the entire inner margin with large teeth and on the outer margin with a few fine ones*. Outer apical angle of same segment without spine. Second basal segment without plumose seta at outer apical angle. *sinensis.*

Based on the Characters of the Male.

1 (2). Right outer ramus of fifth legs 3-segmented (third segment indistinct). Hook-like process of second segment of this ramus simply and but slightly curved; provided with hyaline plate. Inner rami alike. *macrurus.*

2 (1). Right outer ramus of fifth legs clearly 2-segmented. Hook-like process of second segment of this ramus somewhat sinuously curved. Inner rami unlike. *sinensis.*

Limnocalanus macrurus SARS.

Limnocalanus macrurus, Sars, '62, p. 226.
Limnocalanus macrurus, Forbes, '82a, p. 649.
Centropages grimaldii, de Guerne, '86, p. 276.
Limnocalanus macrurus, Nordqvist, '88, p. 31. Pl. I., Fig. 9–11; Pl. II., Fig. 1–5; Pl. III., Fig. 1–4.

*In de Guerne and Richard's "Revision," Fig. 5a in the description of Plate IV. should be Fig. 15a.

Limnocalanus macrurus, de Guerne et Richard, '89b. p. 77, Pl. IV., Fig. 5, 11, 12.
Limnocalanus macrurus auctus, Forbes, '90, p. 648.
Limnocalanus macrurus, Marsh, '93, p. 201, Pl. IV., Fig. 7.
Limnocalanus macrurus, Marsh, '95, p. 11, Pl. IV., Fig. 1, 2; Pl. V., Fig. 1–5.
Limnocalanus macrurus, Herrick and Turner, '95. p. 49, Pl. I., Fig. 1–4.
Limnocalanus grimaldii, Sars, '97, p. 39, Pl. IV., Fig. 1–18.

Body slender. Thorax rather more than one fourth as broad as long, and composed of six well-defined segments, of which the first (constricted at about the middle and armed at the front with two hook-like processes pointing forward and downward) is the longest—about equal to the three succeeding segments taken together; third and fourth segments subequal, together slightly longer than the second, which is armed on the dorsal and lateral surfaces, near the distal end, with a row of rather stout spines; fifth segment somewhat longer than the last, which is not produced laterally, but armed on each side with a very small spine. Abdomen of female composed of four segments, the first about a third longer than either of the two succeeding segments, which are subequal. Furcal rami about a fifth longer than the first segment, and slightly shorter than the second and third segments taken together; sparsely provided on the dorsal surface with short sharp spines, and on the inner margin with spines and hairs; one plumose seta on the outer margin at the beginning of the distal fifth; and four plumose apical setæ and a delicate smooth seta on the dorsal surface near the inner apical angle. In the male the first and fourth abdominal segments are subequal, each about a fourth longer than the fifth, which is the shortest; second and third segments subequal, each about twice as long as the fifth; second, third, and fourth segments armed like the second abdominal segment of the female. Furcal rami proportioned about as in the female and similarly armed.

Antennæ 25-segmented; right male antenna geniculate between the 18th and 19th segments. The armature of the segments is as follows: 1 and 10 have a short seta and two sense-hairs; 2, a short seta and three sense-hairs; 3, a short

seta and a sense-hair; 4, a short seta and a short spine; 5 and 7, a long seta, a short one, and a sense-hair; 6, a short stunted spine; 8, a short broad seta, a short curved spine, and a sense-hair; 9, a long broad seta and a sense-hair; 11, a short broad seta and a sense-hair; 12, a sense-club, a short curved spine, and a short broad seta; 13, a short broad seta and a sense-club; 14, a long seta and a short broad seta; 15, a sense-club and two short broad setæ; 16, a long seta, a sense-club, and a short broad seta; 17, a sense-club, and a broad, pointed, knife-like process; 18, a long sense-club, and a hyaline lamella armed with teeth and extending almost the entire length of the segment; 19, 20, and 21 (ankylosed, the suture between 19 and 20 obscurely indicated), a blunt digitiform process at the inner apical angle, a seta, a blunt stunted spine slightly below the middle, and a stunted spine and a knife-like process still lower down; 22 and 23, (ankylosed, suture indistinct), two setæ and a sense-hair; 24 two setæ; and 25 (very short), four setæ and a sense-club.

First basal segment of right fifth leg of male subquadrate. Second basal segment about as wide as the first and about twice as long, provided at the outer apical angle with an inconspicuous hyaline process. First segment of outer ramus considerably narrower than the second basal segment, less than twice as long as wide; armed at the outer apical angle with a stout spine, serrate on the inner margin, and on the inner margin below the middle with a hyaline process. Second segment slightly narrower than the first; produced at the inner apical angle into a hook-like process, which is armed on the outer margin, near the base, with two sharp slender spines, and provided on both margins with a hyaline lamina having an appearance of transverse striation. The hook is fully three times as long as the segment itself.

Inner ramus of right fifth leg three-segmented, the first segment irregular in form, about twice as long as wide; armed on almost the entire outer margin with a few fine hairs, and at the beginning of the distal third with a slender plumose seta. Second segment somewhat wider than the

first, and rather more than twice as long as wide; armed on the outer margin with a few hairs and a moderately stout plumose seta. Third segment about as wide as the second, with margins sulcate; outer margin armed with two stout plumose setæ, the proximal third with a few fine hairs; inner margin and apex each armed with two stout plumose setæ.

First basal segment of left fifth leg subquadrate, having near the inner apical angle a large tubercle bearing a few rather long hairs. Second basal segment somewhat narrower than the preceding and not twice as long as wide; armed at the outer apical angle with a prominent hyaline process. First segment of outer ramus subquadrate, rather more than twice as long as wide; armed on the inner margin, at the beginning of the distal third, with a small process provided with hairs, and at the outer apical angle with a short blunt spine and a long stout movable spine serrate on the inner margin. Second and third segments ankylosed, forming one very long narrow segment, slightly narrower than the first and more than twice as long; provided for the greater part of the inner margin with hairs, and armed on the outer margin with three spines, the upper two similar to the larger one of the preceding segment, the third sometimes serrate on both margins; provided at the inner apical angle with a narrow digitiform process about half as long as the segment itself and serrate on the outer margin.

Inner ramus of the left fifth leg very similar in every respect to that of the right leg.

