BULLETIN

OF THE

ILLINOIS STATE LABORATORY

OF

NATURAL HISTORY,

URBANA, ILLINOIS

VOLUME V.

ARTICLE III.—THE NORTH AMERICAN SPECIES OF DIAPTOMUS.

By FREDERICK WILLIAM SCHACHT, B. S.

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

State Laboratory of Natural History.

LABORATORY STAFF.

Professor Stephen Alfred Forbes, Ph. D.,
Director of State Laboratory and State Entomologist.

Charles Arthur Hart,
Systematic Entomologist and Curator of Collections.

Frank Smith, A. M.,
Assistant Zoölogist.

Charles Atwood Kofoid, Ph. D.,
Zoölogist, and Superintendent of Biological Station.

Charles Christopher Adams, B. S.,
Entomological Assistant.

Ralph Waldo Braucher, B. S.,
Entomological Assistant.

Mary Jane Snyder,
Secretary.

Henry Clinton Forbes,
Business Agent and Librarian.

Lydia Moore Hart,
Artist.

ERRATA.

Page 136, line 2, and page 182, line 17 from bottom, for '*95a* read '*95*.

Page 226, line 2, page 263, line 17 from bottom, and page 267, lines 2 and 15, for '*98*, read '*96*.

Page 233, line 15 from bottom, for '*82* read '*82a*.

Page 355, line 2 from bottom, for C. *F.* Hudson read C. *T.* Hudson.

Page 389, foot-note, for Vol. *V.* read Vol. *IV.*

Page 457, line 5, for *Genera* read *Genus*.

The following paper was prepared in the course of undergraduate study in the Zoölogical Department of the University of Illinois, and was accepted by the Faculty of the University June 7, 1897, as a thesis for the degree of Bachelor of Science in Zoölogy.

ARTICLE III.—*The North American Species of Diaptomus.*
BY FREDERICK WILLIAM SCHACHT.

INTRODUCTION.

The first published reference to that group of genera of *Entomostraca* now known under the family name of *Centropagidæ* is contained in O. F. Müller's "Entomostraca seu Insecta testacea quae in aquis Daniae et Norvegiae reperit," etc., published at Frankfort-on-the-Main in 1785, in which paper certain copepod species now included under the genus Diaptomus were treated under the general name of *Cyclops*. Species of Diaptomus were later described by Jurine ('20) under *Monoculus*, but the genus Diaptomus was first established by Westwood ('36). Various names have since been applied more or less closely to the generic group: *Cyclopsina*, Milne-Edwards ('38); *Glaucca*, Koch ('38); and *Cyclops*, Nicolet ('48).

The first American species of Diaptomus recognizably described was *D. sanguineus* Forbes ('76). Later Dr. Forbes ('82a) described three additional species of this genus (*sicilis*, *leptopus*, and *stagnalis*), and two new genera of *Centropagidæ* (*Epischura* and *Osphranticum*), with a single species of each. Prof. C. L. Herrick's publications on the group began in 1877 and those of Marsh in 1891. A single species (*D. kentuckyensis*) named by Chambers in 1881 is so imperfectly described that its recognition is apparently impossible. Since the publication of Underwood's "List of the described Species of Fresh-water Crustacea from America North of Mexico" ('86) the number of recognized North American species of Diaptomus has increased from five to twenty-three.

The literature of the genus previous to 1889 was widely scattered and the synonymy greatly complicated, but the comprehensive and careful "Revision" published in that year by de Guerne and Richard ('89b) has had the effect greatly to facilitate its study. The most important recent European contributions to a knowledge of the *Centropagidæ*

have been made by Claus, Schmeil, Poppe, Imhof, Zacharias, and others, in Germany; by Brady, in England; by Nordqvist, in Finland; by Sars, in Norway; and by Lilljeborg in Sweden, the latter especially having described a number of American species. Perhaps the finest work yet published on *Copepoda* in general is Giesbrecht's monograph on the "Pelagischen Copepoden des Golfs von Neapel" ('92), the general classification of which is followed in the present article.

It has been my purpose in preparing this paper to do for the students of American *Centropagidæ* a service similar to that which de Guerne and Richard have rendered to students of this group as distributed throughout the world. I am under especial obligation to my instructor, Prof. S. A. Forbes, to whose encouragement and aid any value this paper may have is to be largely attributed. I am indebted also for specimens or other favors to Dr. Wilhelm Lilljeborg, of Upsala, Sweden; to Dr. Otto Schmeil, of Magdeburg, Germany; to Herr S. A. Poppe, of Vegesack, Germany; to Prof. C. Dwight Marsh, of Ripon College, Wisconsin; to Prof. L. S. Ross, of Drake University, Des Moines, Iowa; to Mr. Adolph Hempel, now of the Museu Paulista, São Paulo, Brazil; to Prof. Frank Smith, of the University of Illinois; to Mr. C. E. Phillips, of Millington, Ill.; and to my friend and fellow student, Mr. E. B. Forbes. I have also to call attention to the fact that most of the figures accompanying this paper were drawn by the Artist of the State Laboratory, Miss Lydia M. Hart.

From Dr. Lilljeborg I received specimens of *Diaptomus signicauda*, *D. minutus*, *D. trybomi*, *D. ciseni*, *D. franciscanus*, *Epischura nevadensis*, and *E. nordenskiöldi*. Prof. Ross and Mr. Hempel kindly loaned me their personal collections, the former thus furnishing me *D. siciloides*, *D. piscinæ*, and *D. clavipes* sp. nov., and the latter, *D. mississippiensis* and *D. albuquerquensis*. Prof. Marsh has sent me slides or entire specimens of *D. ashlandi*, *D. mississippiensis*, and *D. reighardi*. To Dr. Schmeil I owe thanks for several kind letters, for the European species *D. gracilis*, *D. graciloides*, *D. castor*, *D.*

salinus, *D. caeruleus*, and *D. zachariasi*, and for specimens of *Heterocope* and *Temorella*,—all of which, however, arrived too late to be of service to me in connection with this paper. From Herr Poppe I received the following species: *D. tyrrelli*, *D. gibber*, *D. incongruens*, *D. deitersi*, *D. drieschi*, *D. zachariasi*, and *Limnocalanus sinensis*.

The material at my command was nearly complete, including all but two of the known North American forms (*D. novamexicanus* and *D. birgei*), and the collection of the literature of the group to which I have had access is probably as ample as that to be found in any library in this country. In compiling the bibliographical list appended to this paper, Schmeil's monograph on the *Centropagidæ* ('96) was taken as a basis and was especially helpful, while a great deal was also gained from the works of de Guerne and Richard.

By far the greater part of the collections examined are the property of the Illinois State Laboratory of Natural History. They represent localities distributed over the entire continent, from Massachusetts in the East to Oregon in the West, as far south as Florida and as far north as Canada, and including the following states: Massachusetts, Florida, Mississippi, Ohio, Indiana, Illinois, Iowa, Minnesota, Michigan, Wisconsin, Oregon, Washington, Montana, Wyoming, California, Idaho, and Nevada. In addition to the above I have examined specimens from Manitoba, Newfoundland, and Greenland.

The localities represented by these collections vary widely in character, ranging from temporary pools on the Illinois prairies to Lakes Michigan and Superior; from the warm lakes of the Florida swamps to the cold mountain lakes of the Rockies; and from the small head-water streams of the Kaskaskia to the sluggish Illinois and the mighty Mississippi. The collections were made at all seasons of the year and at nearly all times of the day and night.

Although no very complete data for any single locality are at hand, it is found that in ordinary years the spring and early summer are the most favorable seasons for collecting in our latitudes. Individuals are found, however, at all times; and in some cases the normal habitat is a lake whose waters are

but little above the freezing point, or even, as in the case of *D. minutus*, water flowing from the foot of a glacier. Although this would seem to indicate that these crustaceans are quite hardy, I have repeatedly found that in jars containing living specimens of *Cyclops*, *Diaptomus*, and *Osphranticum*, those of *Diaptomus* were the first to succumb to unfavorable conditions.

The genus Diaptomus is the most cosmopolitan of its family, species having been reported from North and South America, Europe, Asia, Africa, and Australia. No species, however, is known to be common to the mainlands of Europe and of America. This fact is the more remarkable since almost the direct opposite is true of the companion genus, *Cyclops*, only one or two species of which are, so far as known, peculiar to this continent. Even *D. minutus*, which is found in Oregon, Illinois, Wisconsin, Minnesota, Michigan, Newfoundland, Greenland, and Iceland, has not as yet been found in northern Europe or even in Great Britain, although the expanse of salt water between Iceland and Scotland or between Iceland and Scandinavia is but little greater than that between Greenland and the mainland of North America. But few species of this genus have been described from tropical regions, most of them having thus far been found in the north temperate zone; a fact to be attributed doubtless in large measure to the greater attention paid to zoölogical studies in these northern latitudes.

In this paper the plan followed by de Guerne and Richard in their "Revision" has been adopted, separate keys being made for males and for females. When females are so nearly alike as in *D. sicilis*, *siciloides*, *pallidus*, and *ashlandi*, it is somewhat difficult to find distinguishing characters, and differences not usually taken into account must be seized upon. The males are much more easily separated, since they offer a larger number of peculiarities. Giesbrecht and Schmeil have paid considerable attention to the armature of the entire male prehensile antenna instead of regarding only that of the last three segments, and in one or two cases I have done the same. In this connection a fact became

evident which if found to be generally true will necessitate a slight modification of the description of the family *Centropagidæ*. I refer to the presence of a sense-club on the first segment of the right male antenna. In his monograph Giesbrecht in his description ('92, p. 85), says, "Vordere antennen ähnlich wie bei den Calaniden gebaut." On another page (42) we find this statement: "The normal number of processes seems to be three for each segment, a proximal seta, a distal seta, and a sensory structure [*æsthetask*], but this triad is never complete on all segments, the sense-club on the first segment being always wanting and the sense-club and proximal seta nearly always absent on the twentieth to the twenty-fourth." In *Diaptomus stagnalis* and *D. claripes* a sense-club is present on the first segment. The statement that the inner rami of the fifth pair of feet are "rudimentary, one-segmented, or lacking" will not hold in many species. Taking only those forms among non-American species which were described in de Guerne and Richard ('89b), we find the following with *two*-segmented inner rami: *D. mirus*, *D. lobatus*, *D. theeli*, and *D. glacialis*, Lilljeborg; *D. cæruleus* Fischer, *D. gibber* Poppe, and *D. wierzejskii* Richard; and at least three American species have the inner ramus two-segmented—*D. stagnalis* Forbes distinctly, and *D. eiseni* Lillj. and *D. albuquerquensis* Herrick indistinctly so.

It is expected that the keys here printed will be used in connection with the descriptions and figures, since the species vary within certain limits, and no hard and fast description can be given which will cover the peculiarities of every individual of a species. Local varietal differences or slight variations in proportion may make a key useless, and in all cases the totality of characters should be considered. A glance at the figures will indeed often be found more helpful than any verbal description.

Following the usual plan of specific descriptions, the first paragraph, referring to the general appearance of the body, thorax, abdomen, and furca and their relative proportions, applies always to the female unless especially stated otherwise.

SYNOPSIS OF THE RELATIONSHIPS OF THE GENERA *Osphranticum*, *Limnocalanus*, *Diaptomus*, AND *Epischura*, OF THE FAMILY *Centropagidæ*.

(Adapted and compiled from Giesbrecht ('92), and from manuscript of Prof. S. A. Forbes.)

1 (19). Division of body into cephalothorax and abdomen between the thoracic segment bearing the fifth pair of feet and the segment bearing the genital apertures. In the male the fifth pair of feet assists in copulation. Abdomen with five segments; without appendages. Genital organs of the male unsymmetrical. Pulsating dorsal vessel generally present. Female deposits eggs singly or carries them with her in single sac until emergence of the nauplii. Suborder I. GYMNOPLEA.

2 (3). Anterior antennæ of male symmetrical or nearly so, and more richly provided with sense-clubs [*æsthetasks*] than those of the female. Fifth pair of feet of female either normal, or degenerate to complete disappearance. Secondary sexual distinctions of male not confined to peculiarities in the structure of the body, the antennæ, the fifth pair of feet, and the segmentation of the abdomen, but usually present in the cephalic appendages and sometimes also in the swimming feet. Marine. Tribe I. AMPHASKANDRIA.

3 (2). Anterior antennæ of male unsymmetrical. Fifth pair of feet in the female either normal or degenerated, but never absent. Secondary sexual characters of male generally confined to peculiarities in the structure of the body, the antennæ, and the fifth pair of feet. Marine and fresh-water. Tribe II. HETERARTHRANDRIA.

4 (18). Rostrum present. Fourth and fifth thoracic segments confluent.

5 (6). Abdomen of female 1–3-segmented. Antennæ 16–24-jointed; last two segments always confluent. In the male the fifth pair of feet rarely with a rudimentary inner ramus. Antennæ with segments 19–21 and sometimes 22–25 confluent. Marine.

Family PONTELLIDÆ.

6 (5). Abdomen of female 3- or 4-segmented; sometimes unsymmetrical. Antennæ never with less than 24 segments. In the male, segments 19–21 and generally 22 and 23 are confluent. Abdomen 5-jointed; either right or left antenna prehensile. The fifth pair of feet are grasping organs and both always present, but with inner ramus normal, or degenerate to complete disappearance. Family CENTROPAGIDÆ.

7 (8). Thorax 6-jointed. All the feet of female with 3-segmented rami. Abdomen 3-jointed. Antennæ 25-jointed, segments 24 and 25 confluent. Right male antenna prehensile. Outer ramus of left fifth foot 2-jointed; of right, subchelate.
Subfamily CENTROPAGINA.

8 (7). Thorax 5-jointed. Fourth and fifth thoracic segments confluent.

9 (16,17.) Abdomen of female 3-jointed, sometimes unsymmetrical. Antennæ 23- or 24-jointed. Four anterior pairs of feet generally with 3-segmented rami. Fifth pair of feet degenerate, with inner ramus wanting or small and 1-jointed, outer ramus 1–3 jointed. Prehensile antenna generally the right; segments 19–21 and 22 and 23 confluent. Subfamily TEMORINA.

10 (11). Furca with but three large terminal setæ to each ramus. Abdomen of male unsymmetrical, provided with lateral prehensile apparatus. Fifth pair of legs of female uniramose, 3-jointed, not terminating with a long spine. Genus *Epischura*.

11 (10). Furca with four large terminal setæ to each ramus.

12 (13). Inner ramus of first pair of legs 2-jointed; of the following three pairs 3-jointed. Fifth pair of legs in both male and female biramose, inner ramus rudimentary. Genus *Diaptomus*.

13 (12). Both inner and outer rami of the first four pairs of legs 3-jointed. Fifth pair of legs in both sexes biramose, those of the female differing from the other legs only by the presence of a strong inner hook on the second

joint of the outer ramus; those of the male with the inner ramus 3-jointed and provided with plumose hairs, as in the other legs.

14 (15). Fifth pair of legs of female with the inner hairs of the last joint of the outer ramus transformed into short thick spines. In the male, outer ramus of left leg of fifth pair with two joints; outer ramus of right leg with three. Genus *Osphranticum.*

15 (14). Fifth pair of legs of female with the inner hairs of the last joint of the outer ramus long and plumose. Fifth pair of legs of male with both outer rami 2-jointed. Genus *Limnocalanus.*

16 (9, 17). Abdomen of female 4-jointed, symmetrical. Antennæ 25-jointed, articles 24 and 25 not confluent. Four anterior pairs of feet generally with 3-segmented rami, the fifth with 3-segmented outer and 2- or 3-segmented inner ramus. Male antennæ with segments 19–21 and 21–23 confluent. Fifth pair of feet subchelate; the right with 2-, the left with 3-segmented rami. Subfamily Leuckartiina.

17 (9,16). Abdomen 3- or 4-jointed, not always symmetrical. Four anterior pairs of feet with 3-jointed rami. Generally the left antenna of the male geniculate. Articles 19–21, 22 and 23 (or 22–25), and 1 and 2 confluent. Fifth pair of legs with 3-segmented outer and 1–3-segmented inner rami. Chelæ undeveloped or wanting. Subfamily Heterochætina.

18 (4). Rostrum wanting. Fourth and fifth thoracic segments of female not confluent. Abdomen 3-segmented. Male genital opening on the left; right antenna prehensile, segments 17 and 18, and 19 and 20 confluent. Inner rami of fifth pair of feet wanting; outer ramus of left foot 4-segmented, of right foot 3-segmented. Marine. Family Candacidæ.

19 (1). Division of body into anterior and posterior parts in front of the last (fifth) thoracic segment. This bears, almost without exception, a more or less rudimentary

pair of feet, which in the male never assist in copulation; on the contrary, the male attaches the spermatophores directly to the vulva of the female without the help of appendages. Genital organs of the male generally paired, the openings always symmetrical. Pulsating dorsal vessel almost always absent. The female carries the eggs with her, generally cemented into one or two egg sacs, until emergence of the young.

Suborder II. PODOPLEA.

DIAPTOMUS Westwood.

Cyclops, O. F. Müller. 1785.
Monoculus, Jurine, '20.
Diaptomus, Westwood, '36.
Cyclopsina, Milne-Edwards, '38.
Glaucea, Koch, '35–'41
Cyclops, Nicolet, '48–'49.