First basal segment of fifth leg of female of the ordinary form. Second basal segment about as wide as the first and barely twice as long as wide; outer half of the distal margin produced in the form of an irregularly triangular flap extending over the margin of the first segment of the outer ramus. First segment of outer ramus quadrate, about twice as long as wide; armed at the outer apical angle with a stout spine serrate on the inner margin. Second segment somewhat narrower than the first and not quite twice as long as wide; armed with hairs on both margins and at the outer apical angle with one short spine and a longer, stouter one serrate

on the inner margins; inner apical angle produced in the form of a moderately curved hook armed on both margins with spines or teeth. Third segment narrower than the second and fully three times as long as wide; hairy on the upper part of both margins, and armed on the outer margin, at the beginning of the distal third, with two spines, one stout and serrate and the other short and smooth; outer apical angle armed with three spines, two short and smooth, the other long and serrate on the inner margin; inner margin sulcate, and armed with two stout plumose setæ; apex armed with two setæ, the inner seta plumose on both margins, the outer plumose on the inner margin and provided on the outer with a hyaline lamina.

Inner ramus of fifth leg of female three-segmented. First segment hairy on the outer margin; outer apical angle armed with a moderately stout plumose seta. Second segment subquadrate, more than twice as long as wide; hairy on both margins; armed at the outer apical angle with a plumose seta. Third segment somewhat longer and broader than the second; margins sulcate, both hairy at the upper part; armed with six stout plumose setæ, two apical and two on each margin.

Length of female 2.2—2.6 mm.; that of male 2.05—2.4 mm.

The above description was prepared from specimens of *L. macrurus* sent by Professor Sars to the Illinois State Laboratory of Natural History, and from specimens of *L. grimaldii* kindly sent by him to me. Nothing further need be said about *L. macrurus*, the type of the genus, except in regard to synonymy and distribution.

The original description of the species appeared in the "Forhandlinger i Videnskabs-Selskabet i Christiana" (Sars '62). De Guerne ('86) described it under the name of *Centropages grimaldii*; Nordqvist, in "Die Calaniden Finlands" ('88), made this a synonym of *L. macrurus*; and de Guerne and Richard, in their "Revision" ('89b), acknowledged the correctness of Nordqvist's view. Recently, however, Professor Sars, in his "Pelagic Entomostraca of the Caspian Sea" ('97), re-established de Guerne's form as a new species of

Limnocalanus, *L. grimaldii* de Guerne. Except for a difference in size and in the proportions of the segments of the fifth legs of both sexes, which segments are somewhat less robust in the fresh-water form than in the one from the Caspian Sea, and but for a slight though noticeable difference in the lateral aspect of the head, the two forms exactly correspond. It does not seem to me that such slight differences warrant the establishment of a new variety, much less of a new species. With the exceptions just noted, the details of structure mentioned in the foregoing description are equally prominent in both forms, as are those noted in the following discussion of the published figures of the species.

The best illustrations of *L. macrurus* are given in "Die Calaniden Finlands" (Nordqvist, '88) and in the "Revision des Calanides d'eau douce" (de Guerne et Richard, '89b), although in neither publication are they strictly correct. De Guerne and Richard's figures of the fifth pair of legs of the female do not show the projection of the second basal segment over the first segment of the outer ramus, nor the hairs on the inner margin of the second segment of this ramus and on the third segment of the inner ramus, nor the serrations on the spine at the outer apical angle of the last segment of the outer ramus. Nordqvist says that the outer ramus has three segments but figures it with two. The inner ramus he represents as smooth on the outer margin of all its segments, and gives the ordinary form to the outer of the two setæ on the apex of the last segment of the outer ramus, while de Guerne and Richard picture it with a hyaline lamina on both margins and a few fine spinules on the inner margin. Neither is correct with regard to this seta, since it is plumose on the inner margin and has a hyaline lamina on the outer one.

Both de Guerne and Richard's and Nordqvist's figures of the fifth pair of legs of the male fail to show the hairs on the inner margins of the inner rami, the hyaline processes on the outer margin of the second basal segment of the left leg and on the first segment of the right outer ramus, and the serrations on the hook of the last segment of the left outer ramus. Further, Nordqvist fails to figure the hyaline process on the

second basal segment of the right leg, the two spines on the outer margin near the base of the hook of the second segment of the right outer ramus, the serrations of the apical spine of the second segment of the left outer ramus, and the process on the inner margin of the first segment of the same ramus. De Guerne and Richard omit the tubercle on the inner apical angle of the first basal segment of the left leg, the hairs on the inner margin of the second segment of the left outer ramus, and the hyaline lamina on the process of the second segment of the right outer ramus, which is figured by Nordqvist as being on the outer margin only, while it is really on both. Nordqvist also fails to show the spines at the base of the outer margin of this hook.

I have had no opportunity to examine specimens of the marine genus *Centropages*, but the drawings of the fifth pair of legs of the female of *L. macrurus* and of *C. hamatus* are so similar that it is hardly to be wondered at that de Guerne regarded the two forms as belonging to the same genus. The fifth pair of the legs of the males also show the same general structure in the two genera, although they differ materially in detail.

L. macrurus is the only species of the family *Centropagidæ* which is common to Europe and America. This is probably due to the fact that it occurs in both fresh and salt water, and thus the Atlantic offers no barrier to its distribution. It has been recorded from Sweden, Norway, and Finland, from the Kara and Baltic Seas and the Gulf of Finland, and from the ocean off Spitzbergen; and it is probably widely distributed in the countries of northern Europe and Asia. In America it was first recorded from Lake Michigan (Forbes, '82), and later, under the name of *L. macrurus auctus*, from Lake Superior (Forbes, '90). Marsh ('93 and '95) found it in Green Lake, Wisconsin, in Lake St. Clair, Michigan, and in Lake Huron.

Limnocalanus sinensis Poppe.

Limnocalanus sinensis, de Guerne et Richard, 89b, p. 79, Pl. IV., Fig. 4, 15, 15a, 16.
Limnocalanus sinensis, Herrick and Turner, '95, p. 49.

Body six-segmented, slender, more attenuate at the anterior than at the posterior part; suture between head and thorax distinct. Second thoracic segment about as long as the other five, which differ but little in length. Last two thoracic segments distinct, the last segment somewhat produced posteriorly and armed on each side with a short blunt spine. First abdominal segment barely three times as long as the second, which is but slightly longer than the fourth; third segment about one and three fourths times as long as the second. Furcal rami more than twice as long as the third segment and barely four times as long as broad; somewhat sparsely hairy within. All of the furcal setæ in both sexes distinctly plumose, the innermost seta much more slender than the others and placed on the dorsal surface of the ramus, almost directly opposite the base of the outer one. In the male the first and fifth segments are subequal, each slightly longer than the second and third, which are also about equal. Fourth segment the shortest, about three fourths as long as the second. Furcal rami fully three times as long as the fourth segment, about four and a half times as long as broad, and armed as in the female.