"Cephalothorax always with seven segments, of which the anterior two, indistinctly confluent, form the head. The last thoracic segment in the female rather large, posteriorly deeply emarginate in the middle, and often produced laterally on both sides into a biangulate lamina. Abdomen short, narrower than the thorax; in female of four segments (caudal rami included), of which the first is dilated anteriorly and very often armed with a lateral spine on each side; in male composed of six obvious segments of about equal width. Caudal rami with five uniarticulate plumose setæ and with another much smaller, more slender seta within. The front provided with two minute tentaculiform appendages. The first pair of antennæ composed of 25 segments, increasing slightly in length toward the tip. The geniculate articulation between the 18th and 19th segments of the right male antenna; the six preceding segments swollen, the five following sometimes confluent into two articles. The outer ramus of the second pair of antennæ 7-jointed, longer than the inner ramus, the last article longest of all and armed with very long apical setæ; setæ of preceding articles short and

subequal. Second pair of maxillæ short and thick; third pair elongate, directed forward, 7-segmented, and provided with short setæ. The eight anterior swimming feet biramose, the inner ramus of the first pair 2-, of the following pairs 3-segmented. The last pair of feet different from the rest, 5-segmented, the second segment armed within with a small appendage or rudiment of an inner ramus; in the female short, equal, the last segment very short and rudimentary, the penultimate always produced into a strong hook curved inward; in the male the right foot subchelate, the last article formed into a very long movable hook. Eye single."*

The following remarks on the genus are from de Guerne and Richard's "Revision":

"The genus *Diaptomus*, known at a very early date, was for a long time confounded with *Cyclops*. Clearly distinguished much later, it contained for a very long time only a few recognized species, and even these were insufficiently defined. Since their study has been taken up with more attention other forms have been distinguished, and the number of species now exceeds forty, and further explorations will undoubtedly bring others to light.†

"If we attempt to arrange characters in the order of their importance from a systematic point of view, we must say in the beginning that they are furnished almost wholly by the males. Except in certain cases the isolated females are difficult to determine. They are, however, rarely met with alone, and collections commonly contain, whatever the season, both sexes together.

"Among the characters furnished by the male, the greatest importance must be assigned to those of the fifth pair of feet. The length of the inner rami, composed of one or two segments, varies considerably (*minutus* to *castor*). As for the outer rami, the last article of the left foot should be examined first. It sometimes has the form of a kind of forceps and sometimes terminates in a sort of cushion bearing two short obtuse spines, which perhaps represent the branches of the

*Translated from the Latin diagnosis of de Guerne and Richard's "Révision des Calanides d Eau Douce," pp. 9 and 10.

†Sixty-five now, many having been added since the publication of the "Revision."

forceps. All the transitions between these two forms may be found in a series of species. Certain articles of the right ramus may also bear divers characteristic appendages. Finally, the terminal claw and the lateral spine of the last article often present by their form and their position enough peculiarities to greatly facilitate the determination.

"The right antenna of the male also furnishes some good characters, among which figure in the first rank the appendages of the antepenultimate article, much varied as to form and size (*D. bacillifer, wierzejskii, cœruleus*).

"Generally speaking, the fifth pair of feet of the females furnish the most important specific characters, although they do not have the same technical value as in the male. At the same time various peculiarities drawn from the conformation of the last cephalothoracic and of the first abdominal segments and from the length of the antennæ, aid greatly in the determination."

KEY TO THE NORTH AMERICAN SPECIES OF *Diaptomus*, BASED ON THE CHARACTERISTICS OF THE MALE.

1 (15). Antepenultimate article of right antenna without hook-like process at tip.

2 (3). Antepenultimate article of right antenna with narrow hyaline lamina. Second basal segment of right fifth foot armed at the inner margin with two hook-like processes, and on the anterior surface at the apical margin, with a hook-like process extending beyond the middle of the first segment of the outer ramus. Inner ramus extending barely beyond the middle of the first segment of the outer ramus; heavily spined at apex. Marginal spine below the middle of the segment, near the apical angle; short, stout, much less than half as long as the segment. Terminal hook very stout, longer than preceding segment. Left leg extending about to end of first segment of outer ramus of right leg; second basal segment tuberculate on inner margin. Inner ramus very long, extending about to middle of last segment of outer ramus; incurved,

tuberculate, and armed at apex with short, blunt spines. Last segment of outer ramus armed with a short blunt spine and a very long spinulose one. *clavipes.*

3 (2). Antepenultimate article of right antenna without hyaline lamina.

4 (5,10). Inner ramus of right fifth foot not reaching end of first segment of outer ramus; sharply pointed. First segment of outer ramus with hyaline lamina. Marginal spine below middle of segment; less than half as long as segment. Terminal hook longer than the two preceding segments. Left leg extending slightly beyond end of first segment of outer ramus of right leg; inner ramus reaching slightly beyond end of first segment of outer ramus, indistinctly 2-segmented, apex bluntly rounded. *tyrrelli.*

5 (4,10). Inner ramus of right fifth foot reaching end of first segment of outer ramus.

6 (7). Inner ramus of left fifth foot extending to base of second segment of outer ramus, or slightly beyond. Marginal spine below middle, near apical angle; less than half as long as segment. Terminal hook at least as long as the two preceding segments. Left leg reaching about to middle of second segment of outer ramus of right leg. Last segment of outer ramus armed with forcipate structure; inner digitiform process armed with cushion on inner margin. *pallidus.*

7 (6). Inner ramus of left fifth foot reaching to middle of second segment of outer ramus.

8 (9). Marginal spine of right leg above middle of segment, very stout, as long as or longer than segment. Terminal hook almost as long as the two preceding segments and second basal segment taken together. Inner ramus as long as first segment of outer ramus. First segment of outer ramus with broad hyaline lamina on inner margin. Left leg not quite reaching middle of second segment of outer ramus of right leg. *birgei.*

9 (8). Marginal spine of right leg below middle of segment; slender, less than half as long as segment. Terminal hook longer than the two preceding segments, a sharp angle dividing it approximately into halves. Inner ramus reaching end of first segment of outer ramus; apex bluntly rounded. Left leg reaching beyond middle of last segment of outer ramus of right leg. Last segment of outer ramus ending in a forcipate structure; outer digitiform process stout, armed on inner margin near tip with cushion-like hairy process. *reighardi.*

10 (4, 5). Inner ramus of right fifth foot reaching well beyond end of first segment of outer ramus.

11 (12). Inner ramus of left fifth foot long, extending beyond middle of second segment of outer ramus; leg itself (disregarding terminal spines) not reaching end of first segment of outer ramus. Marginal spine of right leg inserted below middle of segment, near apical angle; much less than half as long as segment. Terminal hook shorter than the preceding segment. *piscinæ.*

12 (11). Inner ramus of left fifth foot short, not extending beyond middle of second segment of outer ramus.

13 (14). Inner ramus of left fifth foot not reaching to middle of second segment of outer ramus; leg itself reaching end of second segment of outer ramus of right leg. Marginal spine below middle of segment near apical angle; almost as long as segment. Terminal hook longer than the preceding segment. Inner ramus of right foot extending beyond end of first segment of outer ramus. *oregonensis.*

14 (13). Inner ramus of left fifth foot reaching middle of second segment of outer ramus; leg itself reaching about to middle of second segment of outer ramus of right leg. Marginal spine below middle of segment, about half as long as segment. Terminal hook longer than the two preceding segments. Inner ramus of right foot extending to middle of second segment of outer ramus. *mississippiensis.*

15 (1). Antepenultimate article of right antenna with hook-like process at tip.

16 (27). Process on antepenultimate article as long as or longer than penultimate article.

17 (20). Process curved.

18 (19). Inner ramus of right leg alone 2-segmented, extending almost to middle of second segment of outer ramus. Marginal spine below middle, near distal angle, smooth, about half as long as segment. Terminal hook fully as long as the two preceding segments and the second basal segment taken together. Second basal segment not dilated. Left leg reaching about to middle of first segment of outer ramus of right leg; inner ramus barely reaching middle of last segment of outer ramus. *franciscanus.*

19 (18). Inner ramus of both legs 2-segmented. Marginal spine below middle, near apical angle; hairy, almost as long as segment. Terminal hook longer than the two preceding segments, but not as long as those and the second basal segment taken together. Second basal segment dilated into rugose lamella. Inner ramus of right leg extending about to middle of second segment of outer ramus. Left leg extending about to middle of second segment of outer ramus of right leg; inner ramus extending beyond middle of last segment of outer ramus. *ciseni.*

20 (17). Process straight.

21 (22). Process sharply pointed. Marginal spine below middle, about half as long as segment. Terminal hook longer than the two preceding segments. Inner ramus of right leg extending a little beyond end of first segment of outer ramus. Left leg reaching slightly beyond end of first segment of outer ramus of right leg; last segment of outer ramus with hairy cushion on inner margin; inner ramus extending almost to middle of last segment of outer ramus. *shoshone.*

22 (21). Process blunt or swollen at tip.

23 (24). Inner ramus of right leg rudimentary, barely surpassing end of segment from which it arises. Marginal spine about at middle of segment, very small. Terminal hook shorter than the very long preceding segment. Left leg extending slightly beyond end of first segment of outer ramus of right leg; inner ramus very narrow, extending about to middle of second segment of outer ramus. *minutus.*

24 (23). Inner ramus of right leg not rudimentary, longer than first segment of outer ramus.

25 (26). Marginal spine well above middle of segment, about half as long as segment. Terminal hook longer than the two preceding segments. Inner ramus of right leg very narrow. Left leg reaching slightly beyond end of first segment of outer ramus of right leg; inner ramus extending to middle of last segment of outer ramus. *ashlandi.*

26 (25). Marginal spine below middle of segment, less than half as long as segment. Terminal hook very slender, longer than the two preceding segments. First segment of outer ramus with hyaline lamina at inner distal angle. Left leg extending about to middle of second segment of outer ramus of right leg; inner ramus extending barely to middle of second segment of outer ramus. *sicilis.*

27 (16). Process shorter than penultimate article.

28 (33). Process the continuation of a hyaline lamina.

29 (30). Process extending at least to middle of penultimate article. Hyaline lamina extending but little more than the distal half of the segment. Marginal spine below middle of segment; shorter than segment. Terminal hook longer than the two preceding segments but not as long as those and the second basal segment together. Inner ramus of right leg extending slightly beyond end of first segment of outer ramus. Left leg extending slightly beyond end of first segment of outer ramus of right leg; inner ramus extending about to middle of last segment of outer ramus. *novamexicanus.*

30 (29). Process extending very slightly beyond end of article of which it is a part. Hyaline lamina extending entire length of segment.

31 (32). Inner ramus of right leg reaching well beyond middle of the very long first segment of the outer ramus. Marginal spine below middle, near apical angle; less than half as long as segment. Terminal hook shorter than the preceding segment. Left leg (excluding terminal spines) reaching about to middle of first segment of outer ramus of right leg. Last segment of outer ramus terminated by two spines; inner ramus reaching well beyond end of first segment of outer ramus, but not to middle of last segment. *leptopus.*

32 (31). Inner ramus of right leg rudimentary (the suture being rarely visible), barely reaching the end of the very short first segment of the outer ramus. Marginal spine below middle of segment, less than half as long as segment. Terminal hook stout, longer than the preceding segment. Second basal segment very broad, armed at outer distal angle with a process about as large as the inner "ramus." Left leg very short, barely reaching end of second basal segment of right leg; inner ramus very short, extending barely beyond end of first segment of outer ramus. *sanguineus.*

33 (28). Process not the continuation of a hyaline lamina.

34 (41). Process straight.

35 (36). Process serrate on outer margin, extending beyond middle of penultimate article. Inner ramus of right leg very broad and short, extending but slightly beyond middle of first segment of outer ramus. Marginal spine above middle of segment, less than half as long as segment. Terminal hook longer than the very long preceding segment. Left leg very short, extending barely beyond end of first segment of outer ramus of right leg. First basal segment of both legs with long slender spine on posterior surface. *trybomi.*

36 (35). Process not serrate.

37 (38). Inner ramus of right leg rudimentary, extending but slightly beyond the end of the segment to which it is attached. Marginal spine below middle of segment, slender, fully half as long as the very long segment. Terminal hook shorter than the preceding segment. Left leg (disregarding terminal spines) not reaching end of first segment of outer ramus of right leg. Last segment with two spines : one long, slender, outcurved ; the other short, stout. Inner ramus extending almost to end of last segment of outer ramus. *lintoni.*

38 (37). Inner ramus of right leg not rudimentary, extending to middle of first segment of outer ramus or beyond.

39 (40), Inner ramus of right leg extending about to middle of first segment of outer ramus. Marginal spine below middle, about half as long as segment. Terminal hook longer than the preceding segment. Second basal segment with hyaline lamina on inner margin. Left leg (disregarding terminal spines) reaching about to middle of first segment of outer ramus of right leg; inner ramus reaching end of first segment of outer ramus, corrugate on inner margin. *stagnalis.*

40 (39). Inner ramus of right leg extending beyond the end of the very short first segment of outer ramus. Marginal spine below middle of segment, stout, longer than segment. Terminal hook very long, stout, longer than remainder of leg. Left leg extending beyond end of first segment of outer ramus of right leg; second segment with ciliate lamina on inner margin; inner ramus reaching end of first segment of outer ramus. *albuquerquensis.*

41 (34). Process curved.

42 (43). Process small, not reaching middle of penultimate article. Marginal spine below middle; rather stout, less than a third the length of segment. Terminal hook noticeably longer than the two preceding segments. First segment of outer ramus with hyaline lamina on inner margin, the inner apical angle of which is not

produced. Inner ramus of right leg not reaching end of first segment of outer ramus; apex bluntly rounded. Left leg reaching about to end of first segment of outer ramus of right leg; inner ramus reaching middle of last segment of outer ramus, margins sinuously curved. *siciloides.*

43 (42). Process stout, reaching to middle of penultimate article or beyond. Marginal spine below middle of segment, less than half as long as segment. Terminal hook not much if any longer than the two preceding segments. First segment of outer ramus with hyaline lamina on inner margin, which is much produced at the outer apical angle. Inner ramus of right leg conical, not reaching end of first segment of outer ramus. Left leg reaching to tip of first segment of outer ramus of right leg. Inner ramus extending beyond middle of last segment of outer ramus; margins parallel; armed on outer margin near base with small hemispherical process. *signicauda.*

KEY TO THE NORTH AMERICAN SPECIES OF *Diaptomus*, BASED ON THE CHARACTERISTICS OF THE FEMALE.

1 (18). Inner ramus of fifth pair of legs noticeably shorter than first segment of outer ramus.

2 (10). Outer ramus distinctly or indistinctly 3-segmented.

3 (4,7). Inner ramus distinctly 2-segmented, the first segment very short and subquadrate; barely reaching end of first segment of outer ramus; armed with two straight hairy spines, almost as long as the ramus. Second segment of outer ramus with small spine near base of third segment; spinose on both margins. Third segment armed with two stout spines, the inner hairy, about twice as long as the outer, which is about as long as the spine on the preceding segment. Last thoracic segment strongly produced. First abdominal segment longer than remainder of abdomen, greatly dilated, armed on each side with large spine; second segment shorter than third. Furcal rami about as

long as wide, hairy within. Antennæ extending barely to base of abdomen. *stagnalis.*

4 (3,7). Inner ramus indistinctly 2-segmented.

5 (6). Terminal spines of inner ramus about half as long as ramus. Second segment of outer ramus armed with a single spine. Two spines on the third segment; suture between this and preceding segment indistinct. Inner ramus extending beyond middle of first segment of outer ramus; armed at apex with two long spines. Third segment of outer ramus armed with two very large stout spines, the inner hairy, less than twice as long as the outer. First abdominal segment longer than remainder of abdomen; armed anteriorly with large lateral process. Antennæ reaching process on first abdominal segment. *eiseni.*

6 (5). Terminal spines of inner ramus not nearly half as long as ramus. Second segment of outer ramus with a spine. Inner ramus extending slightly beyond middle of first segment of outer ramus. Third segment of outer ramus hairy and about twice as long as the inner, which is smooth. First abdominal segment longer than remainder of abdomen, armed laterally with strong spines. Antennæ extending beyond tips of furcal setæ. *albuquerquensis.*

7 (3, 4). Inner ramus 1-segmented.

8 (9). Terminal spines of inner ramus smooth, more than half as long as ramus, which is rounded at apex and hairy. Second segment of outer ramus straight, as long as or longer than preceding segment; armed at base of third segment with short spine, shorter than either of the two on third segment. Inner spine of third segment hairy, about twice as long as the outer, which is smooth. Both spines considerably longer than the segment itself. Last thoracic segment armed on each side with two small spines. First abdominal segment shorter than remainder of abdomen, dilated, armed with large spines; second segment very short.

Third segment and furcal rami about equal. Antennæ reaching base of abdomen. *shoshone.*

9 (8). Terminal spines of inner ramus smooth, not nearly half as long as ramus, which is hairy at apex and on inner margin. Second segment of outer ramus curved, barely as long as preceding segment; armed at base of third segment with an inconspicuous spine. Third segment armed with two short spines but slightly longer than the segment. Last thoracic segment armed with small spines. First abdominal segment with a sharp spine; longer than remainder of abdomen. Antennæ reaching furcal rami. *novamexicanus.*

10 (2). Outer ramus 2-segmented.