Antennæ 25-segmented, hardly extending to the base of the furca. Right antenna of the male moderately swollen from the 12th to the 18th segments inclusive. The armature of the segments anterior to the 10th segment is as follows: 11 has a sense-club and a short seta; 12, a sense-club, a short seta, and a short curved spine; 13, a sense-hair and a sense-club; 14, a sense-hair, a sense-club, and a long plumose seta; 15, a sense-hair, a sense-club, and a long spine; 16, a sense-hair, a sense-club, and a long plumose seta; 17 a broad knife-like process and a sense-club; 18, a short stunted spine, another spine somewhat longer, and a hyaline lamina armed with teeth about half as long as the lamina is broad; 19, 20, and 21 (completely ankylosed), a short

stunted spine, a long plumose seta, two processes, and a hyaline lamina armed with teeth about as long as the lamina is wide and occupying about a third of the margin slightly below the middle; 22 and 23 (completely ankylosed), a short seta, a short stunted spine, and a long plumose seta; 24, two long plumose setæ; and 25 (very short), three long plumose setæ and a sense-club.

First basal segment of right fifth leg of male not characteristic. Second basal segment irregular in form, about two and a half times as long as wide, armed on the anterior aspect, below the inner proximal angle, with a stout sharp spine, and at the middle of the inner margin with a number of exceedingly short hairs or spines. First segment of outer ramus narrower than second basal segment, about one and three fourths times as long as wide; armed at the outer distal angle with a straight sharp spine serrate on the inner margin. Second segment produced in the form of a long stout sub-sigmoid hook, widest some distance below the base and tapering gradually to a rather blunt point; inner margin of broadest part roughened by a number of irregularly disposed ridges, otherwise both margins perfectly smooth.

Inner ramus of right fifth leg three-segmented, the first segment subelliptical, more than twice as long as wide, and hairy at the middle of the inner margin. Second segment considerably broader than the first, bulging out at the middle and armed here with a few rather long hairs; inner apical angle armed with a rather short plumose seta. Third segment subelliptical, more than twice as long as wide; armed with six stout plumose setæ, two apical and two on each of the lateral margins.

First basal segment of left fifth leg not characteristic. Second basal segment about one and three fourths times as long as wide; armed at the outer distal angle with a plumose seta, and at the middle of the inner margin with a few very short hairs or spines; produced at the inner apical and proximal angles into smooth hemispherical processes, the lower of which is the larger. First segment of outer ramus subquadrate, about twice as long as wide, produced at the

middle of the inner margin into a smooth rounded process, and armed at the outer apical angle with a stout straight spine serrate on the inner margin. Third segment about twice as long as its greatest width, dilated at the middle of the inner margin and armed here with a few rather long hairs; outer margin armed with three spines similar to the one on the preceding segment, and at the apex with a long, narrow, slightly curved process, perfectly smooth, and somewhat longer than the segment from which it springs.

Inner ramus of left fifth leg three-segmented. First segment subquadrate, slightly more than twice as long as wide; provided at the middle of the inner margin with a hemispherical process armed with a few scattered hairs. Second segment somewhat broader than the first and about as long; armed at the inner proximal angle with a small sharp spine, and at the middle of the inner margin with two irregularly roughened processes provided with hairs; a long plumose seta on the inner margin just below the lower of the two processes. Third segment slightly narrower and shorter than the second, both margins sulcate, armed with six stout plumose setæ arranged about as in the corresponding segment of the inner ramus of the right leg.

First basal segment of fifth leg of female subquadrate. Second basal segment about as wide as the first and approximately one and three fourths times as long as broad; hairy at the middle of the inner margin and armed on the outer apical angle with a plumose seta. First segment of outer ramus subquadrate, about one and three fourths times as long as broad; armed on the inner margin, near the proximal angle, with a smooth hemispherical process, and on the outer apical angle with a stout spine, serrate on the inner margin. Second segment slightly narrower at the base than the first, but widening distally and produced at the inner apical angle into a stout hook-like process armed on the inner margin with six or seven strong teeth, largest near the middle of the hook, and near the proximal end with five or six smaller teeth. On the outer margin of the hook and opposite the smaller teeth of the inner margin are a number of rather minute

teeth. Third segment about half as wide as the second and approximately three times as long as its greater width; inner margin sulcate and armed with five stout parallel plumose setæ; outer margin armed with two strong straight spines, the upper at about the beginning of the distal third, the lower at the apical angle, and both serrate on the inner margin. Just within the apical spine are a short blunt process and a long, narrow, awl-like process almost twice as long as the segment.

Inner ramus of fifth leg of female three-segmented, the first segment subelliptical, somewhat less than twice as long as wide, and hairy at the middle of the inner margin. Second segment a little wider than the first, about twice as long as wide, hairy at the middle of the inner margin; outer apical angle armed with a stout plumose seta. Third segment about as wide as the first, margins sulcate; armed with six stout plumose setæ, two apical and two on each side.

Length of female about 1.65 mm.; that of the male 1.60 mm.*

The above description is based on specimens kindly sent me by Herr S. A. Poppe. On examination I found a few minor differences between the specimens sent me and the original figures. These differences I note below. The second thoracic segment instead of being only as long as the two succeeding ones is about as long as the remainder of the thorax. The innermost furcal seta is plumose instead of smooth—as figured in the original drawings. In the fifth pair of legs of the male the spines on the outer ramus of the left leg were found to be serrate on the inner margin instead of smooth. The spine or seta on the outer apical angle of the second basal segment of this leg is plumose. The inner margin of this segment is hairy or minutely spinose. Neither the short hook-like spine at the inner proximal angle of the second segment of the left inner ramus, nor the stout straight spine (serrate on the inner margin) at the outer apical angle of the right outer ramus is figured or described in de Guerne and Richard's "Revision." I was unable to find the hairs

* Measurements as given in de Guerne and Richard's "Revision" (89b).

which Poppe figures on the inner margin of the second segment, and on the outer margin of the third segment, of the outer ramus of the fifth leg of the female.

This species differs so much from *L. macrurus*, that it might almost be regarded as the type of a new genus, but Poppe has not considered the differences as of generic value, nor have de Guerne and Richard. Unlike *L. macrurus*, the inner rami of the fifth pair of legs of the male although both three-segmented differ from one another, and the right outer ramus is composed of two segments instead of three. In the female the differences are not so striking, for while the outer rami are noticeably unlike, the inner rami are very similar.

This species was found in Lake Sitai, China, and in the Whangpoo River, which flows from it, the waters of both of which are perfectly fresh. To my knowledge it has not yet been recorded from any other locality.

EPISCHURA FORBES.

Scopiphora (?), Pickering, '44, p. 62.
Epischura, Forbes, '82a. p. 647.
Epischura, Herrick, '83a. p. 384.
Epischura, Herrick, '87, p. 13.
Epischura, Herrick and Turner, '85, p. 81.
Epischura, de Guerne et Richard, '89b, p. 141.