11 (12). Inner ramus almost rudimentary, not nearly reaching the middle of first segment of outer ramus. Second segment of outer ramus considerably shorter than first; third segment represented by two spines, the inner about twice as long as the outer. Last thoracic segment armed on each side with small spine. First abdominal segment as long as remainder of abdomen; second segment very short; third, longer than furcal rami. Antennæ reaching slightly beyond furca. *minutus.*

12 (11). Inner ramus not rudimentary, reaching beyond the middle of first segment of outer ramus.

13 (14). Second segment of outer ramus armed with a short spine; denticulate within and without. Third segment represented by two subequal spines. Inner ramus not nearly reaching end of first segment of outer ramus; hairy on inner margin; terminal spines fully half as long as segment. First abdominal segment dilated, about equal in length to remainder of abdomen; second segment and furcal rami each longer than third segment. *piscinæ.*

14 (13). Second segment of outer ramus not armed with a spine.

14 (15). Inner ramus armed with very short subequal spines and hairy at apex. Second segment of outer ramus curved, denticulate on inner margin; third segment represented by two spines, the inner the longer and about half as long as the second segment. Last thoracic segment produced, armed with two large spines on each side; penultimate thoracic segment produced into dorsal hump. First abdominal segment as long as remainder of abdomen, armed with large spine on each side; second segment shorter than the third, which is about equal to the furcal rami. Antennæ extending about to base of abdomen. *sanguineus.*

15 (14). Inner ramus armed with long conspicuous spines.

16 (17). Second segment of outer ramus straight, about as long as the first, armed with a spine at base of third segment. Inner spine of third segment slightly the longer. Inner ramus hairy at apex; terminal spines straight, hairy, about a third as long as the ramus. Last thoracic segment armed on each side with a spine. First abdominal segment short, unarmed. Antennæ extending to end of thorax. *leptopus.*

17 (16). Second segment of outer ramus straight, slightly shorter than first; third segment represented by two subequal spines. Inner ramus barely as long as first segment of outer ramus, hairy at apex, armed with two rather long spines. Antennæ extending to end of furca. *birgei.*

18 (1). Inner ramus clearly reaching end of first segment of outer ramus or beyond.

19 (22). Outer ramus 3-segmented.

20 (21). Third segment of outer ramus small but distinct; inner of the two spines slightly the longer. Second segment curved, shorter than first; denticulate on inner margin; armed with small spine at base of third segment. Terminal spines of inner ramus very long, almost as long as the ramus. Last thoracic segment armed with two minute spines. First abdominal

segment as long as remainder of abdomen, dilated, armed with small spines; second segment very short; third segment longer than furcal rami. Antennæ extending to furca. *franciscanus.*

21 (20). Third segment of outer ramus very indistinct or aborted; armed with two short subequal spines. Second segment of outer ramus about as long as the first, hairy within and without. Inner ramus reaching about to end of first segment of outer ramus, hairy, armed with two long hairy subequal spines. First abdominal segment shorter than remainder of abdomen, dilated but unarmed; second segment shorter than the third, which is longer than the furca. Antennæ not reaching end of furca. *piscinæ.*

22 (19). Outer ramus 2-segmented.

23 (26). Second segment of outer ramus armed with a spine in addition to the two spines representing the third segment.

24 (25). Terminal spines of inner ramus hairy, nearly half as long as ramus, which reaches to the end of the first segment of the outer ramus. Second segment of outer ramus shorter than the first, slightly curved, denticulate within; third segment represented by two spines, the inner hairy, about half as long as the outer, which is smooth. First abdominal segment longer than remainder of abdomen; second segment shorter than third; the third longer than furca. Antennæ reaching tip of furcal rami. *lintoni.*

25 (24). Terminal spines of inner ramus hairy, not nearly half as long as ramus, which is hairy at the apex. Third segment of outer ramus represented by two spines, the inner about twice as long as the outer. Second segment armed with a small spine. Last thoracic segment greatly produced laterodorsally; armed on each side with two small spines. First abdominal segment about as long as remainder of abdomen and armed with two large spinose processes; second segment

shorter than third and about equal to furcal rami. Antennæ extending beyond base of furca but not beyond the tip. *tyrrelli.*

26 (23). Second segment of outer ramus not armed with an additional spine.

27 (32). Second segment of outer ramus longer than preceding segment.

28 (29). Outer of the two spines representing the third segment of outer ramus very small and inconspicuous; second segment shorter than the first, denticulate. Inner ramus reaching slightly beyond end of first segment of outer ramus; hairy on outer margin and at apex; armed with two rather long subequal spines. Last thoracic segment produced laterodorsally, armed with two spines on each side. First abdominal segment slightly shorter than remainder of abdomen, dilated, armed on each side with a large spine; second segment shorter than third; third segment and furca about equal. Antennæ reaching beyond tip of furca. *clavipes.*

29 (28). Outer spine rather conspicuous.

30 (31). Terminal spines of inner ramus smooth. Inner ramus reaching end of first segment of outer ramus; apex hairy; spines small. Second segment of outer ramus about as long as the first, denticulate, point acute; third segment represented by two spines. First abdominal segment as long as remainder of abdomen, dilated, armed with small spines; second segment shorter than third; third about equal to the furca. Antennæ extending to tips of furcal setæ.

oregonensis.

31 (30). Terminal spines of inner ramus hairy, subequal. Second segment of outer ramus about equal to the first; third segment represented by two subequal spines. Last thoracic segment armed on each side with two small spines; the penultimate thoracic segment with a small hump. First abdominal segment slightly

shorter than remainder of abdomen; second segment shorter than third; third segment and furca about equal. Antennæ extending beyond end of furca but not to tips of furcal setæ. *signicauda.*

32 (27). Second segment of outer ramus shorter than preceding segment.

33 (34). Last thoracic segment with a large dorsal process, armed with two spines, one minute. First abdominal segment longer than remainder of abdomen, with short mucronate process anteriorly, and posteriorly with large triangular process. Second segment of outer ramus straight, hairy; third segment represented by two spines, the inner about twice as long as the outer. Inner ramus noticeably shorter than first segment of outer ramus, with two long subequal spines at the apex. Antennæ barely reaching furca. *trybomi.*

34 (33). Last thoracic segment without dorsal process.

35 (36). First abdominal segment longer than remainder of abdomen, dilated, armed with small spine on each side; second segment very short; third segment shorter than furcal rami. Second segment of outer ramus shorter than the first; third segment represented by two spines of which the inner is the longer. Inner ramus extending beyond end of first segment of outer ramus, hairy, armed with two smooth subequal spines. Antennæ extending just beyond furca. *ashlandi.*

36 (35). First abdominal segment about equal to remainder of abdomen.

37 (38). Second abdominal segment very much shorter than the third. Last two thoracic segments confluent; the last one armed on each side with two small spines. First abdominal segment with large spine on each side; third segment longer than the second or the furca. Second segment of outer ramus shorter than the first; third segment represented by two small spines, the inner about twice as long as the outer. Inner ramus

hairy, armed with two small spines. Antennæ reaching slightly beyond end of furcal rami. *siciloides.*

38 (37). Second abdominal segment slightly shorter or at least not longer than the third.

39 (42). Furca longer than third abdominal segment.

40 (41). First abdominal segment nearly as long as remainder of abdomen; dilated laterally, armed with one small spine on each side. Second segment of outer ramus shorter than the first; third segment represented by two spines, the inner the longer and pointed obliquely outward. Inner ramus reaching end of first segment of outer ramus; apex hairy and armed with two spines. Antennæ reaching end of furcal setæ. *reighardi.*

41 (40). First abdominal segment as long as remainder of abdomen; dilated laterally but unarmed. Last thoracic segment produced, armed with one small spine on each side. Head partially divided by a suture. Third segment of outer ramus represented by two spines, the inner smooth, about twice as long as the outer, which is delicately hairy. Inner ramus hairy, armed with two long subequal spines. Antennæ reaching beyond end of furca. *pallidus.*

42 (39). Furca about equal to third abdominal segment.

43 (44). First abdominal segment about as long as remainder of abdomen and armed with small spines, equal on the two sides. First thoracic segment armed with small spine on each side. Second segment of outer ramus shorter than the first; third segment represented by two spines, the inner about twice as long as the outer. Inner ramus longer than first segment of outer ramus; hairy, armed with two spines, the inner twice as long as the outer; margins sinuously curved. Antennæ reaching beyond tip of furca. *sicilis.*

44 (43). First segment of abdomen as long as remainder of abdomen; armed with two large lateral spines, the

right somewhat the longer. First two thoracic segments equal, together about half as long as entire thorax; last segment armed with two small spines. Second segment of outer ramus very broad, especially at the base. Inner ramus hairy on outer margin and at tip, which is armed with two rather long slender spines. Antennæ reaching beyond furca.

mississippiensis.

Diaptomus sicilis Forbes. (Pl. XXI., Fig. 1–3.)

Diaptomus sicilis, Forbes, '82a, p. 645, Pl. VIII., Fig. 9, 20.
Diaptomus pallidus var. *sicilis*, Herrick, '84, p. 142, Pl. Q, Fig. 18.
Diaptomus sicilis, de Guerne et Richard, '89b, p. 23, Fig. 13, 14; Pl. II., Fig. 13.
Diaptomus sicilis, Forbes, '90, p. 702, Pl. I., Fig. 6.
Diaptomus sicilis, Marsh, '93, p. 197, Pl. III., Fig. 8, 10.

Body slender, widest in front of the middle; suture between head and thorax distinct. Last two thoracic segments confluent; the last one produced laterodorsally and armed on each side with one or two small spines; (in the male unarmed.) Abdomen long and narrow, especially in the male, in which the first segment is the longest and slightly the broadest. In the female (Pl. XXI., Fig. 3) this segment is fully as long as the remainder of the abdomen, dilated, and armed on each side with a spine; last three segments subequal. Furcal rami fully twice as long as broad and hairy within.

Antennæ 25-segmented, reaching well beyond the tips of the furcal rami. Male geniculate antenna moderately swollen beyond the twelfth segment; first two segments without special armature; antepenultimate segment armed with narrow spine-like process with swollen apex, reaching to the middle of the penultimate segment; segments 19, 20, and 21 confluent, as are also 22 and 23.

Fifth pair of legs in the male (Pl. XXI., Fig. 1) rather long and slender. First basal segment of the right foot with a large tubercle on the posterior surface near the outer margin, bearing a minute blunt spine. Second basal segment subquadrate, about one and a half times as long as broad. At the beginning of the distal third of its outer margin, is a

small cuticular projection bearing a delicate hair. First segment of the outer ramus subquadrate, slightly longer than broad, the inner distal angle provided with a small semi-elliptical hyaline lamina arising from the anterior surface of the leg; second segment slightly arcuate, the two margins parallel, fully twice as long as wide. Marginal spine long and slender, slightly curved, about half as long as the segment, and inserted at the beginning of the distal third. Terminal hook long, slender, and regularly curved; very minutely denticulate on the inner margin.

Inner ramus of the right leg either one- or two-segmented, extending beyond the end of the first segment of the outer ramus; minutely hairy at the tip.

There is nothing distinctive about the basal segments of the left leg. The first segment of the outer ramus is about one and a half times as long as broad; the inner distal angle gradually rounded and minutely hairy. The second segment is narrow, twice as long as broad; armed at the tip with two digitiform processes and sometimes with a much smaller third process between the two. This segment appears very broad and fleshy because of a cushion-like process with rugose surface which extends beyond the inner margin of the segment for half its length. The other, upper, half is occupied by a minutely hairy semicircular cushion.

Inner ramus of the left foot either one- or two-segmented, extending to the middle of the last segment of the outer ramus; hairy at the tip.

Basal segments of the fifth pair of feet in the female (Pl. XXI., Fig. 2) not characteristic. The usual delicate hair is found on the outer margin of the second basal segment. First segment of outer ramus long and narrow, more than twice as long as broad. Second segment almost as long as the first, narrow, tapering to a fine point, delicately spinose at the inner margin. Third segment wanting; represented by two spines, both sharp and slender, the inner about twice as long as the outer.

Inner ramus of fifth leg of female one-segmented, projecting slightly beyond the end of the first segment of the outer

ramus, the proximal four fifths of uniform width. At the beginning of the distal fifth of the inner margin is a rather sharp angle, from which projects a long, slender, slightly curved spine, about one fifth the length of the ramus. Beyond this the ramus tapers to a blunt point, hairy at the apex. Besides the spine already mentioned there is a smaller one, only about half as long, having its point of insertion very near and slightly above the first.

Length of female 1.23–1.28 mm; of male 1.00–1.18 mm.

D. sicilis closely resembles both *D. ashlandi* and *D. pallidus*, differing from the latter, however, in the presence of a hook on the right male antenna, and from both in the details of structure of the fifth pair of feet of the male.

A very interesting variation was noticed in the inner rami of the fifth pair of feet of the male. In specimens taken from Lake Superior, at Marquette, Mich., the rami were sometimes both one-segmented, sometimes both were two-segmented, and at other times one ramus was two-segmented while the other was one-segmented. Herrick (Herrick and Turner, '95) states that all his specimens had one-segmented rami; also that the process on the right male antenna was shorter than described by Dr. Forbes.

Although *D. sicilis* is not at all uncommon, it has occurred less frequently in the collections I have examined than have *D. siciloides* Lillj., *D. ashlandi* Marsh, or *D. oregonensis* Lillj. Marsh ('93) records *D. sicilis* from the Great Lakes and from Green Lake, Wis., it being the common pelagic species in 1890 and 1891, while in 1892 not a single specimen was found there although the collections were made at the same time of year. The type was described (Forbes '82a) from Lake Michigan and had not then been found anywhere else. In 1890 Dr. Forbes found it in Lake Michigamme, in northern Michigan, as well as in Lake Michigan. His variety *imperfectus* is *D. ashlandi* Marsh. In the Yellowstone Park collections *sicilis* was found in considerable quantities, but as both *D. sicilis* and *D. ashlandi* were present, it would require a re-examination of the material to determine the distribution of the two species in that locality.

Diaptomus piscinæ Forbes. (Pl. XXII., Fig. 1–4.)

Diaptomus piscinæ, Forbes, '93, p. 253. Pl. XLI., Fig. 22.
Diaptomus piscinæ, Herrick and Turner, '95, p. 74, Pl. V., Fig. 13.

"A species of medium size and symmetrical proportions, antennæ reaching to the tip of the abdomen, cephalothorax broadest about the middle, with four distinct sutures, the posterior lateral angles not produced but armed with two distal spines.

"The right antenna of the male is without appendage to the antepenultimate joint, and the fifth pair of legs in the same sex has the inner ramus well developed on both the right and left sides. The usual length is 1.75 millimeters, the transverse diameter 0.45 millimeters; the abdomen with furca is a little more than one third the length of the cephalothorax.

"The fifth pair of legs of the female [Pl. XXII., Fig. 2, 4] is without especially marked characters, except that the inner ramus, which reaches to the tip of the principal segment of the outer, is provided with two long, stout, equal setæ more than half as long as the ramus itself. The third joint of the outer ramus is aborted and bears two short, stout spines, and the joint preceding bears a slender spine outside the base of the last. The terminal claw of this joint is simple and nearly straight, viewed in the usual position.

"In the male the fifth pair of legs [Pl. XXII., Fig. 1] has a considerable resemblance to the corresponding appendages of *D. leptopus*, from which, however, this species differs by its more slender form and by the absence of the antennal hook. The peduncle of the left leg is quadrate and equal in length to the basal segment of the outer ramus, but is nearly twice as wide. The sides of this latter segment are parallel, the inner terminal angle is broadly rounded and minutely ciliate, and to the outer terminal angle is attached the second segment of the ramus. This segment is a trifle shorter than the preceding and less than half as wide, and bears at its tip a stout, blunt, conical spine, whose length is equal to that of the diameter of the ramus, and within this a long flexible

hair as long as the ramus itself. The inner ramus of this leg is very long, reaching beyond the middle of the terminal joint of the outer ramus. It is slightly concave towards this ramus and terminates with a broadly rounded or subtruncate, thickly ciliate end, forming an acute outer angle and an obtuse inner one. Seen at right angles to this view, the tip is simply obtusely pointed.

"The right leg of the male is without remarkable distinguishing characters. Basal joint of the outer ramus about two thirds as long as the peduncle and nearly as wide; second joint slightly longer than the peduncle, equal to the first in width; and the terminal claw sinuate or irregularly curved. The stout seta on the outer margin of the second segment of this ramus is borne at about a quarter the length of the segment from the distal end, and is approximately half as long as the segment to which it is attached. The inner ramus is a little longer than the basal joint of the outer. It is not dilated or otherwise modified, but terminates bluntly, bearing at the tip a covering of long cilia.

"The right antenna of the male is without notable distinctive characters. The antepenultimate segment is as long as the two following taken together; the fourth from the tip bears two long sword-like spines at its margin, both attached to its basal fourth; the expanded segments are well armed with conical spines, straight and curved, but without hooks.

"Small lakelet near Gardiner, Montana."*

This is the only one of the four species described by Dr. Forbes ('93) which I have found in any other collections than the original ones. In collections loaned me by Prof. L. S. Ross, of Drake University, Iowa, made by him at Portage Slough, Manitoba, Canada, in June, 1895, I found quite a number of specimens of this species, which, however, exhibit a number of peculiarities. The fifth pair of legs in the female are stouter and the inner ramus is relatively shorter than in the Montana specimens, the latter not reaching to the end of the first segment of the outer ramus as it does in the type. The spines on the inner ramus also have a more

*Description quoted from Forbes, '93

distinct and broader basal portion than the individuals from Yellowstone Park. Both the inner and outer margins of the second segment of the outer ramus are hairy in Dr. Forbes's specimens, but much more pronouncedly so in the specimens from Portage Slough.