Cephalothorax more or less distinctly six-segmented. Abdomen (furca included) composed of five segments in the female and of six in the male; in the female, of the ordinary form (*nevadensis, nordenskiöldi*) or flexed to the right and provided with a process on the right side of the second segment (*lacustris*); in the male, straight or very slightly flexed (*nordenskiöldi*) or strongly flexed to the right (*lacustris, nevadensis*); in the males of all species, second, third, and fifth segments provided on the right side with processes. Furcal rami hairy on the inner margin, provided in both sexes with three plumose terminal setæ, one slender simple seta at the inner apical angle, and a stout spine at the outer apical angle.

First pair of antennæ 25-segmented. Right male antenna geniculate between the 18th and 19th segments; segments

19—21, and 22 and 23 ankylosed; antepenultimate segment unarmed; segments preceding geniculation very slightly swollen. Second pair of antennæ about as in *Diaptomus*.

All the swimming legs biramose, the outer ramus three-segmented, the inner, one-segmented. Fifth pair of legs of the female alike, uniramose, three-segmented, the first segment of the ramus being, however, really the second basal segment; armed at the outer apical angle with a hair or delicate spine. Third segment armed with a varying number of spines (5—7).

Fifth pair of legs of the male unlike, uniramose, modified into a grasping organ. Right leg two- (*lacustris*, *nevadensis*) or three-segmented (*nordenskiöldi*); last segment almost always flexed. Left leg three-segmented, the first segment produced on the inner margin to form a strong hook-like process; last segment variously armed on the outer margin with a number of spines, and provided on the inner margin with fine long hairs.

Female generally bears spermatophore, and does not carry eggs in egg-sac.

Inhabits deep fresh water lakes.

As will be seen from the above, the doubtful *E. fluviatilis* Herrick has not been considered in this description, but only the three recognized species, *lacustris*, *nevadensis*, and *nordenskiöldi*.

The species of this genus seem not to be fully differentiated from each other. This is illustrated by the variable armature of the fifth pair of legs of the females, *nevadensis* having sometimes one and sometimes two spines at the outer apical angle of the second segment and either six or seven spines on the last segment, and *nordenskiöldi* also varying in the latter respect, having sometimes five and sometimes six spines. All female specimens of *lacustris* observed, were constant in the armature of the fifth legs, but in the left fifth leg of the male the second segment, although generally unarmed, was sometimes provided at the outer apical angle with a small spine.

This genus, confined so far as known to North America,

and represented in different sections by different species, is found from Newfoundland on the north and east to Washington on the west, and as far south as central Illinois and Indiana.

KEY TO THE SPECIES OF EPISCHURA.

Based on the Characters of the Female.

1 (2). Abdomen flexed to the right; second segment armed on the right side with a process. Furcal setæ and spines very broad. Fifth leg with last segment twice as long as the first; last segment armed with seven spines. *lacustris.*

2 (1). Abdomen straight; second segment unarmed. Furcal setæ and spines of ordinary width.

3 (4). Fifth legs very robust, first segment almost as wide as long; second segment sometimes armed with two spines; third segment armed with six (occasionally seven) spines. *nevadensis.*

4 (3). Fifth legs slender, first segment considerably longer than wide; second segment armed with a single small spine; third segment armed with five (sometimes six) spines. *nordenskiöldi.*

Based on the Characters of the Male.

1 (2). Abdomen straight, abdominal processes small and inconspicuous. Right leg three-segmented, the first segment armed on the inner margin with a hook; second and third segments armed at the outer apical angle with a small spine. Process on first segment of left leg but slightly curved. *nordenskiöldi.*

2 (1). Abdomen flexed to the right; abdominal processes large. Right leg two-segmented.

3 (4). First segment of right leg with subtriangular toothed plate on the inner margin, and a hair at the outer apical angle. First segment of left leg very stout and strongly curved; second segment unarmed. *nevadensis.*

4 (3). First segment of right leg entirely unarmed. First segment of left leg with comparatively slender process; second segment armed at the outer apical angle with a small spine. *lacustris.*

Epischura nordenskiöldi LILLJEBORG.

Epischura nordenskiöldi, de Guerne et Richard, '89b, p. 94, Pl. I., Fig. 36; Pl. II., Fig. 15, 23.

Epischura nordenskiöldi, Herrick and Turner, '95, p. 85, Pl. XI., Fig. 2, 5, 9.

Epischura nordenskiöldi, Schmeil, '98, p. 183.

About medium size, body rather robust, widest in front of middle. Cephalothorax six-segmented, the first two segments confluent and together somewhat longer than the remainder; third segment slightly longer than either of the last three, which are subequal; last two segments distinct, the last segment produced on each side at the posterior angle into a bluntly-rounded lobe armed at the tip with a minute spine. Abdomen (including furca) five-segmented, slender, a little less than half as long as the cephalothorax; first two segments indistinctly confluent below; third segment slightly longer than the fourth. Furcal rami about twice as long as broad and ciliate on the inner margin; armed at the apex with three slender plumose setæ fully three times as long as the ramus itself, at the outer apical angle with a short stout spine, and on the dorsal surface, near the inner margin, with a delicate smooth seta. Abdomen of male (furca included) six-segmented, the second, third, and fifth segments armed on the right side with prehensile processes; flexed to the right but slightly or not at all. First segment somewhat broader than long, slightly produced along the left margin into a process ending at the posterior angle in a lobe-like expansion. Second segment slightly narrower and longer than the first; produced on the right side in the form of a subtriangular plate, somewhat longer than wide and pointing obliquely backward. The process is armed at the tip with a small sharp spine, on the inner margin, near the apex, with two or three rather large teeth, and within these with a number of smaller

ones. Third segment slightly shorter than the preceding; process very simple, small and inconspicuous, bluntly pointed, extending almost straight backward; armed on outer margin, near the tip, with a slight, blunt protuberance. Fourth segment unarmed, about half the length of the first. Fifth segment about as long as the fourth; armed with a narrow triangular plate, broadest anteriorly and bluntly rounded at the apex. Dextral margins of the fourth and fifth segments tuberculate. Furcal rami about as in the female.

Antennæ 25-segmented, extending almost to the base of the furca. Right antenna of the male geniculate between the 18th and 19th segments; segments preceding the geniculation slightly or not at all swollen.

Right fifth leg of the male three-segmented. First segment irregular in form, about twice as long as wide, armed on the outer margin, near the distal angle, with the usual delicate hair; inner margin provided with a curious, smooth, bluntly-pointed hook-like process extending downward almost parallel to the margin. Second segment irregular, about twice as long as wide; outer margin smoothly convex, armed near the distal angle with a small spine; outline of inner margin sinuous. Third segment long and narrow, with a broad basal portion about half as wide as the segment is long; curved inward slightly at the tip and armed here, on the outer margin, with a minute spine.

First segment of left fifth leg with a subquadrate main portion produced on the inner margin into a long, smooth broad hook but slightly curved; armed at the outer distal angle with the usual hair. Second segment somewhat narrower than the first, subquadrate, about twice as long as wide; outer distal angle armed with a small sharp spine; inner margin sometimes with indications of minute teeth or serrations at about the middle. Third segment curved inward slightly, about as broad as the second and fully four times as long as broad; armed on the outer margin with four rather small sharp spines, the first at about the middle, the second midway between this and the apex of the segment, the other two near the apex and nearer together than the upper ones; armed on

the distal part of the inner margin with long delicate hairs. This segment is much simpler than the corresponding segment of *lacustris* and *nevadensis*.

Fifth pair of legs of the female uniramose, three-segmented. First segment subquadrate, somewhat longer than wide, armed near the outer distal angle with a hair or delicate spine. Second segment somewhat narrower than the first and slightly longer; armed at the outer apical angle with a small sharp spine. Third segment slightly narrower than the second and barely one and a half times as long; armed with five or six spines*, two (one) outer, one inner, and three apical. Of the outer spines, the upper one is at about the middle of the segment and the lower one is directly opposite the inner spine. Of the apical spines, the middle one is spinulose on both margins and the outer one on the inner margin.†

Length of female 1.9 mm.;‡ that of male 1.1 mm.

The above description was prepared from specimens kindly sent me by Dr. Lillejeborg, the measurements, however, with the modification explained in the foot-note, being those given in the original description. The material was a part of that collected by Dr. C. Nyström, a member of the Nordenskiöld expedition to Greenland in 1871, and was not in the best state of preservation, owing no doubt to the length of time since its collection.

Figures of this species may be found in de Guerne and Richard's "Revision" ('89b), and imperfect copies of these in Herrick's "Synopsis" (Herrick and Turner '95). The fifth pair of legs of the male are correctly represented in the "Revision" except that the spine at the outer apical angle of the right leg is not shown; indeed it is not mentioned in the description. The spine figured on the outer margin of the

* The armature of this segment differs somewhat in different specimens. See on a subsequent page the discussion in regard to the fifth leg of the female.

† Having only a few specimens to study, I could not satisfactorily determine whether the other spines were also spinulose or not, but I am quite positive with regard to the two mentioned. I think it likely that they are armed as in *lacustris*.

‡ It is quite evident that a mistake was made in regard to the measurements given in the original description: "Length of female, caudal setæ excepted, about 2.9 mm., and of male 1.1 mm." In the specimens I examined there was no such difference in length in favor of the female; in fact the single entire female I had the opportunity to measure was 1.333 mm. in length, while the average length of five males was considerably above this—1.698 mm. I have hesitated to substitute these measurements because of the limited number examined, and have altered Lillejeborg's figures to what I think they were intended to be.

second segment of the right leg, which Schmeil ('98) says he could not find, was present in all the specimens examined by the writer. In one of the two specimens of females examined the last segment of the fifth leg was armed with five spines, as shown in the original figures, while the other had six. I think that six may perhaps be found to be the rule, in which case the species approaches *nevadensis* and *lacustris* more closely, the former having six and sometimes seven spines, and the latter constantly seven. The fact that none of the other writers, Lilljeborg, de Guerne and Richard, and Schmeil, have mentioned the existence of a sixth spine would, however, militate against this assumption.

The male of *nordenskiöldi* is very easily distinguished from the males of the other two species. The fifth pair of legs, while of the same general type as in the rest of the genus, are less modified and yet very characteristic. But for the fact that it is, as a rule, difficult to make out, the hook-like process on the first segment of the right leg would alone serve to distinguish *nordenskiöldi*. Further, the right leg is three-segmented instead of two; the last segment is armed on the outer margin, at the apex, with a small spine; and the hook on the first segment of the left leg is comparatively simple. The abdomen is also less modified than that of *nevadensis* and *lacustris*. Instead of being quite strongly flexed to the right it is almost or entirely straight, while the processes are small and inconspicuous, there being some difficulty in discerning the one on the fifth segment.

The fifth pair of legs of the female also serve, though not so readily, to distinguish this species. They differ from those of *lacustris* in that the last segment is armed with only five or six spines, instead of seven, and in the relative length of the segments. From the fifth legs of *nevadensis* they may be distinguished by the difference in proportions, those of *nevadensis* being much more robust than those of *nordenskiöldi*, which are intermediate between the other two. The different arrangement of the spines on the last segment, the occasional absence of the sixth spine on this segment, and the presence, at least occasionally, of a second spine at the outer apical

angle of the second segment of the leg of *nevadensis*, will all assist in determining the species.

De Guerne and Richard (89b) make the statement that the females always have the spermatophore—which they describe as curved in a semicircle around the abdomen—attached. On none of the females examined by the writer was this structure present. It may of course have been torn off, although even then the statement that it is always present seems to me too strong, since in *E. lacustris* and *E. nevadensis* the female, even when mature, is very often found without a spermatophore.

Epischura nevadensis Lilljeborg.

Epischura nevadensis, de Guerne et Richard, '89b, p. 93, Pl. II., Fig. 17, 24; Pl. III., Fig. 21.
Epischura nevadensis columbiæ, Forbes, '93. p. 254, Pl. XLI., Fig. 19–21.
Epischura nevadensis, Herrick and Turner, '95, p. 84. Pl. XI., Fig. 1, 6, 8.
Epischura nevadensis columbiæ, Herrick and Turner, '95, p. 84, Pl. XI., Fig. 4, 10.
Epischura nevadensis, Schmeil, '97, p. 183.

Of medium size and somewhat oval in form, broadest before the middle. Front armed on each side with a hook-like process pointing downward. Cephalothorax six-segmented, the second segment the longest, about twice as long as the first or last, which are subequal, the remaining three segments subequal, each about a fourth the length of the second. First two segments somewhat confluent, as are the last two; last segment, seen from above, not produced and entirely unarmed. Abdomen (furca included) composed of five segments, the first two confluent and together almost as long as the two following, which are subequal and slightly longer than the furca. Furcal rami subquadrate, very short and broad, and provided on the posterior part of the inner margin with a few fine hairs; armed at the outer apical angle with a stout pointed spine, and at the inner apical angle with a slender smooth seta, posterior margin armed with three long delicately plumose setæ, of which the inner is the longest, the other two being about equal. In the male the abdo-

men is asymmetrical, flexed to the right, and consists of six segments (furca included). The segments vary but little in length, the furca being, however, the shortest, the fifth, second, and first increasing in length in the order of their mention, the third and fourth subequal, each slightly longer than the first. Seen from above, the first segment is produced slightly to the left at its posterior margin. Second, third, and fifth segments armed with processes on the right side. The process on the second segment is a broad thin lamina about as long as the segment is broad, smooth on the convex anterior margin and for about the distal fourth of its posterior margin (which is almost straight), but for the remaining three fourths of this margin provided with minute irregular teeth having a tendency to point toward the abdomen; apex acute and slightly recurved. The process on the third segment springs from the posterior part as a broadly rounded smooth hyaline lamina slightly longer than broad. Fourth segment unarmed. Fifth segment provided with two processes, the anterior one (pointing forward and upward) consisting of a narrow irregularly triangular plate with an acute apex and smooth margins, the posterior one having the form of a truncated triangle, armed at the apical margin with three or four large equal teeth and one or two much smaller ones. Posterior to this process the right margin of the segment is armed with a row of bead-like tubercles which, near the suture between the furca and this segment, lengthen to form two or three blunt spines. Furcal rami slightly longer proportionally than in the female, but similar in other respects.