The fifth pair of feet of the male are very similar to the corresponding appendages of *D. claripes* sp. nov. and *D. leptopus* Forbes. Dr. Forbes notes the differences between his species (*piscinæ* and *leptopus*), and from *claripes* both may be distinguished at a glance by the inner rami and the other peculiarities mentioned in the description of that species. A characteristic of *D. piscinæ*, and one which was neither figured nor described, is a fin-shaped process on the middle of the anterior surface of the second basal segment of the right fifth foot of the male. This is armed on the inner margin with a row of bead-like tubercles and is more distinct in the Portage Slough specimens. This process corresponds to a similar one in *D. claripes*. The lower two thirds of the inner margin of this segment are hairy, and at the end of the proximal third is a small triangular projection.

The terminal hook and the marginal spine of the outer ramus of the right male foot are both denticulate on the lower half of the inner margin.

In the "Preliminary Report on the Aquatic Invertebrate Fauna of the Yellowstone National Park, Wyoming, and of the Flathead Region of Montana" the inner ramus of the right fifth leg of the male (Fig. 22) by mistake was not figured. The description was correct but the figure did not correspond.

The first and second segments of the outer ramus of the left fifth foot of the male are hairy on the inner margin.

The length of the Portage Slough specimens is as follows: female, 2.11 mm; male, 2.06 mm.

Diaptomus lintoni Forbes. (Pl. XXVII., Fig. 1.)

Diaptomus lintoni, Forbes, '93, p. 252, Pl. XLII., Fig. 26–28.
Diaptomus lintoni, Herrick and Turner, '95, p. 68, Pl. V., Fig. 12.

"A large red species occurring commonly with *D. shoshone*, but distinguishable from it at a glance by its different shape,

its longer antennæ, its smaller size, and by characters derived from the right antenna and the fifth foot of the male. The thorax is symmetrically elliptical in shape, broadest at the middle. The posterior angles are not produced or bifid, but are each armed with a minute spine. The first segment of the abdomen of the female is not especially produced, but bears at its broadest part a minute spine on each side. The abdomen itself is very short, its length contained about three and one third times in that of the cephalothorax. The antenna of the female is long and slender, 25-jointed, reaching a little beyond the tip of the abdomen.

"The fifth pair of legs in this sex is similar to those of *D. shoshone*, but much smaller. The inner ramus is not jointed. It is longer than the basal joint of the outer ramus, bears two stout plumose setæ at its tip, somewhat shorter than the ramus itself, and has likewise at its inner tip a patch of small spines or fine hairs. The second segment of the outer ramus with its terminal claw is two thirds as long again as the preceding segment, the breadth of the latter two thirds its length. The third joint is indicated by a single long stout seta and one or two smaller ones.

"In the male the geniculate antenna is relatively rather slender, its last two joints without special appendages, its penultimate with a slender transparent apical process, reaching about to the middle of the succeeding segment, acute at tip, but neither serrate nor emarginate. Fifth pair of legs in the male [Pl. XXVII., Fig. 1] usually without internal ramus to the right leg, but this ramus sometimes represented by a small rudiment. The limb is usually slender and its terminal claw short. The basal segment of the outer ramus is nearly as long as the adjacent segment of the pedicel, and the slender second segment of this ramus is fully as long. Long lateral spine borne near the tip of this segment. The terminal claw is about two thirds as long as the segment, is somewhat abruptly angulated near its base and slightly recurved at the tip. The inner ramus of the left leg is very stout and long, reaching almost to the tip of the outer ramus, is slightly curved outwards and has the apex

minutely hairy. The basal segment of the outer ramus is thick, two thirds as broad as long, somewhat inflated within, where it extends downward and beyond the articulation with the second segment as a rounded expansion covered with extremely fine hairs. Second segment of this ramus longer than first, but only half as wide, bearing at its tip, within, a rather small, obliquely projecting cushion covered with cilia, and with two stout terminal spines, one short, blunt, straight, and smooth, the other curved and plumose, its length about half that of the segment to which it is attached.

"The total length of this species is about 2.5 millimeters, excluding caudal setæ; depth, 0.42 millimeters.

"This species is closely related to *D. stagnalis*, Forbes, from which it differs conspicuously by its smaller size, more symmetrical cephalothorax, without prominent or bifid angles, and longer and more slender antennæ, with longer and more slender appendage to the antepenultimate segment.

"In the fifth legs of the female this species differs from *stagnalis* especially with respect to the inner ramus, which is larger and longer than in the other, lacks the characteristic segmentation of *stagnalis*, and bears at its tip shorter and broader setæ. In the male the terminal claw of the outer ramus of the right fifth leg is much more slender than in *stagnalis*, and the inner ramus is much less developed. The left leg of this pair is different in a number of details, especially in the length and strength of the inner ramus and the length and dissimilarity of the setæ at the end of the outer.

"Common in lakes and pools of Yellowstone Park."*

This species is one of the three American forms in which the inner ramus is rudimentary or wanting, the other two being *D. sanguineus* Forbes and *D. minutus* Lilljeborg. It has not been recorded from any localities outside of those in which it was originally found.

* Description quoted from Forbes, '93.

Diaptomus leptopus Forbes.

Cyclops longicornis (?), Herrick, '77, p. 238, Fig. 1.
Diaptomus kentuckyensis (?), Chambers, '81, p. 48, Pl. A, Fig. 12–18; Pl. B, Fig. 19–23.
Diaptomus leptopus, Forbes, '82a, p. 646, Pl. VIII., Fig. 17–19.
Diaptomus castor (?), Herrick, '82, p. 221, Pl. I., Fig. 1–7; Pl. II., Fig. 12, 16.
Diaptomus longicornis var. *leptopus*, Herrick, '84, p. 140.
Diaptomus leptopus, de Guerne et Richard, '89b, p. 21, Pl. II., Fig. 19; Pl. III., Fig. 9.
Diaptomus leptopus, Marsh, '93, p. 195, Pl. III., Fig. 4, 5.
Diaptomus leptopus, Herrick and Turner, '95, p. 64, Pl. II.; Pl. IX., Fig. 9.

Body long and slender, widest a little before the middle. Head rather noticeably narrower than thorax, suture between them distinct. Fifth and sixth thoracic segments confluent, the last produced dorsally on each side into a triangular process with a bluntly rounded apex armed with a single blunt spine. The last thoracic segment of the male and the first abdominal segment of both sexes unarmed. First abdominal segment short, a little more than half as long as the succeeding segment. Furcal rami about one and a half times as long as wide, hairy within.

Antennæ 25-jointed, extending to the tip of the furcal rami. The male prehensile antenna rather thickly swollen, the first segment without armature, the other segments armed as follows: 2, with a short seta and a sense-club; 3, short seta and sense-club; 4 and 6, long spine; 5 and 7, long seta and sense-club; 8, long spine and very short spine; 9, long seta, long spine, and sense-club; 10 and 11, process and long spine; 12, long spine, very short spine, and sense-club; 13, process, long spine, and sense-club; 14, long seta, long spine, and sense-club; 15, process, short seta, long spine, and sense-club; 16, process, long spine, long seta, and sense-club; 17, process and short thick spine; 18, process; 19, 20, and 21 (completely ankylosed), a process, a long seta, and a very short spine; 22 and 23 (completely ankylosed), a narrow hyaline lamina produced into a hook which extends but little beyond the end of the segment, and two long setæ; 24, two

long setæ; and 25, four long setæ and a sense-hair. Some of the setæ on the last segments are sparsely hairy.

Second basal segment of the right fifth leg of the male subquadrate, about twice as long as wide; a delicate hair at the outer margin a short distance above the distal angle. First segment of the outer ramus somewhat narrower than the second basal segment, about twice as long as wide; second segment very long and narrow, about three times as long as wide. Marginal spine slender, about one third the length of the segment, inserted about half its length above the outer distal angle of the segment. Terminal hook slender, regularly curved, about as long as the preceding segment; distal half of inner margin denticulate.

Inner ramus of right fifth foot one-segmented, reaching almost to the end of the first segment of the outer ramus; apex broadly triangular and minutely hairy.

Second basal segment of the left leg of the male subquadrate, slightly broader than long; provided with a delicate hair a short distance above the outer apical angle. First segment of the outer ramus irregular in form, about one and a half times as long as broad, with two rounded protuberances, the one forming the inner apical angle delicately hairy. Second segment long and narrow, almost as long as the preceding segment and a fourth as wide as long; delicately hairy at the inner margin; armed at the apex with a short, thick, blunt digitiform process, and a long curved spine as long as the segment itself and hairy at the inner margin.

Inner ramus of left fifth leg long and narrow, extending beyond the middle of the second segment of the outer ramus; margins sinuous; apex triangular, hairy.

Second basal segment of the fifth pair of feet in the female with the usual marginal hair. First segment of the outer ramus subquadrate, about twice as long as wide; second segment narrow, about as long as the first, tapering to a rather blunt point, finely dentate on the inner margin and with a single tooth on the outer, opposite the last tooth on the inner margin; third segment small but distinct, armed with two short sharp spines, the inner slightly longer than the outer.

Just without these, on the second segment, is a third spine, shorter than either of the other two.

Inner ramus of fifth leg of female one-segmented, extending beyond the end of the first segment of the outer ramus; apex hairy; armed with two long subequal spines hairy on both margins and about a third the length of the ramus.

Length of female 1.89 mm.; of male 1.83 mm.

Breadth of female 0.70 mm.; of male 0.60 mm.

The numerous published figures and descriptions of this species have probably made it well known to all students of North American *Centropagidæ*. The synonymy, however, is interesting. In the Geological and Natural History Survey of Minnesota, Herrick ('77, p. 238) describes and figures "A New Cyclops." It is evident at a glance that this is a Diaptomus, but of what species cannot be determined. In "Microscopic Entomostraca" (Herrick, '79, p. 90) he refers to this "Cyclops" and says, "In the Report of the Geological and Natural History Survey of Minnesota for 1878 it [*Diaptomus longicornis*] was mentioned and a figure given, but erroneously called *Cyclops*." In a "Final Report on the Crustacea of Minnesota" (Herrick, '84, p. 140) he makes *D. leptopus* Forbes a variety of *D. longicornis* Herrick, establishing a second variety, *similis* (Plate Q, Fig. 5–7). In his "Synopsis of the Entomostraca of Minnesota" (Herrick and Turner, '95) he recognizes *D. leptopus* Forbes as a distinct species, making *D. longicornis* var. *leptopus* a synonym; although in this same work *D. longicornis* var. *similis* Herrick is not set up as a species, neither is the name regarded as a synonym. The figures (Herrick '84, Pl. Q, Fig. 5–7) are not well drawn, but it is not likely that this form is *leptopus*. *D. similis* is referred to once (Herrick and Turner '95, p. 58) in connection with *D. franciscanus* Lilljeborg. *Diaptomus kentuckyensis* Chambers ('81) is also quite possibly *D. leptopus*, although the description is very vague and the figures are inaccurate.

Diaptomus sanguineus Forbes. (Pls. XXIII., XXIV., and XXV.)

Diaptomus sanguineus, Forbes, '76, pp. 15, 16, 23, Fig. 24, 28–30.
Diaptomus sanguineus, Forbes, '82a, p. 647, Pl. VIII., Fig. 1–7, 13.
Diaptomus armatus(?), Herrick, '82, p. 223, Fig. 1, *a*, *b*.
Diaptomus armatus(?), Herrick, '84, p. 139.
Diaptomus sanguineus, Herrick, '84, p. 138, Pl. Q, Fig. 12.
Diaptomus minnetonka, Herrick, '84, p. 138, Pl. Q, Fig. 8–10.
Diaptomus sanguineus, de Guerne et Richard, '89b, p. 20, Fig. 9–11; Pl. IV., Fig. 24.
Diaptomus sanguineus, Marsh, '93, p. 195, Pl. III., Fig. 1–3.

A rather large species, one fourth to one third as wide as long. The cephalothorax widens gradually to the third segment (being broadest at the suture between that segment and the fourth), then narrows less gradually to the abdomen. In the male the thorax is less uniform in breadth than in the female. The last cephalothoracic segment is greatly produced on each side laterodorsally and bears a large spine, slightly swollen at the base, varying in length from that of the segment to one fourth its length. On the same segment and midway between the outer spine and the abdomen is another broader and shorter spine. Both of these spines are slightly curved. In the female (Pl. XXIV., Fig. 3) they are generally quite noticeably larger than in the male. On the first abdominal segment is still another spine, slightly outcurved and pointing outward, about as large as the second of the spines mentioned above. In the female the penultimate cephalothoracic segment bears a dorsal hump at its anterior margin (Pl. XXIV., Fig. 5, 6). This is wanting in the male. The abdomen is produced dorsally and ventrally at the anterior part, making it look like a keel (Pl. XXIV., Fig. 1, 2), the keel being most pronounced on the ventral side. The egg-mass is large and elliptical, with the major axis transverse to the body.

Antennæ 25-segmented, the seventeenth or eighteenth segment reaching about to the base of the abdomen. The right male antenna is thickly swollen beyond the geniculate joint. The last two segments have no special armature, but the antepenultimate one (Pl. XXIII., Fig. 6–8) is armed at the

inner distal angle with a short thick recurved hook with smooth edges, extending but little beyond the joint. This is merely the continuation of the hyaline lamina at the side of the segment.

Second basal segment of the right fifth leg of the male (Pl. XXIII., Fig. 1–5), seen from behind, irregularly trapezoidal in form, very broad distally, and about twice as long as its narrowest part is wide. On the outer distal angle of this segment is another projection, equal to or greater in length than the inner ramus. This also shows great variation, and is either rounded or acute or even acuminate at the apex. First and second segments of outer ramus subquadrate, the second about as wide as the first and about two and a half times as long. About a third the length of the second segment from its base is a considerable contraction, the width here being about half the width of the broadest part. Slightly below the middle, on the outer margin, is a spine, minutely serrate at the inner edge. This is generally long and straight, about half the length of the segment, but varies, and is sometimes shorter, thicker, curved, and less than one third the length of the segment (Pl. XXIV., Fig. 4; Pl. XXV., Fig. 3–5). Terminal hook rather long and slender, slightly and sometimes sinuously curved, about one and a fourth times the length of the preceding segment. The inner margin is serrate, beginning about the middle of the hook and continuing to the tip.

Inner ramus of the right fifth foot wanting, a peculiarity rarely found among the American species of Diaptomus, but approached most closely by *D. lintoni* Forbes and *D. minutus* Lilljeborg, in which the ramus is very small, almost rudimentary. The ramus is represented by an immovable spine, minutely spinose at the tip. This is greatly diverse in shape and sometimes gives indications of a joint (Pl. XXIII., Fig. 2), as if a case of ankylosis.

Left fifth foot of the male biramose; second basal segment quadrate, with a short thick spine just above the outer distal angle. Second segment of outer ramus irregularly subquadrate, about two thirds as wide as long, provided at the inner

margin with a cushion-like protuberance densely covered with minute hairs. This segment is produced into two spines, forming a forcipate structure. The inner spine is slightly shorter than the main part of the segment, thick, incurved, and movable, and armed on its outer margin and on the distal third of the inner one with minute hairs. The outer spine is immovable, ending in a blunt point, and its curve is rather more pronounced than that of the inner one.

Inner ramus of left fifth foot one-segmented, straight, and armed with minute hairs at the apex. It is about three times as long as broad and reaches beyond the middle of the second segment of the outer ramus.

First basal segment of the fifth foot of the female (Pl. XXV., Fig. 1, 2) subquadrate, slightly longer than broad, bearing a short thick spine near the outer distal angle. The distal segment is also subquadrate and bears the usual delicate hair. Outer ramus two-jointed, the first segment oblong, about twice as long as wide; second segment in the form of a thick incurved hook, with a broad, quadrate basal portion. The hook is about three times as long as its greatest breadth, the distal fourth of the inner edge armed with a variable number of teeth (8–15). Third segment wanting, represented by two spines; the outer short, thick, about one third the length of the segment; the inner rather longer and more slender, sinuously curved, and about half as long as the second segment.

Inner ramus of fifth foot of female straight, one-segmented, about four times as long as broad; armed at the tip with two smooth spines of almost equal length and but slightly curved. The tip of the ramus is delicately hairy.

Length of female 1.4–2.12 mm; of male 1.–2. mm.

Breadth of female .4–.43 mm; of male .3–.33 mm.

The synonymy of this species is almost as complicated as that of *D. leptopus*. First described by Dr. Forbes ('76), it was next described under two different names (*D. sanguineus* and *D. minnetonka*) by Herrick ('84). I am also led to believe very strongly that Herrick's *D. armatus* is nothing but a variant of *D. sanguineus*. The descriptions and figures (Herrick, '82, p. 223, Fig. 1, *a* and *b*) seem to me to be

without specific value. The following, taken from Herrick and Turner '95a, p. 72, is his most complete description. "It appears to be allied to *sanguineus*. The antennæ are said to be shorter than the body, the caudal stylets narrow, the right male antenna has a hook upon its antepenultimate joint and is strongly geniculate. But the one feature which may determine the species is the existence of a tooth or spur near the base of the claw of the right fifth foot of the male."