Antennæ 25-segmented, long and slender, extending slightly beyond the posterior end of the third abdominal segment in the female and beyond the fourth segment in the male. Right male antenna geniculate between the 18th and 19th segments; segments 19, 20 and 21, and 22 and 23 ankylosed; antepenultimate article unarmed.

Right fifth leg of male two-segmented. First segment irregularly pentagonal, the longest base forming the outer margin, which is armed near the distal angle with a delicate seta; basal half of inner margin armed with a broad irregu-

lar hyaline plate which near its middle is somewhat produced and provided with a number of delicate serrations. Second segment consists of a broader basal portion and a narrow terminal part, the latter constituting about three fourths the entire length, and extending upward to the middle of the inner margin of the preceding segment; apex produced at the inner margin, forming a kind of hook.

Left fifth leg uniramose, three-segmented. First segment armed near the outer apical angle with a delicate seta and produced on the inner margin into a large plate-like hook almost as broad as the segment and strongly curved inward. Second segment irregular in shape, slightly longer than broad, and unarmed.* Third segment or terminal hook contorted, about twice as long as the second segment; basal portion broad, with a projecting inner angle; inner margin sinuous, the lower curve densely provided with fine long hairs; outer margin armed with three short, sharp unequal spines increasing in size from above downwards; the attenuate apex provided with a spine considerably larger than the others.

Fifth leg of female uniramose, three-segmented. First segment subquadrate, with flaring sides; armed near the outer apical angle with a rather delicate smooth seta. Second segment subquadrate, about one and a half times as long as the first and about two and a half times as long as broad; armed at the outer distal angle with a short sharp spine (occasionally with two subequal spines). Third segment (terminal spines excluded) about as long and wide as the second; outer margin armed with a short sharp spine at about the beginning of the distal half (another spine occasionally present a short distance above this); apex provided with three spines, the two outer ones subequal and the middle one considerably larger; inner margin armed with two spines near the apex of the segment, the upper about half the size of the lower, and the margins of both denticulate.

Length of female 2–2.5 mm.; that of male 1.7–2.1 mm.

The above description is based on type specimens of *E.*

*On one or two specimens I noticed quite a large tubercle, with a roughened tip, projecting from the anterior aspect of this segment near the outer proximal angle, but did not find it at all constant.

nevadensis columbiæ Forbes; on other specimens collected in the same localities—Swan Lake and Flathead Lake, Montana; and on specimens from Gamble's Lake and Lake Pend d'Oreille, Idaho, from Lake Tahkemitch and Tsiltcoos Lake, Oregon, and from Lake Union and Lake Washington, Washington, sent to the State Laboratory by Messrs. Evermann and Meek of the U. S. Fish Commission. I had also a large number of the Nevada form kindly sent me by Prof. Lilljeborg, but, unfortunately, there was not a single mature individual in this lot, and for this reason I cannot say on my own responsibility that *E. nevadensis* Lilljeborg and *E. nevadensis columbiæ* Forbes are identical. A careful examination of the material at hand, however, inclined me to that belief, and, moreover, Professor Schmeil, both in a personal letter and later in the "Bibliotheka Zoologica" (Schmeil, '97) says that they are, after having examined authentic specimens from both localities. He states also that Professor Forbes was perfectly justified in establishing his *columbiæ* as a new variety, since Lilljeborg's descriptions and figures are inaccurate in several respects. In the following paragraph are given the points in which my observations differ from those of Forbes and of Lilljeborg.

In all the specimens examined the segments of the fifth leg of the female are proportionately longer and narrower than figured by Lilljeborg. This fact may be due to his having made his drawings from an individual not perfectly matured. This difference was noted by Forbes in his description of *columbiæ* ('93). The appendage near the outer distal angle of the first segment of this leg is correctly drawn as a seta by Lilljeborg, while Forbes's figure represents it as spine-like. The fact that a second spine is occasionally found at the outer distal angle of the second segment must have been observed by Lilljeborg, since his drawings show it, although no mention of it is made in the original description of *nevadensis* (de Guerne et Richard, '89b). Forbes refers to it in his description of *columbiæ* but does not figure it. A seventh spine on the outer margin of the last segment was correctly said by Forbes to be occasionally present. Lilljeborg does not seem

to have found this spine, but Schmeil confirms Forbes's statement. The inner two spines on the last segment are serrate on both margins, but this fact is shown in none of the figures, nor is it mentioned in the literature referred to. The first segments of the fifth pair of legs in the male are each provided with a rather delicate seta near the outer distal angle. This is shown in the published figures, but Lilljeborg mentioned only the one on the left leg. The ordinary appearance of the lamina of the second segment of the right leg is best shown in Forbes's figures.

This species is quite common in the western United States, having been found to occur in considerable quantities in collections from Nevada, Idaho, Oregon, Washington, and Montana, and further collections will no doubt show a still more general distribution. It occurred in collections with *Diaptomus ashlandi* Marsh and with *D. minutus* Lilljeborg.

Epischura lacustris Forbes.

Scopiphora vagans (?), Pickering, '44, p. 62.
Epischura lacustris, Forbes, '82a, p. 648, Pl. VIII., Fig. 15, 16, 21–23, 25–27; Pl. IX., Fig. 8.
Epischura lacustris, Herrick, '84, p. 131, Pl. Q, Fig. 15.
Epischura lacustris, de Guerne et Richard, '89b, p. 90, Pl. IV., Fig. 3, 9, 10.
Epischura lacustris, Forbes, '90, p. 704, Pl. I., Fig. 1–5; Pl. II., Fig. 7.
Epischura lacustris, Forbes, '93, p. 255.
Epischura lacustris, Marsh, '93, p. 200, Pl. IV., Fig. 6.
Epischura lacustris, Marsh, '95, p. 10, Pl. II., Fig. 1–6; Pl. III., Fig 1–6.
Epischura lacustris, Herrick and Turner, '95, p. 82, Pl. XIII., Fig. 15.

Of medium size. Body elliptical, widest before the middle. Cephalothorax composed of six segments, the first two subequal and together somewhat longer than the remaining four. Third, fourth, and fifth segments subequal and together about equal to the first. Sixth segment slightly longer than any of the three preceding; not produced laterally. Abdomen flexed to the right, the first segment very short. Second segment the longest and about equal to the remainder of the abdomen

(furca included); produced on the right side into a slight semicircular process. Third segment and furcal rami subequal, each slightly longer than the fourth segment. Furcal rami very broad and delicately hairy within; armed at the outer apical angle with a short, sharp broad spine (the one on the right ramus the larger), and within this with three delicately plumose apical setæ, the outer of which, at the base and for a considerable part of its length, is even broader than the spine but gradually tapers and ends in a delicate flagellum, while the other two setæ are much narrower than the outer seta but about as long. At the inner apical angle is a much smaller delicate smooth seta. Abdomen of male much more strongly flexed to the right than that of female, composed of six segments (furca included), the second, third, and fifth produced on the right side. First segment short, about twice as broad as long. Second segment somewhat longer than the first, the process about as long as the segment is wide, with a smooth anterior margin and an irregularly serrate inner margin with a hooked tip. Third segment about as long as the first; process about as long as the segment, of nearly the same width throughout, the tip bluntly rounded and armed anteriorly with a hemispherical tuberculate cushion or pad, and on the posterior margin, almost opposite, with another similar process. Fourth segment slightly longer than the third, and unarmed. Fifth segment slightly shorter than the fourth and armed with two processes, the anterior of which is perfectly smooth, pointing forward and to the right, the posterior one pointing almost straight to the right, armed on the anterior margin with a number of large teeth (8—10), its posterior margin smooth at the tip but minutely denticulate for the basal three fourths. Furcal rami armed about as in the female but with no such difference in the width of the apical setæ and with narrower spines.

Antennæ 25-segmented, extending to the posterior margin of the fourth abdominal segment. Right male antenna slender, geniculate between the 18th and 19th segments; segments 19—21, and 22 and 23 ankylosed; antepenultimate segment without special armature.

Left fifth leg of male uniramose, three-segmented. First segment subquadrate, produced on the inner margin into a long, broad, strongly curved hook-like process about twice as long as the main part of the segment and armed at the tip with a broad blunt spine; provided at the outer apical angle with a rather stout hair or spine. Second segment about as long as the first but much narrower; margins parallel, the inner margin concave; usually unarmed but sometimes provided at the outer apical angle with a minute sharp spine. Third segment irregularly triangular in form and about one and a half times as long as the second, somewhat produced at the inner proximal angle; armed at the tip with a short broad spine, on the outer margin with three spines, dividing it approximately into thirds, and on the inner margin with a close row of long delicate hairs.

Right fifth leg uniramose, two-segmented. First segment irregular in form, the outer margin almost straight, the inner produced on the lower half into a large lamella or flat process*; usual seta at the outer apical angle wanting. The second segment consists of a broader basal and a narrower terminal part which is always flexed inward and upward; inner margin slightly produced at the tip.

Fifth leg of female uniramose, three-segmented. First segment barrel-shaped, armed at the outer apical angle with a delicate spine. Second segment about half as wide as the first and about three times as long as wide; armed at the outer distal angle with a minute spine. Third segment slightly narrower than the second and about one and a half times as long; armed on the outer margin with three spines (the upper two smooth, the lower one spinulose); on the apical margin with three spines (the outer two spinulose on their opposed margins and the inner one on both), and on the inner margin with one spine, spinulose on the inner margin.

Length of female 1.784 mm.; that of male 1.376 mm.

The above description was prepared from type specimens, from Dr. Forbes's slides, from specimens taken in the same

*In one or two specimens I thought I saw indications of several teeth, similar to those in *E. nevadensis*, but could not fully satisfy myself of their presence.

locality as the type,—Normal, Ill.,—and from other specimens collected at various times and places in Illinois, Indiana, and Michigan.

This species, the type of the genus, was first described in the "American Naturalist" (Forbes, '82a), and de Guerne and Richard, Forbes, Herrick, and Marsh have since published descriptions and figures. *Scopiphora vagans* Pickering is, as de Guerne and Richard, Herrick, and Marsh have said, probably identical with *Epischura lacustris*, but this can never be definitely determined since the following quotation is all that has been published concerning *S. vagans*.

"Genus *Scopiphora*, Pickering. Body small. Eye single, in the anterior margin of the shield. Antennæ large, and as long as in the preceding genus [Cyclops], and has the same motions in the water. Abdomen terminating in two styles each with three setæ; a brush under the last or last three joints. Ovaries none. Legs spiny.

"*S. vagans* (Pickering) MSS."*

This is, of course, too meager a description upon which to establish a genus, and the writers mentioned above, as well as Dr. Schmeil ('98), have considered it insufficient and allowed Forbes's name to stand. Herrick explains the "brush" as some parasitic growth. May it not rather have been the fifth, and perhaps the fourth, pair of legs projecting straight backward under the abdomen which caused this appearance?

In the following three paragraphs are noted the points in which my observations differ from those of previous writers as shown by their descriptions and figures.

The abdomen of the male is very complicated in its segmentation, and in the original description (Forbes, '82a) was described as having processes on the second, third, fourth, and fifth segments. All figures published previous to the appearance of "A Preliminary Report on the Aquatic Invertebrate Fauna of the Yellowstone National Park, etc." (Forbes, '93), including those of de Guerne and Richard's "Revision," were incorrect. In Forbes's paper attention was called to the fact that the fourth segment was without a

*See Pickering, '41.

process but that the fifth had two as in all the other species, and in the same year Marsh in his "Cyclopidæ and Calanidæ of Central Wisconsin" ('93), published the first correct figure of the abdomen, but seems to have been unaware of it, since in his "Cyclopidæ and Calanidæ of Lake St. Clair" ('95) he says, "Forbes has recently called attention to the fact that the fourth abdominal segment of the male is without a process and that the fifth bears two processes." His figure in this paper also ('95) is correct.

The armature of the fifth leg of the female is nowhere represented with exact correctness. The first segment is correctly figured by Forbes ('90) and by de Guerne and Richard in their "Revision," with a spine at the outer apical angle, but this is wanting in Marsh's figure ('95). The second segment is correctly shown in all the illustrations. The third segment, which has three outer spines, three apical ones, and one inner spine, is represented in all the figures without the upper spine on the outer margin. The armature of the spines themselves is nowhere correctly shown, the differences being evident by comparing the specific description with the drawings.

The left fifth leg of the male is usually represented with the outer apical angle of the first segment unarmed; de Guerne and Richard, however, figure this correctly. The second segment is often armed with a spine at the outer apical angle, but this is wanting in all of the figures; nor are the three spines on the outer margin of the third segment shown, there being in most cases only one but sometimes two. The right leg is correct in all the figures.