In collections from Phelps Lake, Havana, Ill., made May 18, 1894, occurred a single male specimen of a variant of *D. sanguineus* which might easily be described as a new species if the spine at the base of the terminal hook were taken as the one specific characteristic to which all others must be subordinated. This spine is straight and minutely dentate on both margins. In all other respects, except a slight difference in the length of the terminal hook, the specimen is a normal *D. sanguineus*. The fifth pair of legs is shown in Pl. XXV., Fig. 5. The occurrence of this specimen, taken in connection with the loose descriptions of *armatus*, has led me to believe in the identity of Herrick's species and this variant.

In regard to *D. minnetonka*, Marsh ('93) points out that it is probably but a variety of *D. sanguineus*. In his "Synopsis of the Entomostraca of Minnesota" Herrick says: "We are inclined to agree with Marsh that this form is but one of the many variations of *D. sanguineus*"; but he nevertheless retains *minnetonka* as a species name instead of making it a synonym of *sanguineus*.

Diaptomus sanguineus occurs in early spring in standing water in connection with *D. stagnalis* Forbes, from which it may be distinguished at a glance by the difference in size, *D. stagnalis* being about twice as large as *D. sanguineus*. The latter is generally a deep red, but *D. stagnalis* is often blue, with abdomen and antennæ a brilliant red.

The theory of Herrick (Herrick and Turner, '95) in regard to the transition of forms, "beginning with *D. stagnalis* and passing through several varieties to *D. sanguineus* later in the season," will not hold owing to the fact that sexually mature specimens of both species have been found in the same pools at the same time.

The collection from which the variant mentioned above was taken, made in May, 1894, consisted almost entirely of *D. sanguineus*. Collections from the same waters made in July, 1896, did not contain a single individual of this species, but *D. siciloides* Lilljeborg and *D. pallidus* Herrick, were present in immense numbers.

VARIATION IN D. SANGUINEUS FORBES.

Plates XXIII., XXIV., and XXV. were prepared before the thesis work proper was undertaken and exhibit the results of a study in variation. From these figures it will at once be evident that *D. sanguineus* is an unusually variable species, and without the intermediate forms the extremes might almost be regarded as distinct. The specimens examined were all from the collections of the Biological Station at Havana, so that the variations are probably not so great as they would be if widely separated localities were represented. Especial attention was given to variations of specific characters, and most particularly to the relative proportions.

The second basal segment of the right leg of the male, which is usually very broad, in fact one of the most characteristic features of the male, is shown in Pl. XXIII., Fig. 2, to be sometimes of very ordinary width, the other extreme being shown in Pl. XXIV., Fig. 4. The relative position and length of the projection on the outer distal angle of this segment also vary a great deal, the extremes noted being shown in Pl. XXIII., Fig. 1 and 2.

The marginal spine of the outer ramus of the right fifth leg, the position, relative length, and characters of which are of specific value in most species, lacks such value almost entirely in *D. sanguineus*. The extreme variation is shown in Pl. XXIV., Fig. 4, and Pl. XXV., Fig. 3.

The inner ramus of the right fifth leg, though always very short, varies in length from that shown in Pl. XXIV., Fig. 4, to that in Pl. XXIII., Fig. 2, on the latter of which is also shown a rather clearly marked suture which is usually wanting.

The variation in the size of the males is indicated by the drawings of the fifth pair of legs. (See Pl. XXV., Fig. 3–5, and Pl. XXIV., Fig. 4.)

The antepenultimate article of the prehensile antenna (Pl. XXIII., Fig. 6–8) is not so variable, but still quite a difference may be noted in the width of the hyaline plate and in the relative lengths of the segments.

In the female the variation in size is even greater than in the male, the fifth legs being shown in Pl. XXV., Fig. 1, 2. The variation in the "hump" of the female is slight (Pl. XXIV., Fig. 5, 6), as is also that of the first abdominal segment (Pl. XXIV., Fig. 1, 2).

While I have found no variation whatever in the color of *D. sanguineus*, all of the specimens I have seen alive being a bright uniform red, as were also those examined by Dr. Forbes ('76), and by Gissler ('81), Gissler later ('81a) found individuals colored as follows: body and legs bluish, antennæ and furca red, and abdomen yellow. Herrick says in the description of *D. minnetonka* (Herrick and Turner, '95), which is a synonym of *D. sanguineus*, "color dark." In the same work, in his description of *D. sanguineus*, he says "brilliantly colored." According to my observation color is of no certain specific value in Diaptomus, but it may be that there are definite seasonal variations—a subject which I have not investigated.

Diaptomus stagnalis Forbes. (Pl. XXVIII., Fig. 2.)

Diaptomus stagnalis, Forbes, '82a, p. 646, Pl. VIII., Fig. 8, 10–12, 14.
Diaptomus giganteus, Herrick, '82, p. 222, Pl. II., Fig. 3, 11, 15.
Diaptomus stagnalis, Herrick, '84, p. 139, Pl. Q, Fig. 11, 13.
Diaptomus stagnalis, de Guerne et Richard, '89b, p. 23, Pl. IV., Fig. 14.

Head distinct from thorax; fifth and sixth thoracic segments confluent. Lateral angles of last thoracic segment strongly produced backward, each angle bilobed, the outer lobe about twice as large as the inner; (in the male this segment is salient.) Abdomen peculiar in that there is a sudden narrowing at the beginning of the third segment. First abdominal segment armed with a large spine on each side (in the male unarmed); second and third segments of the abdomen subequal, about twice as wide as long. Furcal rami subquadrate, hairy within. Furcal setæ rather short,

densely plumose. There is but little difference in the length of the abdominal segments of the male.

Antennæ 25-segmented, reaching to the middle of the abdomen. Prehensile antenna of the male (Pl. XXVIII., Fig. 2) thickly swollen anterior to the twelfth article, with armature as follows: segments 1 and 5, long spine and sense-club; 2, three long spines and sense-club; 3, short seta; 4 and 6, long spine; 7, short seta and sense-club; 8 and 12, long spine and short spine; 9, long spine, short seta, and sense-club; 10, 11, 13, and 17, process and long spine; 14 and 16, long spine, short seta, and sense-club; 15, process, two long spines, and sense-club; 18, process; 19, 20, and 21 (ankylosed, with the sutures indistinctly indicated), two processes, a stunted spine, and a long seta; 22 and 23 (ankylosed), a broad hook-like process not reaching the end of the penultimate segment, and four setæ; 24, two setæ; and 25, four setæ, a sense-hair, and a sense-club.

Second basal segment of the right fifth foot of the male subquadrate, about twice as long as wide; on the posterior surface a large smooth hyaline lamina occupying about a third of the inner margin near the middle, and near the outer distal angle a minute cuticular process bearing a delicate hair. First segment of the outer ramus almost three times as long as broad; second segment about as long as the first and for about the proximal third nearly as wide, but beyond this considerably broader. Marginal spine near the outer distal angle; straight, very strong and thick, little less than half as long as the segment. Terminal hook rather short and very stout, irregularly curved, heavily and closely denticulate at the distal half of the inner margin.

Inner ramus of the right fifth leg spatulate, not nearly reaching the middle of the first segment of the outer ramus; apex rounded, armed with a few strong spines.

Second basal segment of the left fifth foot armed at the outer margin, a short distance above the distal angle, with a short, thick, pointed spine. First segment of the outer ramus about three times as long as wide, armed at the distal third of the inner margin with a few strong hairs. Second segment

about half as long as the first, having on the inner margin two cushion-like processes (the upper, smaller one hairy, and the lower densely tuberculate), and being armed at the tip with two processes forming a forcipate structure, the outer broad, plowshare-shaped, the inner a long and narrow spine, hairy within.

Inner ramus of left fifth foot one-segmented, of the same width throughout, with a broadly rounded tip; inner margin rugose.

Second basal segment of the fifth foot of the female with the usual delicate hair at the outer margin. First segment of outer ramus short and broad. Second segment large, about one and a half times as long as the first, armed on the middle third of the inner margin with seven or eight very large, strong, pointed spines, and on the outer margin and opposite the upper spines of the inner margin with three or four spines. Third segment distinct, armed with two spines, the outer one short, thick, sharp, smooth, the inner one about twice as long and armed with a few rather strong spinules. Just without these spines, on the second segment, is a shorter, smooth spine.

Inner ramus of the fifth foot of the female distinctly two-segmented, the first segment subquadrate, the second as wide as the first and nearly twice as long, and armed at the tip with two thick heavy spines reaching to the end of the second segment of the outer ramus. These spines are armed with heavy spinules. Disregarding the spines, the ramus reaches just to the end of the first segment of the outer ramus.

Length of female 4.0–4.5 mm.; of male 3.5–4 mm.

This Diaptomus is the largest of the American species and a very beautiful one. Dr. Forbes states in his original description ('82a) that "all were red throughout." Specimens taken in April, 1897, from ponds south of Urbana, Ill., when they were in the height of sexual activity, were colored as follows: thorax and anterior appendages (all but the first pair of antennæ) blue; first pair of antennæ, fifth pair of legs (in the male), and abdomen red. In the female all the legs were blue.

The pool from which they were taken was particularly rich in decaying vegetable material and received the drainage of a pasture in which cattle and horses were allowed to graze. The water literally swarmed with *Volvox;* and *Diaptomus, Cyclops,* and insect larvæ were very abundant. The food supply was practically inexhaustible and the specimens taken were unusually large.

Diaptomus shoshone Forbes. (Pl. XXVI., Fig. 1–3.)

Diaptomus shoshone, Forbes, '93, p. 251, Pl. XLII., Fig. 23–25.
Diaptomus shoshone, Herrick and Turner, '95, p. 61, Pl. V., Fig. 11.

"A very large and robust species. Thorax broadest in front, across the maxillæ, tapering gradually, with little convexity, to the posterior third. In the female the angle of the last segment is bifid, both projecting points being minutely spinose at tip. The first segment of the abdomen (Pl. XXVI., Fig. 1) is laterally expanded, the expansion of the left side with a minute spine at the apex, behind, that on the right produced at the same point into a small, prominent, rounded tubercle, 0.03 millimeter in length, about as broad as long, making this first segment somewhat unsymmetrical. This is not merely a modified cuticular appendage, but is penetrated by the hypodermis. Egg-mass very large, obovate (narrowest forward).

"Right antenna of male robust, the last two joints without special appendages, antepenultimate with a very long inarticulate process at its outer apex, extending beyond the tip of the penultimate and to the middle of the last segment. The margins of this process are smooth, but it is broad and emarginate at the tip.

"The fifth pair of legs in the male resemble the corresponding appendages of *Diaptomus stagnalis,* but differ notably in detail. The left ramus of the right leg is borne at the inner terminal angle of the second joint; is longer than the joint following; is armed at the apex with a few small acute spines; and bears upon its outer margin, near the tip, a broad fascicle of delicate hairs. The basal joint of the outer ramus is two thirds the length of the second joint of the peduncle,

and without hairs or spines of any description. The second joint of this ramus is about equal in length to the second joint of the peduncle, and bears on its outer margin, close to the tip, the usual stout seta, which is two thirds as long as the joint to which it is attached. The terminal claw is not regularly curved, but is nearly straight for the basal three fourths. The left leg is biramose, the inner ramus straight, slender, extending about to the middle of the second joint of the outer, and armed at its tip. The second joint of this ramus is as long as the first, if measured from the tip of the apical spine. This spine, seen from behind, is stout, conical, rather blunt, and has opposed to it within, projecting from the inner angle of the segment, a stout, curved seta, slightly plumose on its distal half. Between these, but more closely applied to the outer spine, is a hemispherical cushion-like elevation, set with small, short spinules. On the basal half of the inner margin of this terminal segment is also a much larger hemispherical cushion, but with longer and more slender hairs, while the terminal half of the inner margin of the segment preceding is also moderately inflated and covered with delicate hairs.

"The antennæ of the female are 25-jointed, as usual, and reach to the base of the abdomen. The legs of the fifth pair (Pl. XXVI., Fig. 2) closely resemble those of *stagnalis*, but have the terminal setæ of the inner rami much less developed. This ramus is a little shorter than the basal joint of the outer ramus, and of about half its diameter. It bears at its tip two stout setæ equaling the ramus itself in length, plumose under a high power, and has, in addition, at its inner tip and on the inner margin adjacent, a patch of delicate hairs and spines. The second joint of the outer ramus is as long as the first, if measured to the tip of its terminal claw. The latter is nearly straight, very slightly recurved. This joint bears a single spine at its outer distal angle, just within which is the rudiment of the third segment of the ramus, which bears two spines similar to the above, the inner of which is the longer, the outer itself being longer than the adjacent spine of the second joint. Adults of both sexes are blood-red throughout except the egg-sac of the female, which is purple.

"Dimensions of female: Length to tip of caudal setæ, 3.1 millimeters; abdomen, with setæ, 1.16 millimeters, without, 0.67 millimeters; thorax, 1.95 millimeters in length; depth, 0.725 millimeter; width, 1 millimeter.

"Male averaging scarcely smaller, but somewhat differently proportioned: Thorax, 1.85 millimeters in length; depth, 0.58 millimeter; width, 0.08 [1.08]* millimeter; abdomen, without setæ, 0.745 millimeter; with setæ, 1.35 millimeters in length.

"Especially abundant in Shoshone Lake, but occurring in other lakes and even in pools of some size in Yellowstone Park."†

The drawings here given are in some cases the same as those in the original description with unimportant corrections or additions, but two new figures (Pl. XXVI., Fig. 1, 3) have been added. I have not found this species in any collections except those from Yellowstone Park and the Flathead region, in which it is rather abundant.

A few points may be added to the original description. In the female the first basal segment of the fifth pair of legs bears a short sharp spine on the outer margin a short distance above the distal angle. Both spines of the rudimentary third segment of the outer ramus are distinctly spinose on the inner margin. The first abdominal segment is almost as long as the remainder of the abdomen; the second segment very short, about half as long as the succeeding segment or the furca. Furcal rami about one and a half times as long as wide and hairy within. My observations differ from those of Prof. Forbes in that, as a rule, the abdomen of the female is not asymmetrical, the first segment bearing on each side a small tubercle armed with a minute spine. In the male the first abdominal segment is very slightly dilated laterally but unarmed, and about half as long as any one of the five succeeding segments, which differ very little in length. The furcal rami are fully twice as long as wide and hairy within.

*The 0.08 in the original description is probably a typographical error, since the specimens measured by myself were about 1.08 millimeters in length.

†Description quoted from Forbes, '93.

Diaptomus pallidus Herrick. (Pl. XXVII., Fig. 3.)

Diaptomus pallidus, Herrick, '79, p. 91, Pl. II.
Diaptomus pallidus, Herrick, '83a, p. 383, Pl. VII., Fig. 1–6.
Diaptomus pallidus, Herrick, '84, p. 142, Pl. Q, Fig. 17.
Diaptomus pallidus, de Guerne et Richard, '89b, p. 62, Fig. 34.
Diaptomus pallidus, Marsh, '93, p. 196, Pl. III., Fig. 6, 7, 9.
Diaptomus pallidus, Herrick and Turner, '95, p. 73, Pl. IV, Fig. 1–6; Pl. V., Fig. 10; Pl. XIII., Fig. 17.

Of medium size, slender; cephalothorax widest near the middle; head partially divided by a suture; suture between head and thorax distinct. Fifth and sixth thoracic segments confluent; last thoracic segment produced laterodorsally, bearing a small spine on each side. First abdominal segment unarmed but dilated laterally (not dilated in the male), about as long as the remainder of the abdomen; second segment the shortest. Furcal rami hairy within.

Antennæ 25-segmented, reaching about to the tips of the furca or slightly beyond. Male prehensile antenna moderately swollen; no special armature on the last three segments; segments 19 and 20 ankylosed, armed with a process and a long seta; 21, 22, and 23 ankylosed, armed with two long setæ; 24, with two long setæ; and 25 with four long setæ and a sense-club. Some of the antennal setæ are very minutely and sparsely hairy.

First basal segment of right fifth foot of male (Pl. XXVII., Fig. 3) with large tubercle bearing a small spine on the posterior aspect; second basal segment as usual, about equal in length to the first. First segment of the outer ramus subquadrate, about as long as wide; second segment about as wide as the preceding and about one and a half times as long, bearing on the inner margin, at the end of the proximal third, a small sharp-pointed cuticular projection. The outer margin of this segment is almost straight to the beginning of the distal third, where a sharp angle is made from which springs the marginal spine. This spine is sharp, slender, slightly curved, a little more than one third the length of the segment. Terminal hook slender, about one and a half times as long as the second segment; not regularly

curved, but with a sharp angle at the beginning of the distal third; minutely denticulate within.

Inner ramus of right fifth foot one-segmented, slender, narrowing gradually from base to tip, extending but slightly beyond the proximal third of the second segment of the outer ramus; hairy at the apex and very delicately denticulate on the outer margin.

Basal segments of left fifth foot subquadrate, the second slightly longer than the first and both slightly longer than broad; second segment delicately tuberculate on the inner margin. First segment of outer ramus about half as wide and three fourths as long as the basal segment. Second segment about as long as the first, and very similar to the corresponding segment of *D. sicilis* Forbes, from which it differs, however, in its armature. This consists of a movable claw, blunt or slightly thickened at the tip, forming a forcipate structure with an inner cushion-like process. The claw usually lies close against this and is difficult to make out. It is hairy on both margins.

Inner ramus of the left fifth foot one-segmented, hairy at the apex and delicately denticulate on the outer margin, extending to the end of the first segment of the outer ramus or slightly beyond it.

Second basal segment of the fifth foot of the female with the usual hair at the outer distal angle. First segment of the outer ramus subquadrate, about twice as long as broad. Second segment about as long as the first, tapering to a blunt point; inner margin denticulate. Third segment wanting, represented by two spines, the inner about twice as long as the outer and smooth, while the outer is delicately hairy.

Inner ramus of fifth foot of female one-segmented, reaching the end of the first segment of the outer ramus; hairy at the apex and within, and armed at the tip with two long subequal delicately hairy spines.

I have found specimens from the Illinois River at Havana with the inner ramus of the right fifth foot reaching barely beyond the end of the first segment of the outer ramus. The first basal segment of the left foot of the male is provided with

a hyaline lamina ending in a pointed spine-like projection; and the second basal segment is tuberculate at the inner margin, as is also the outer margin of its inner ramus. All of these differences are quite constant but not of sufficient importance to constitute even a variety.

D. pallidus was found in immense numbers in connection with *D. siciloides* Lilljeborg during the entire time of my stay at the Biological Station at Havana—that is July and part of August, 1896. So far as I was able to ascertain, *siciloides* was slightly the more abundant, but the difference was not very evident.

Herrick's original description of *D. pallidus* ('79) was very indefinite, and the establishment of the species really dates from 1893, when Marsh figured and described it in a manner to make it recognizable by later students. De Guerne and Richard ('89b) place it among their "species insufficiently described."

Diaptomus albuquerquensis Herrick. (Pl. XXVII., Fig. 2, 4.)

Diaptomus albuquerquensis, Herrick, '95, p. 45, Fig. 16–26.
Diaptomus albuquerquensis, Herrick and Turner, '95, p. 67, Pl. VI., Fig. 1–3; Pl. VII., Fig. 1–11.

A medium-sized species. Cephalothorax widest about the middle. Suture between head and thorax distinct. Last two thoracic segments, seen from above, indistinctly confluent, the last one produced laterodorsally and armed on each side with two rather long spines; in the male produced but but very slightly and armed with only one spine on each side. First abdominal segment in the female longer than the remainder of the abdomen, dilated laterally, and armed on each side with a single spine; second and third segments subequal; each shorter than the furcal rami, which are barely twice as long as wide and hairy within. First abdominal segment in the male short, a little more than half as long as any one of the succeeding three segments; dilated very slightly, and armed on each side with a spine; fifth segment about as long as the first. Furcal rami barely twice as long as wide and hairy within.

Antennæ of the female 25-segmented, extending well beyond the tips of the furcal setæ; somewhat shorter in the male, reaching about to the tips of the furcal setæ. Right male antenna moderately swollen beyond the thirteenth segment. Beyond the twelfth segment the antenna is armed as follows: 13, with large process; 14, process, short seta, and very long seta; 15, very short stunted spine, short seta, and long seta; 16, a short and a long seta; 17, process, short seta, and long seta; 18, large process; 19 and 20 (completely ankylosed), short stunted spine and long seta; 20, 21, and 22 (also completely ankylosed), two setæ, and a hooked process extending beyond the middle of the penultimate article; 24, two setæ; and 25, four setæ.

Left fifth leg of the male (Pl. XXVII., Fig. 4) short, not reaching to the end of the second segment of the outer ramus of the right leg. First and second basal segments subequal, the first armed at the middle of the outer margin with a rather long sharp spine; the second slightly broader than the first, and provided a short distance above the outer distal angle with the usual delicate hair, and at the middle of the inner margin with a small hyaline plate. First segment of the outer ramus about twice as long as wide; outer margin arcuate, inner margin convex and delicately hairy. Second segment racket-shaped, the broad basal half being almost circular; hairy on the inner margin. The digitiform terminal half is blunt and delicately denticulate on the margin. From the anterior aspect projects a delicately hairy spine about as long as the digitiform process, but more acute and pointing inward.

Inner ramus of left fifth leg short, one-segmented, barely reaching to the end of the first segment of the outer ramus; margins slightly sinuous; apex bluntly rounded, very delicately hairy, the hairs at the apical angles being somewhat stouter and spine-like.

First basal segment of right fifth leg of male subquadrate, slightly longer than broad; armed at the outer distal angle with a stout, sharp spine pointing straight outward. Second basal segment subquadrate, about equal to the first, and

armed on the outer margin, a short distance above the apical angle, with a spine-like hair. First segment of outer ramus subquadrate, slightly narrower than the second basal segment, and about as wide as long; second segment about as wide as the first and twice as long, provided at the end of the proximal third with a small bead-like tubercle. Marginal spine very large and strong, longer than the segment itself, somewhat sinuously curved, and inserted near the distal angle. Terminal hook very long, as long as the remainder of the right leg including the basal segments, but not twice as long as the marginal spine; very slightly recurved at the tip and denticulate at the inner margin.

Inner ramus of the right fifth leg one-segmented, very short, barely reaching the end of the first segment of the outer ramus; apex bluntly rounded and delicately hairy.

First segment of outer ramus of fifth foot of female (Pl. XXVII., Fig. 2) subquadrate, about twice as long as wide. Second segment, or unguiform process, about as long as the first, subconical or but slightly curved, delicately denticulate on the inner margin. Third segment small but distinct, armed with two spines, the inner of which is more than twice as long as the outer, reaching about to the middle of the second segment.

Inner ramus of fifth foot of female indistinctly two-segmented, short, reaching just beyond the end of the first segment of the outer ramus; apex bluntly triangular, armed with a few short hairs, the innermost of which is longer than the rest and spine-like.

Length of female 1.2 mm.; of male 1.05 mm.

The material in which the specimens described were found was loaned me by Mr. Adolph Hempel, of Gotha, Florida, and was collected by him in a series of Florida lakes from January to March, 1896.

D. albuquerquensis is one of the few American species of Diaptomus in which the inner ramus of the fifth leg of the female is two-segmented. In some cases this ramus, instead of being bluntly triangular, is acute, and reaches only to the end of the first segment of the outer ramus. The first basal

segment is sometimes armed at the outer distal angle with a short, sharp spine.

Herrick (Herrick and Turner, '95) states that he found the second segment of the left fifth leg of the male to be granular on the inner margin, and the marginal spine of the right leg denticulate on the inner margin and at the base. In both these respects my specimens differ from his, the second segment of the left foot being hairy instead of granular, and the marginal spine of the right foot perfectly smooth. Herrick's statement that "the first pair of antennæ reach to the extremity of the furca or surpass them" leads me to think that they are longer in the Florida specimens than in his, since they clearly reach beyond the tips of the furcal setæ in every individual which I have examined.

In New Mexico Herrick found this species, in connection with *D. novamexicanus*, in the water supply of the city of Albuquerque; but in the Florida lakes it was found with *D. mississippiensis* Marsh, the two forms being about equally abundant. They are very much alike in general appearance, but the males may be distinguished without dissection by the antepenultimate article of the right antenna, which is armed in *D. albuquerquensis* while it is unarmed in *D. mississippiensis*. Herrick gives the length of the female as 1.4–1.6 mm., but the largest female from Florida was 1.2 mm., while the male was only 1.05 mm. in length, the average being considerably smaller.

Diaptomus novamexicanus Herrick.

Diaptomus novamexicanus, Herrick, '95, p. 46, Fig. 27–29.
Diaptomus novamexicanus, Herrick and Turner, '95, p. 70, Pl. VI., Fig. 7–10.

Among the smaller species of the genus, moderately robust. Cephalothorax widest somewhat in front of the middle. Last two thoracic segments distinct, the last armed on each side with a small, short spine. First abdominal segment very long, much exceeding the remainder of the abdomen, provided on each side with a short, sharp spine; second segment the shortest. Furcal rami equal in length to the

preceding segment and about twice as long as wide; provided with short apical setæ.

Antennæ of the female 25-segmented, reaching to the base or the end of the furca. Antepenultimate article of the right male antenna armed with a lamina produced anteriorly into an unguiform process which is shorter than the penultimate article.

Outer ramus of the fifth pair of feet in the female obviously three-segmented. Unguiform process of the second segment arcuate, finely denticulate within and at the end, armed on the outer margin near the base of the last segment with a small spine. Last segment small but distinct and armed with two short subequal spines.

Inner ramus of fifth foot of female one-segmented, as long as the basal segment of the outer ramus; apex ciliate and armed with two subequal spines.

Left fifth leg of male reaching slightly beyond the end of the first segment of the outer ramus of the right foot. First basal segment armed on the outer margin with a short, sharp spine. Second segment of the outer ramus oblong-ovate, armed with two large spines; inner margin delicately aculeate toward the apex, and bearing a ciliate lamina.

Inner ramus of left fifth leg one-segmented, quite long, reaching beyond the middle of the second segment of the outer ramus; hairy at the apex.

First basal segment of right fifth leg of male armed on the outer margin with a rather long, sharp spine. First segment of the outer ramus subquadrate, slightly longer than broad; second segment very long and narrow, more than twice as long as the preceding segment. Marginal spine slender, more than half as long as the segment itself, and inserted at about the beginning of the distal third. Terminal hook long and slightly curved.

Inner ramus of right fifth leg one-segmented, rather long, reaching beyond the end of the first segment of the outer ramus; apex acute, minutely ciliate.

Length of female 1.1–1.2 mm.

The above description is compiled from Herrick's first paper on this species ('95) and from the figures and the English and Latin descriptions in his later paper (Herrick and Turner, '95). Both of these articles are published as original descriptions, although there was nine months' difference in the time of their appearance.

Diaptomus oregonensis Lilljeborg. (Pl. XXIX., Fig. 1, 2.)

Diaptomus oregonensis, de Guerne et Richard, '89b, p. 53, Pl. II., Fig. 5; Pl. III., Fig. 8.

Diaptomus oregonensis, Marsh, '93, p. 200, Pl. IV., Fig. 4, 5.

Diaptomus oregonensis, Marsh, '95, p. 8, Pl. VII., Fig. 5.

Diaptomus oregonensis, Herrick and Turner, '95, p. 72, Pl. IV., Fig. 7–12; Pl. IX., Fig. 3.

A species of medium size. Cephalothorax widest about the middle. The last two thoracic segments confluent above, the last one, seen from above, slightly produced laterally, bluntly rounded but unarmed; in the male armed with two very minute spines on each side. First abdominal segment as long as the rest of the abdomen.* Third segment and furcal rami subequal, the latter about one and a half times as long as broad and delicately hairy within. In the male the first abdominal segment is short and unarmed; second and third segments and furcal rami about equal; fourth segment the longest, about equal in length to the first two segments taken together. Furcal rami about as in the female.

Antennæ of the female 25-segmented, extending beyond the tips of the furcal setæ. Prehensile antenna of the male but slightly swollen, the antepenultimate article entirely unarmed.

First basal segment of fifth leg of female (Pl. XXIX., Fig. 2) with the usual delicate hair on the outer margin. First segment of outer ramus about twice as long as wide, slightly arcuate, margins parallel; second segment about as long as the first, moderately curved, terminating in an acute point,

*This segment had a very peculiar appearance. Owing to the thicker anterior part, the segment seemed to have a suture at about the middle, and this was so misleading that I doubted if the specimens on the slides were really females until I could see the antennæ, and not until I could get a side view was I at all certain that there was only one segment.

very minutely hairy on the inner margin; third segment wanting, represented by two short spines, the inner twice as long as the outer.

Inner ramus of fifth leg of female one-segmented, extending very slightly beyond the first segment of the outer ramus; apex obtuse, hairy, armed on the inner margin and at the tip with two rather long subequal spines.

First basal segment of right fifth leg of male (Pl. XXIX., Fig. 1) with a small tubercle on the outer margin; second segment subquadrate, about one and a half times as long as the first. First segment of the outer ramus subquadrate, about as long as the first basal segment with overhanging outer apical angle; second segment slightly narrower than the first, about twice as long as wide, with a small projection at the middle of the inner margin. Marginal spine near the apical angle, slender, with a slight angle about one fourth its length from the base; length about equal to the distance between its base and the base of the segment. Terminal hook long and slender, longer than the two preceding segments but not as long as those and the second basal segment; very minutely denticulate on the inner margin.

Inner ramus of right fifth leg one-segmented, extending to a point about midway between the base of the second segment of the outer ramus and the projection on the inner margin of this segment; outer margin hairy; apex bluntly triangular and hairy.

Second basal segment of left fifth leg of male subquadrate, about one and a half times as long as broad, slightly produced on the inner margin a short distance above the apical angle. First segment of outer ramus slightly narrower than the second basal segment and about twice as long as wide; outer margin moderately arcuate, the inner margin hairy. Second segment produced into three digitiform processes: the outermost blunt and by far the longest; the middle one blunt, barely one fourth the length of the outer; and the last very short, hardly more than a tubercle, with an acute apex pointing straight inward. The segment is armed on the inner margin with a hairy, cushion-like process.

Inner ramus of left fifth leg somewhat spatulate, extending slightly beyond the end of the first segment of the outer ramus; inner margin hairy; apex bluntly rounded and hairy.

Length of female 1.25 mm.; of male 1.15 mm.

The above description is based on specimens found in collections made in Lake Calhoun, Minn., in July, 1891, and differs considerably from Lilljeborg's original description in de Guerne and Richard's "Revision."

He gives the length of the female as about 1.5 mm.; that of the male, 1.4 mm.

I did not find in a single instance that the female had the last thoracic segment armed with two minute spines on each side, although they were present in the male. Lilljeborg does not specify to which sex this part of his description applied, but I assume that he followed the usual custom of referring to the female unless especially stated otherwise.

The spines on the inner ramus of the female I found to be on the inner instead of the outer margin, and they are so figured by Marsh ('93).

In most cases I found but one spine representing the third segment of the outer ramus of the fifth foot of the female, while one specimen was found having one outer ramus as in the type, the other with only one spine. I have thought it best to make the description correspond to the type in this particular, regarding the variation as local since Marsh ('93) figures the two spines.

The inner ramus of the right fifth foot of the male in the Minnesota specimens was longer than represented in the original figures, and hairy on the inner margin and at the apex. This hairiness is not mentioned in the original description and this ramus is figured smooth, while the inner ramus of the left fifth foot, which is no more hairy than the right, is hairy in the drawings.

In the left fifth foot of the male the first segment of the outer ramus, although hairy, has not the definite cushion-like process figured by Lilljeborg, and the outer two digitiform processes of the second segment instead of being serrate within are perfectly smooth. From Herrick's statement

(Herrick and Turner, '95, p. 73) that "according to Richard's drawing the spines are dentate," I judge that he also found them smooth, since his own figures show them to be so.

This species was first found in 1888 at Portland, Oregon, by Trybom, and described in 1889 by Lilljeborg in de Guerne and Richard's "Revision." Marsh says ('93) that it is the most common form in central Wisconsin, being found quite generally in the shallower lakes, and that it occurs in the Great Lakes, but not abundantly ('95). Herrick (Herrick and Turner, '95) says that within the limits of Minnesota it had been found only in Lake Minnetonka. I can now add Lake Calhoun, Minn., and Sand Lake in northern Illinois.

Diaptomus siciloides Lilljeborg.

Diaptomus siciloides, de Guerne et Richard, '89b, p. 54, Pl. I., Fig. 7, 8, 28, 34.

Diaptomus siciloides, Herrick and Turner, '95, p. 69, Pl. VIII., Fig. 10.

"Among the smaller of this genus. The general form of the body agrees almost exactly with that of *D. gracilis* Sars. Cephalothorax slender, widest at the middle. The last two thoracic segments confluent above. Lateral lobes of the last one, seen from above, short and rounded, with rather large mucros. First abdominal segment long, fully as long as the remaining part of the abdomen (without the setæ); with distinct lateral processes at the anterior part, acuminate and bending forward slightly. Furcal rami short, but fully one and a half times as long as broad.

"First pair of antennæ of the female, reflexed, surpass the furca but do not reach the tips of the furcal setæ; composed of 25 articles. Antepenultimate article of the prehensile antenna of the male provided with a rather long hook-like process reaching about to the middle of the penultimate article.

"Fifth pair of feet in the female small but rather thick; outer ramus biarticulate, hook-like process of second segment slightly curved, and almost equal to the first segment; the inner margin partly ciliate. Inner ramus simple, slightly longer than the first segment of the outer ramus; with a small seta, slightly hairy at the apex.

"The inner margin of the first segment of the outer ramus of the right fifth foot of the male dilated into a rather large hyaline lamella. The second segment of this ramus moderately curved, the outer margin obtusely biangulate, the spine placed below the middle. Claw simply curved. Inner ramus small and slightly surpassing the middle of the first segment of the outer ramus.

"The second segment of the outer ramus of the left fifth foot almost triangular, with a beak-like spine and delicately hairy within (*intus tenui ore et subtiliter hispido*); the apical process obtuse, with a spine at the inner margin. Inner ramus simple, sinuous, and reaching to or beyond the middle of the second segment of the outer ramus.

"Length of female about 1.3 mm.; that of male slightly less.

"Found in the month of May in Lake Tulare near the city of Fresno, Cal., by G. Eisen.