The spermatophore is very persistent, and a female is rarely found without one or several. In this species it is a long tube-like sac extending upward and to the left under the abdomen, differing considerably from the same appendage in *E. nevadensis*, in which it extends downward and backward, and when in position has somewhat the appearance of a keel. It is also much longer in *E. lacustris* than in *E. nevadensis*.

E. lacustris is quite common in the North Central States, being found in the deeper, clearer lakes in connection with *Limnocalanus macrurus* Sars, *Diaptomus sicilis* Forbes, *D.*

ashlandi Marsh, *D. pallidus* Herrick, or *D. siciloides*, *D. oregonensis*, and *D. minutus*, Lilljeborg, and sometimes with two or more of these species. It has been found in Illinois, Indiana, Ohio, Minnesota, Michigan, Wisconsin, and also at East Portland, Oregon.

DOUBTFUL SPECIES.

Epischura fluviatilis HERRICK.

Epischura fluviatilis, Herrick, '83a, p. 381, Pl. V., Fig. 10–20.
Epischura fluviatilis, Herrick, '84, p. 133, Pl. Q, Fig. 14–16.
Epischura fluviatilis, Herrick, '87, p. 13, Pl. II., Fig. 21–24.
Epischura fluviatilis, de Guerne et Richard, '89b, p. 92, Pl. IV., Fig. 13, 20.
Epischura fluviatilis, Forbes, '93, p. 254 (foot-note).
Epischura fluviatilis, Herrick and Turner, '95, p. 83, Pl. XIII., Fig. 14–16.
Lamellipodia [*Epischura*] *fluviatilis*, Schmeil, '98, p. 183.

Of small size, body rather slender; color greenish blue. Cephalothorax imperfectly six-segmented. Abdomen three-segmented, differing in no way from that of *Diaptomus* except in the number of furcal setæ. In the male the second abdominal segment bears on its left side a peculiar process consisting of two parts forming a clasping organ, the inner part of which is about as long as the third segment and armed at the apex with two small spines, the outer part being slender, curved, and about twice as long as the inner.

Antennæ 25-segmented, extending somewhat beyond the end of the thorax. Right male antenna geniculate between the 18 and 19th segments; last six segments not ankylosed, enlarged portion not greatly swollen.

Swimming legs biramose, the outer ramus consisting of three segments, the inner ramus of one segment. Basal segments of the two legs fused beyond the last.

Fifth pair of legs of male uniramose, the two basal segments entirely fused. Right fifth leg three-segmented, the first two segments subquadrate and subequal, about three times as long as wide and entirely unarmed. Third segment slightly longer and broader than the second, tapering to a

blunt point and armed on the outer margin with three spines.

Left fifth leg very peculiar, consisting of a single lamelliform subcircular segment, armed on the flat surface with two opposable claws forming a forcipate structure.

Fifth pair of legs of female uniramose, three-segmented (two basal segments). First segment about twice as long as broad. Second segment narrower than the preceding and about twice as long; armed at about the middle of the outer margin with a spine. Third segment curved inward, somewhat longer and narrower than the second, ending in a sharp point, and armed on the outer margin with two spines dividing it approximately into thirds.

Mulberry Creek, Cullman county, Alabama.

Length, about 1.103 mm.

The above description was compiled from drawings and descriptions found in Herrick's writings (Herrick, '83a, '84, and '87, and Herrick and Turner, '95), since all attempts to obtain material from Cullman county, Ala., or from any other part of that State, were unsuccessful.

A brief discussion of the published figures and descriptions will not be superfluous in connection with a doubtful species. In the American Naturalist, Vol. 17 (Herrick, '83a), is published the original description of *E. fluviatilis*, and a figure representing apparently a ventral view of the last thoracic segment and abdomen, and the fifth pair of legs of the male. In this drawing the process on the third segment is on the right side, making it sinistral in the animal as Herrick says it is; but in his "List of Fresh-water and Marine Crustacea of Alabama" ('87) he gives another figure, which is just as apparently a ventral view of the same thing. In this latter figure, however, the process is sinistral, making it dextral in the animal, and also making the left leg three-segmented and the right leg one-segmented. Two other figures (Herrick, '84 and Herrick and Turner, '95) also show the process on the right side, but there is nothing to indicate whether they are dorsal or ventral views.

Now, in regard to the synonymy. If the process is on the left side, as is maintained in all of Herrick's descriptions, this

species cannot belong to the genus *Epischura*, as has already been pointed out by Forbes ('93, p. 254) and Schmeil ('98), since the process cannot be homologized with the similar process in *Epischura* proper. If, however, the process is dextral, as shown in three out of the four figures published, it might be more easily homologized with the process in the other species of the genus. It would also be more likely that the left leg was three-segmented and the right one especially modified into a clasping organ if *E. fluviatilis* belonged to this genus, although even then the fact that the second segment of the left (right?) leg is not at all produced inwardly and the structure of the right (left?) leg is radically different would present difficulties. The fifth legs of the female are very similar to those of *Epischura*, but partake slightly of the characters of *Heterocope*. Schmeil says ('98) that, judging from analogy with other genera, there is one basal segment too many in the fifth pair of legs of both sexes. Herrick, in the "American Naturalist" (Herrick, '83), gives a drawing of a swimming leg of *E. fluviatilis*, with its one-segmented inner ramus, which, if the upper, incomplete part shown is to be regarded as another segment, certainly gives it, as Schmeil says, one too many segments. If, however, it is an adhering part of the thoracic segment, it will differ from a swimming leg of *E. lacustris* only in that in *lacustris* the first basal segments instead of being fused their entire length, as in *fluviatilis*, are fused for about the basal two fifths only. The fifth legs of both sexes are similar in arrangement to the above, although on account of the absence of an inner ramus it is less evident. I believe that the appendage figured at the outer apical angle of the furca is intended for a spine, rather than a seta as Schmeil supposes it to be. From this it will be seen that the drawings and descriptions conflict, and Dr. Schmeil was perhaps justified in proposing to establish a new genus, *Lamellipodia*, to receive this species. It seems to me, however, that it would be better to wait until material collected in the same locality and described and figured by a more careful observer has determined whether or not this species is a good one, and I have hesitated, therefore, to adopt a new name for a form the description of which, to use Marsh's words in regard to *Scopiphora vagans* Pickering, "is manifestly inaccurate in some particulars, and may be in all."

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INDEX.

(Synonyms in italics.)

BULLETIN

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ILLINOIS STATE LABORATORY

OF

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VOLUME V.

ARTICLE IV.—THE NORTH AMERICAN CENTROPAGIDÆ BELONGING TO THE GENERA OSPHRANTICUM, LIMNOCALANUS, AND EPISCHURA.

BY FREDERICK WILLIAM SCHACHT, B. S.

Illinois State Laboratory of Natural History,
URBANA, ILLINOIS.
~~1897.~~
1898.

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