"In the general form of the body this Diaptomus closely resembles *D. gracilis* Sars as well as *D. sicilis* Forbes. It is on account of this last resemblance that it was called *siciloides*. It differs, however, from both: from *D. gracilis* in the shape of the last thoracic segment and of the abdominal segments, of the first pair of antennæ, and of the fifth pair of feet; from *D. sicilis* in the shape of the fifth pair of feet, although this difference is not very great. It resembles *D. sicilis* more closely than *D. gracilis*.

"It seems to live in great numbers in Lake Tulare near Fresno, Cal. The female bears only four eggs."*

The statement concerning the number of eggs borne by the female is erroneous, the number being variable, and apparently dependent to a great degree on the temperature of the water and on the food supply. In the high mountain lakes from which the species was first described the statement above quoted may hold true, but in the warm sluggish waters of the Illinois River, where food is abundant, the egg-sac is very large, as many as eighteen eggs having been counted on a single female. This is true also of specimens taken

* Lilljeborg's description from de Guerne et Richard, 89b.

from other localities, and no tendency toward constancy in number of eggs for the same locality was made out.

The furcal rami in both sexes are hairy within, a point not mentioned in the original description, although the rami are so figured. All the specimens which I examined from the various localities had this characteristic, although individuals varied slightly in this particular.

As mentioned under the description of *D. pallidus*, *D. siciloides* was the most abundant form found at Havana. It also formed the greater part of the material from Spirit Lake, Iowa, which was kindly loaned me by Prof. L. S. Ross, of Drake University, Iowa.

The individuals taken from the Illinois River at Havana, Illinois, in July and August, 1896, were all of an indefinite color about like opalescent glass. The egg-sac in these was blue, and there was a small pink spot near the eyes and just behind them. These were the only specimens of *siciloides* which I had opportunity to examine alive.

Diaptomus minutus Lilljeborg. (Pl. XXX., Fig. 5–8.)

Diaptomus minutus, de Guerne et Richard, '89b, p. 50, Pl. I., Fig. 5, 6, 14; Pl. III., Fig. 25.
Diaptomus minutus, Marsh, '93, p. 199, Pl. IV., Fig. 1–3.
Diaptomus minutus, Marsh, '95, p. 8, Pl. VII., Fig. 3.

"Among the smallest of the genus. Body slender, widest in front of the middle of the cephalothorax and at the posterior part of the head. Fourth and fifth segments commonly confluent above, sometimes in the adult specimen separated by a suture; the lateral lobes, seen from above, short and rounded, and provided with minute mucros. First abdominal segment of the female (Pl. XXX., Fig. 8) about as long as the remainder of the abdomen; rather dilated at its anterior part and rounded laterally; furnished with very minute spines. Second segment very short, third segment much longer, and these segments indistinctly joined. Furcal rami about twice as long as broad. Furcal setæ unusually long.

"First pair of antennæ of female somewhat surpass the furca; composed of 25 segments. Antepenultimate article of

the prehensile antenna of the male (Pl. XXX., Fig. 7) with a slender process, long and straight, having a slight appearance of an apical curve, and extending beyond the penultimate article and sometimes almost reaching the end of the last article.

"Setæ of swimming feet unusually long. Outer ramus of the fifth pair of feet in the female (Pl. XXX., Fig. 5) biarticulate; unguiform process of second article slightly curved and minutely ciliate without. Inner ramus small and almost rudimentary, with acuminate apex.

"Right foot of the fifth pair of the male (Pl. XXX., Fig. 6) large but slender; the second article of the outer ramus with marginal spine minute and placed above the middle. Terminal claw thick toward the base, rather short, and partly minutely ciliate within. Inner ramus very small and quite rudimentary.

"The left foot of the same pair very similar to that of *D. siciloides* and *D. signicauda*; the second article of the outer ramus almost elliptical, the inner margin slightly emarginate and partly ciliate at the lower part; with a large and obtuse apical spine and a smaller inner spine. Inner ramus simple, attenuate toward the apex, and extending about to the middle of the second article of the outer ramus.

"Length of female 1–1.1 mm; of male hardly 1 mm.

"Found in Greenland, 61° 30′– 69° N. Lat., by Dr. C. Nyström and N. O. Holst, and at St. John's, Newfoundland, by the former.

"This species is distinguished from others by its minute size and by the fifth pair of feet. The female bears only two eggs. *D. minutus* has been found in the Isle of Disko, northern Greenland, but it seems to be more common in the southern part. It is without doubt spread over the northern part of North America, since it has also been found at St. John's, Newfoundland."*

"We are able to confirm in every respect the description given above by Professor Lilljeborg. We have, in fact, recognized some rare specimens of *D. minutus* in a collection

* Lilljeborg's description from de Guerne et Richard, 89b.

which M. Riballier des Isles, French consul at Newfoundland, was kind enough to make according to our directions at Kinney's Pond near St. John's. This *Calanid* [centropagid] was found in great numbers by M. Ch. Rabot in 1888 in the following localities in Greenland: Lake Egedesminde (Bay of Disko); Godhavn; near the glacier of Jakobshavn, and in the Tasersuak of Julianehaab."*

"Marsh finds this form in Green Lake [Wisconsin], and in the Great Lakes; it may, therefore, be expected in Lake Superior in Minnesota."†

Marsh ('95) places *sicilis* var. *imperfectus* as a synonym under *minutus*, but does it, as he says, "with considerable hesitation." In looking over the drawings in the possession of the State Laboratory I found some which had been reproduced but not published, and from these it was evident at a glance that the var. *imperfectus* was not *minutus* but *ashlandi*, although this was not evident from the description. A single specimen of *minutus* was found among the collections from Yellowstone Park, but it was so badly mutilated that no drawings could be made from it.

Specimens from Greenland, kindly sent me by Professor Lilljeborg, conform to his description but are somewhat smaller than those figured by Marsh.

Diaptomus trybomi Lilljeborg. (Pl. XXXI., Fig. 1–5.)

Diaptomus trybomi, de Guerne et Richard, '89b, p. 58, Pl. I., Fig. 35; Pl. II., Fig. 6; Pl. III., Fig. 14; Pl. IV., Fig. 28.

Diaptomus trybomi, Herrick and Turner, '95, p. 57, Pl. VIII., Fig. 17; Pl. IX., Fig. 4; Pl. X., Fig. 13.

"Of medium size. Cephalothorax widest about the middle. Last two segments distinctly separated, and the last, seen from above (Pl. XXXI., Fig. 3), slightly produced laterally, provided with two spines (one of them minute) on each side. Besides this the right part of this segment (Pl. XXXI., Fig. 2) bears a large dorsal appendage, triangular in form, with mucronate apex, and extending toward the right. The

* de Guerne et Richard, 89b.

† Herrick. From Herrick and Turner, '95.

first caudal segment of the female is very characteristic of the species (in the male it is of the ordinary form) and, unlike that of *D. signicauda*, surpasses in length the rest of the abdomen. This segment is provided at the anterior part on both sides with a short and mucronate lateral process, and at the posterior part with a large triangular process extending almost directly toward the right, with apex slightly acuminate. Furcal rami rather short, not twice as long as broad.

"First pair of female antennæ 25-segmented, almost reaching the base of the furca. The antepenultimate article of the prehensile male antenna (Pl. XXXI., Fig. 1) armed with an almost straight and rather slender process reaching almost to the middle of the penultimate article, and provided without with small teeth.

"Outer ramus of the fifth pair of feet in the female (Pl. XXXI., Fig. 5) two-segmented; the unguiform process of the second segment slightly curved, robust, moderately ciliate within and at the middle part, last cilium broad, spine-like. Third segment wanting, produced into two short spines, the outer half as long as the inner.

"Inner ramus one-segmented, almost equal to the first segment of the outer ramus; apex obliquely acuminate, provided with two rather long subequal spines.

"Second segment of the outer ramus of the right fifth foot of the male (Pl. XXXI., Fig. 4) very long, longer than the first segment and the basal segment taken together. Marginal spine of this segment inserted above the middle. Terminal hook slightly curved, inner margin ciliate.

"Inner ramus curved, ovate, broad, pointing inward, with mucronate apex, barely reaching to the end of the first segment of the outer ramus.

"First and second segments of the outer ramus of the left foot ciliate within, the second one obovate, hirsute toward the apex, and bearing two short spines one of which points inward.

"Inner ramus one-segmented, slender, equal to the first segment of the outer ramus."

"Length of female about 1.5 mm.; of male 1.4 mm.

"This species, so remarkable from the peculiarities presented by the last thoracic and the first abdominal segments, was found by the Swedish naturalist, Trybom, at Multrooma Falls, Oregon."

The above is the description as given by Dr. Lilljeborg (de Guerne et Richard, '89b). It agrees with the specimens sent me by himself, but I note a few additional details.

The abdomen of the female, seen from above, is asymmetrical, as is also the last thoracic segment. The first abdominal segment is dilated anteriorly, and posteriorly is produced on the right to form a blunt, almost semicircular, process. Seen from the side this is fin-shaped, and both this process and the one on the last thoracic segment are penetrated by muscles. The furcal rami are hairy within.

In the male the peculiar form of the right inner ramus, the extreme shortness of the left leg, and the very irregular shape of its last segment are especially characteristic. The spines on the first basal segment of each leg and the teeth on the terminal segment of the right leg are also conspicuous because of their great size.

The peculiarity of a dorsal process is found, to my knowledge, in but two other species: *D. sanguineus* Forbes, and *D. signicauda* Lilljeborg. In the small size of the inner ramus of the right fifth foot of the male, *D. trybomi* approaches the male of *D. sanguineus* Forbes, *D. minutus* Lillj., and *D. lintoni* Forbes.

De Guerne and Richard give Multrooma Falls as the locality, which was probably intended for Multnomah Falls, Oregon, although Prof. Lilljeborg in a personal letter also gives the former spelling.

Diaptomus franciscanus Lilljeborg. (Pl. XXX., Fig. 1–4.)

Diaptomus franciscanus, de Guerne et Richard, '89b, p. 45, Pl. I., Fig. 12, 13, 34; Pl. III., Fig. 23.

Diaptomus franciscanus, Herrick and Turner, '95, p. 58, Pl. VIII., Fig. 12, 16.

"Larger and more robust than *Diaptomus tyrreli*. Cephalothorax widest in the middle, and the last two segments confluent above. Lateral lobes of the last thoracic segment

seen from above, short and obtuse posteriorly; armed with small spines. First abdominal segment (Pl. XXX., Fig. 1) about equal to the rest of the abdomen, moderately dilated anteriorly, rounded at the sides, and armed here with small spines or mucros; always destitute of all lateral processes. An imperfect suture remains long after maturity in the posterior part of this segment. Second segment of the abdomen much shorter than the third, and also more slender and easily pushed within the preceding joint.* Furcal rami short, fully one and a half times longer than broad; sparsely ciliate within.

"First pair of antennæ of female, reflexed, extend about to the furca; composed of 25 articles. Antepenultimate article of the male prehensile antenna (Pl. XXX., Fig. 2) provided with an unguiform process, slightly surpassing the end of the penultimate article.

"Outer ramus of the fifth pair of feet in the female (Pl. XXX., Fig. 4) three-segmented, the third segment very small but distinct, and bearing two spines. The unguiform process of the second segment of this ramus rather arcuate and finely ciliate within at the lower part, the last spine thicker than the rest. Inner ramus simple and equal to the first segment of the outer ramus, bearing two long equal spines at the apex, of which the outer is ciliate within at the base.

"The right fifth foot of the male (Pl. XXX., Fig. 3) rather robust. The second segment of the outer ramus almost rectangular and comparatively short; the outer marginal spine placed near the apex, and the inner margin armed with a minute spine. Terminal hook long, distinctly sigmoid or S-shaped and tapering toward the apex. Inner ramus small and barely reaching the middle of the second article of the outer ramus; either imperfectly two-segmented or one-segmented and armed with an apical spine.

"The second segment of the outer ramus of the left fifth foot of the male lamelliform, almost triangular, and thinner within. This segment on the thicker, outer, side bears a short

*The meaning of the original at this point is rather obscure. It reads: "*Segmentum 2-dum caudæ 3-tio multo brevius ejusque testa tenuior et facile adstringenda.*"

spine in the middle, and ends in a short obtuse process, the inner apical angle of which exhibits three small oblique incisions. The inner margin is minutely ciliate. The inner ramus is simple and slender, attenuate toward the apex, and reaching about to the middle of the second segment of the outer ramus.

"Length of female, 2.3 mm.; of male, 2.0 mm.

"Found near San Francisco by G. Eisen.

"This *Diaptomus* approaches *D. longicornis* var. *similis* Herrick in the shape of the body and of the lateral lobes of the last thoracic segment, but it differs greatly in respect to the fifth pair of feet, especially in the male. It seems to be common in the vicinity of San Francisco, hence the name, *franciscanus*."*

The female is conspicuous chiefly for the extremely long spines with which the inner rami of the fifth pair of feet are armed. These are about as long as the ramus itself and hairy at the base. The thorax and abdomen are of ordinary form. The furca are hairy within, and also, but more sparsely, on the outer margin. In the male the outer margin is not hairy.

The outer ramus of the left fifth foot of the male is terminated by a peculiarly flattened segment (Pl. XXX., Fig. 3). In a male of this species sent me by Professor Lilljeborg, both inner rami of the fifth pair of legs are two-segmented.

Diaptomus eiseni Lilljeborg.

Diaptomus eiseni, de Guerne et Richard, '89b, p. 44, Pl. I., Fig. 19, 29, 33.†

Diaptomus eiseni, Herrick and Turner, '95, p. 58, Pl. X., Fig. 11.

"Among the largest of the genus. Cephalothorax widest at the posterior part of the head. The last two thoracic segments usually confluent above or indistinctly segmented, and the lateral lobes of the last segment, seen from above, short

*Lilljeborg's description and remarks from de Guerne et Richard, '89b.

†Confusion may be caused by a slight mistake which crept into de Guerne and Richard's "Revision." In the index and under the species names, Fig. 20, Pl. I. is given as the fifth foot of *D. serricornis* and also of *D. eiseni*. The "explanation of plates" however, gives Fig. 29, Pl. I., as that of *D. eiseni*, which by comparison with the description is found to be correct.

in the female; upper posterior angle rather acute, lateral angle very obtuse, the spines of both angles thick and short. First abdominal segment slightly longer than the remainder of the abdomen (setæ excepted), produced anteriorly into a rather large lateral process with spines pointing obliquely backward. Second abdominal segment very short. Furcal rami short; sparsely hairy; about one and a half times as long as broad.

"First pair of antennæ reach to the lateral processes of the first abdominal segment; composed of 25 segments. Antepenultimate article of the prehensile antenna of the male with a long curved and acuminate process almost surpassing the end of the antenna.

"Outer ramus of the first pair of feet, especially in the female, pectinately setose.

"Outer ramus of the fifth pair of feet in the female two-segmented, the second segment with large unguiform process within and heavily spined without. The inner ramus of this foot rather long, clearly not reaching the end of the first segment of the outer ramus; suture sharply indicated; provided at the apex with two spine-like setæ and within with minute spines.

"Right fifth foot of the male rather robust. Second basal segment dilated within into a rugose lamella; second segment of the outer ramus with marginal spine placed near the apex. Inner margin of terminal claw slightly sigmoid; from the middle toward the apex first delicately pectinately spined, and thence tuberculate. Inner ramus small and indistinctly two-segmented, extending slightly beyond the middle of the second segment of the outer ramus; armed at the apex with a spine, and at the same place and within with thick cilia.

"Left foot of the fifth pair of the male much smaller than the right. Second or last segment of the outer ramus of this foot with the apex narrowed but obtuse, and within this an acuminate spine; an emarginate narrow and hairy lamina on the inner margin. Inner ramus slender, rather long, and notably surpassing the middle of the second segment of the outer ramus; indistinctly two-segmented, the apex similar to that of the right inner ramus.

"Length of female, 4 mm.; of male, 3.5 mm.

"Found, near Fresno, Cal., by G. Eisen, the Swedish zoölogist, member of the San Francisco Scientific Academy."

"This *Diaptomus* is dedicated to Mr. G. Eisen, who found it in California with a great number of other Entomostraca. It was given by him to the Zoölogical Museum of the University of Upsala. *D. eiseni* is very distinct from all the American species described by Profs. Forbes and Herrick."*

The last thoracic segment of the female is strongly produced posteriorly and the first abdominal segment is moderately dilated and armed on each side with a large spine. This form may also be recognized on account of its great size, being but little smaller than *D. stagnalis* or *D. shoshone* Forbes. The fifth pair of legs are remarkable for the extreme size of the inner of the two spines representing the third segment of the outer ramus, which is made still more striking by a row of strong teeth on each margin. The second segment of the outer ramus is also armed with strong teeth on the inner margin.

The fifth pair of legs of the male may be easily recognized from the fact that at least an indication of a suture is found on each inner ramus, making it indistinctly two-segmented. The rugose lamella on the second basal segment of the right fifth leg is also very characteristic.

Diaptomus signicauda Lilljeborg. (Pl. XXIX., Fig. 3–6.)

Diaptomus signicauda, de Guerne et Richard,'89b, p. 55, Pl. I., Fig. 15, 16, 31; Pl. III., Fig. 22.

Diaptomus signicaudatus, Herrick and Turner, '95, p. 63, Pl. VIII., Fig. 13; Pl. IX., Fig. 10.

"This species is among the smaller species of this genus. Form of the body very slender. Cephalothorax widest in front of the middle, at the second segment. Last two segments of the thorax (Pl. XXIX., Fig. 6) confluent above, the last, seen from above, with rather large and projecting lateral lobes, posterior angles acute, with small spines. Fourth thoracic segment, seen from the side, provided above with a small

*Lilljeborg's description and remarks from de Guerne et Richard, '89b.

hump. First abdominal segment of the female very characteristic of the species, giving to it its name. This segment is provided at the anterior part with short, mucronate lateral processes, and at the posterior part on the right side with a large process bent obliquely backward and moderately acuminate. Besides this an indication of a suture is also often present. The length of this segment, posterior process excepted, is slightly less than the remainder of the abdomen. Furcal rami hardly more than half as long as broad.

"First pair of antennæ of the female always 25-segmented; reflexed, slightly surpass the furcal rami, but do not reach the end of the furcal setæ. The antepenultimate article of the prehensile antenna of the male (Pl. XXIX., Fig. 4) armed with a medium-sized hook-like process.

"Fifth pair of feet of female (Pl. XXIX., Fig. 5) very similar to the corresponding pair of *D. siciloides*. Outer ramus two-segmented; unguiform process of the second segment slightly curved, almost parallel with the first article; very delicately ciliate within, the last cilia thicker and spine-like.

"Inner ramus one-segmented, longer than the first segment of the outer ramus; apex obliquely acuminate and ciliate, and bearing two equal ciliate spines.

"The right fifth foot of the male (Pl. XXIX., Fig. 3) rather slender. First segment of the outer ramus dilated within into a small hyaline lamina. The second segment as long as the first article and the second basal segment together. The marginal spine of the second segment is situated a little below the middle. Terminal hook simply curved.

"Inner ramus rather broad, acuminate, and short, not reaching to the end of the first segment of the outer ramus.

'The second segment of the outer ramus of the left foot elliptical or oblong-ovate; within and toward the apex very delicately aculeate, and bearing two large spines, one of which inclines inward.

"Inner ramus simple and slender, but long, and extending beyond the middle of the second segment of the outer ramus.

"Length of female about 1.5 mm.; of male, 1.3 mm.

"Found in the Sierra Nevada Mountains, California, at a height of from 8,000–10,000 feet above sea-level by G. Eisen. Appears to be very common in small pools in this locality.

"This *Diaptomus* is very distinct from all known species on account of the peculiar form of the first abdominal segment. In this respect it approaches *D. roubaui* Richard, and the genus *Epischura* Forbes. In the case of these Copepoda, however, it is the male which is distinguished by the irregularity of the abdomen. The name which I have given it refers particularly to the shape of the female abdomen."*

There is nothing to add to the above description of this species except that the furca are delicately hairy within, a fact neither shown in the drawings nor mentioned in the original description. The last thoracic segment of the female is strongly produced, and the first abdominal segment greatly dilated at its anterior part. The process on the first abdominal segment is even larger in some cases than represented in the original drawings.

In the male also the last thoracic segment is produced, but not so much as in the other sex. The fifth pair of legs are very similar to those of *D. siciloides*, from which they may be distinguished by the shape of the right inner ramus and of the hyaline lamina on the first segment of the outer ramus of the right fifth leg. Both inner rami are delicately hairy, but I fail to find the smooth, cushion-like process on the outer margin and at the base of the left inner ramus which is figured in the original drawings but of which no mention is made in the text.

The females of *D. signicauda* and *D. trybomi* both have a "dorsal process," and in this respect approach *D. sanguineus* Forbes.

Individuals of this species were kindly sent me by Dr. Lilljeborg, but were unavoidably delayed until after this description was completed. There was no time to rewrite it, hence these remarks are in the form of addenda. The same is true of *trybomi*, *eiseni*, and *franciscanus*.

*Lilljeborg's description and remarks from de Guerne et Richard, '89b.

Diaptomus ashlandi Marsh. (Pl. XXXII., Fig. 1–4.)

Diaptomus sicilis var. *imperfectus*, Forbes '90, p. 703.
Diaptomus ashlandi, Marsh, '93, p. 198, Pl. III., Fig. 11–13.
Diaptomus ashlandi, Herrick and Turner, '95, p. 60, Pl. VI., Fig. 4–6.
Diaptomus ashlandi, Marsh, '95, p. 7, Pl. VII., Fig. 2.

A small, slender species, about the same width throughout. Suture between head and thorax distinct. Last two thoracic segments distinct, the last one strongly bifid and armed on each side with a small blunt spine. Abdomen long and narrow; inclusive of the furca, about half as long as the cephalothorax. First abdominal segment as long as the remainder of the abdomen exclusive of the furcal rami; dilated laterally; with a small spine on each side (unarmed in the male). Second and third segments subequal. Furcal rami barely twice as long as wide; hairy within.

Antennæ 25-segmented, reaching to the base of the furcal rami or slightly beyond. Prehensile antenna (Pl. XXXII., Fig. 4) moderately swollen; segments 19, 20, and 21, and 22 and 23, ankylosed; process on the antepenultimate segment extending almost to the middle of the last segment, the end knobbed and roughened or tuberculate at the inner margin.

Fifth pair of legs of the male (Pl. XXXII., Fig. 3) rather slender; left leg reaching about to the end of the first segment of the outer ramus of the right leg. On the anterior surface of the first basal segment of the right leg is a large tubercle bearing at the tip a small acute spine. Second basal segment without special characteristics. First segment of the outer ramus subquadrate, slightly broader than long; inner apical angle somewhat produced, the process ending in an acute point. Second segment about three times as long as the first, with a sharp angle at end of proximal third, from the point of which springs the lateral spine. This is about half as long as the segment, with an angle near its base. Terminal hook long and slender, rather more robust than that of *D. sicilis* Forbes, but shaped very much like it; minutely denticulate on the inner margin.

Inner ramus of right fifth leg one-segmented, very narrow, extending about half its length beyond the end of the first segment of the outer ramus; apex with an acute triangle, hairy at the tip; sides parallel.

First basal segment of the left fifth leg produced on the anterior aspect, near the outer margin, into a long tubercle ending in a minute, sharp spine; second basal segment with delicate hair near the outer distal angle. First segment of the outer ramus subquadrate, shorter than the preceding, slightly longer than broad; second segment about as long as the first and about twice as long as wide; very similar to the corresponding segment of *D. sicilis* Forbes.

Inner ramus of left fifth leg long and narrow, margins sinuously curved; extending about to the middle of the last segment of the outer ramus; delicately hairy at the tip.

Second basal segment of fifth leg of female (Pl. XXXII., Fig. 1, 2) with the usual delicate hair at the outer margin. First segment of the outer ramus about twice as long as wide; second segment somewhat longer than the first, tapering to a rather sharp point and curving outward slightly, delicately denticulate on the inner margin; third segment wanting, represented by two spines, the outer about twice as long as the inner.

Inner ramus one-segmented, extending slightly beyond first segment of the outer ramus, hairy, ending in acute triangular tip; armed at the apex with two rather long subequal spines which are sometimes hairy.

Length of female .97 mm.; of male .9 mm.

A reference to the "Distribution of American Species" (see page 183), will show the wide range of this form. In the collections of the U. S. Fish Commission from Lake Sammamish, Lake Union, and Lake Washington, Wash.; Tsiltcoos Lake, Tahkenitch Lake, and Klamath Lake, Oregon; and Lake Pend d' Oreille and Gamble's Lake, Idaho, *D. ashlandi* was found in immense numbers, being either the only centropagid or occurring in connection with *Epischura nevadensis* Lilljeborg.

Diaptomus ashlandi is very similar to *D. sicilis* Forbes and hardly to be distinguished from it but for a slight difference in the last segment of the left fifth foot of the male and the position of the marginal spine of the right fifth foot. In the Laboratory collections from Yellowstone Park and the Flathead region of Montana forms occur which seem to be intermediate between the two, and it was exceedingly difficult to decide to which, if either, of the two species they belonged. *D. ashlandi* seems to me, however, to be a good species, since the form, as described by Marsh ('93 and '95) and as found by myself in other collections, exhibits constant, though somewhat minute, differences from *sicilis* hard to describe, but at once evident from the figures.

A very peculiar modification of the inner ramus of the fifth foot of the female was noted in a specimen taken from an alkaline pond in Yellowstone Park. In this individual one of the feet (Pl. XXXII., Fig. 1) was normal in every respect, while the inner ramus of the other was armed on its outer margin, at the end of the proximal third, with a sharp, smooth spine about half as long as the ramus itself.

D. sicilis var. *imperfectus* Forbes ('90) is here made a synonym of *D. ashlandi*, because unpublished Laboratory drawings of that variety clearly show it to be such. Marsh's description must stand, since the description of *imperfectus* was not complete enough to identify the form. This species was also noticed by Dr. Forbes in the collections reported on in '93, but was erroneously regarded by him as an immature form of *D. sicilis*.

Diaptomus reighardi Marsh. (Pl. XXVIII., Fig. 1.)

Diaptomus reighardi, Marsh, '95, p. 9, Pl. I., Fig. 1–4.

A medium-sized species; body about the same width throughout. Sutures between the first and second, and between the last two, thoracic segments distinct; last thoracic segment not produced, armed on each side with a very minute spine. First abdominal segment almost as long as the rest of the abdomen, dilated laterally, armed on each side with a

minute spine; second and third segments subequal; furcal rami slightly longer than the third segment, about twice as long as wide; and delicately hairy within. In the male the second abdominal segment and the furcal rami are subequal, and each is longer than any of the other segments. The furcal rami are considerably longer than the preceding segment, fully twice as long as wide, and hairy within.

Antennæ 25-segmented, reaching well beyond the tips of the furcal setæ. Right male antenna not much swollen anterior to the geniculate joint· antepenultimate segment unarmed.

Left fifth leg of male (Pl. XXVIII., Fig. 1) short, extending beyond the middle, but not reaching the end of the second segment, of the outer ramus of the right leg. First basal segment armed at the outer distal angle with a short, sharp spine. Second basal segment about equal to the first, almost as wide as long. First segment of the outer ramus irregularly trapezoidal in form, about half as wide as the second basal segment, and delicately hairy on the inner margin. Second segment somewhat as in *D. oregonensis* Lilljeborg. It is produced into two digitiform processes, the outer of which is more than twice as long as the inner and armed on the inner margin at the tip, with a small cushion-like, delicately hairy process. There is a distinct suture between the main part of the second segment and the inner of the two processes, and the process itself is minutely denticulate on the outer margin.

Inner ramus of left fifth leg one-segmented, reaching to the base of the inner digitiform process; outer margin hairy, almost straight; inner margin somewhat sinuously curved.

First basal segment of the right fifth foot of the male subquadrate, slightly longer than wide, armed at the outer distal angle with a short, sharp spine. Second segment about as wide as the first and one and a half times as long; provided with the usual hair on the outer margin. First segment of the outer ramus a little more than half as long as the second basal segment and slightly longer than wide; second segment less than half as wide as long and more than twice as long as the preceding segment. Marginal spine rather short, about

as long as the segment is wide; inserted near the beginning of the distal third; slightly curved and distinctly denticulate on the inner margin. Terminal hook rather slender, a little more than twice as long as the preceding segment; not regularly curved, but divided approximately into thirds by abrupt angles, the upper one very sharp, below which on the inner margin, the hook is delicately but distinctly denticulate.

Inner ramus of right fifth foot short, one-segmented, reaching just to, or extending very slightly beyond, the end of the first segment of the outer ramus; apex bluntly triangular and delicately hairy.

First segment of the outer ramus of the fifth leg of the female subquadrate, about twice as long as wide; second segment slightly shorter than the first, moderately curved, the inner margin distinctly denticulate; third segment wanting, being represented by two spines; the outer short and thick and only about half as long as the inner.

Inner ramus of fifth leg of female, one-segmented, extending slightly beyond the end of the first segment of the outer ramus; delicately hairy at the apex and on the distal fourth, and armed in addition to this with two slender spines about as long as the shorter of the two representing the third segment of the outer ramus.

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

The above measurements are those of Professor Marsh. The largest female I examined was 1.13 mm. in length, the smallest, 1 mm.; while the largest male I measured was 1 mm. in length, the smallest, .96 mm.

Prof. Marsh originally described this species, and I am greatly indebted to him for the specimens from which the above description was made. He found *D. reighardi* in only three localities, all in Michigan; North Lake, on Beaver Island, Intermediate Lake, and Crooked Lake. I do not know of its having been recorded from any other place.

At first sight *D. reighardi*, in respect to the fifth pair of legs of the male, is very like *D. oregonensis* Lilljeborg, but the details of structure are very different in the two, and there can be no doubt as to the validity of the species.

Diaptomus birgei Marsh.

Diaptomus birgei, Marsh, '94, p. 16, Pl. I., Fig. 4–6.
Diaptomus birgei, Herrick and Turner, '95, p. 79, Pl. XLVII., Fig. 4–6.

"Of moderate size. The first segment of the cephalothorax is nearly equal in length to the three following. The first segment of the abdomen of the female is as long as the remainder of the abdomen and the furca. It is much dilated in front. The second segment is nearly twice as long as the third, and about equal in length to the furca. The second and third joints are very closely united.

"The antennæ extend to the end of the furca. The right antenna of the male is much swollen anterior to the geniculating joint; the antepenultimate joint is produced on its distal end into a short, blunt process, which makes very nearly a right angle with the longitudinal axis of the joint.

"The outer ramus of the fifth foot of the female is two-jointed, the third joint being represented by two spines. The inner ramus is one-jointed, hardly as long as the first joint of the outer ramus, and armed at the tip with minute setæ and two rather long spines.

"The basal joint of the right fifth foot of the male is elongated, trapezoidal in form, its greatest breadth being at its distal extremity. The first joint of the outer ramus is broader than long, armed on its inner margin with a broad, thin expansion of the integument. The second joint is elongate, broader at base; the lateral spine is situated at about the middle of its length, is long and stout, and armed on its inner margin with fine serrulations. The terminal hook is slightly angular, and armed with fine serrulations on its inner margin. The inner ramus is one-jointed, equaling in length the first joint of the outer ramus.

"The left fifth foot of the male reaches slightly beyond the first joint of the outer ramus of the right. The basal joint is quadrangular, considerably shorter than the right basal joint. The first joint of the outer ramus is about twice as long as broad. The second joint is slightly longer than the first joint; it is expanded at base, where it is armed with fine hairs, and

terminates in a finger-like process bearing a falciform spine. The inner ramus extends to about one half the length of the second joint.

"Length of female, 1.5 mm.; of male, 1.3 mm."*

Marsh states, in connection with the original description, that the material in which this species was found—collected by Professor Birge at New Lisbon, Wisconsin—contained only a few individuals, and that his own search for it in other Wisconsin localities had been unsuccessful. He says also that the species resembles the European species *D. gracilis* more closely than any other American form.

The description quoted above is the only literature on the subject, and while a request for slides or specimens of the species by Professor Marsh was kindly complied with in the case of most of his species, to his own as well as my regret he was unable to let me have either slides or specimens of *D. birgei*.

Unfortunately, as Marsh says, but few specimens were found, and further study of the species must consequently be deferred until later collections shall afford an opportunity.

Diaptomus mississippiensis Marsh. (Pl. XXXIII., Fig. 1–4.)

Diaptomus mississippiensis, Marsh, '94, p. 15, Pl. I., Fig. 1–3.
Diaptomus mississippiensis, Herrick and Turner, '95, p. 78, Pl. XLVII., Fig. 1–3.

A medium-sized species. Body slender, widest about the middle of the posterior third, the male a little more slender than the female, and the widest part slightly farther forward. Last two cephalothoraic segments indistinctly confluent; suture between the first two distinct. Last cephalothoracic segment, seen from above, not produced, but bearing a minute obtuse spine pointing backward; seen from the side it is broadly rounded, with the spine in the middle, giving it the form of a brace (⁀). First abdominal segment about as long as the remainder of the abdomen (Pl. XXXIII., Fig. 4), with a short obtuse spine opposite the anterior margin of

*Description quoted from Marsh, '94.

the *receptaculum seminis*; the second segment the shortest; third segment slightly longer than the second. In the male (Pl. XXXIII., Fig. 1) there is little difference in the length of the abdominal segments. Furcal rami broad, but little longer than the third abdominal segment; distinctly hairy within. Furcal setæ thick at the base, tapering gradually toward the tip; distinctly setose. The inner furcal seta is smooth in both sexes.

Antennæ 25-segmented, reaching to or slightly beyond the tips of the furcal setæ. The right male antenna with the six segments preceding the geniculation greatly swollen; antepenultimate article unarmed; segments 19, 20, and 21, also 22 and 23 ankylosed.

Fifth pair of feet of the female (Pl. XXXIII., Fig. 2) of moderate size. First basal segment trapezoidal, the longer base forming the inner margin. Second segment of the outer ramus long, narrow, acuminate, shorter than the preceding segment, perfectly smooth within. Third segment wanting; represented by two straight and pointed spines, an inner short one and an outer one more than twice as long.

Inner ramus of fifth foot of female one-segmented, reaching almost to the middle of the second segment of the outer ramus; distinctly hairy on inner margin near the apex, where it is armed with two spines, the inner one being fully one third as long as the ramus itself.

First segment of outer ramus of right fifth foot of male (Pl. XXXIII., Fig. 3) subquadrate, slightly longer than broad, the second segment nearly twice as long as the first, its upper half about as wide as the first. A little below the middle of this segment the inner margin is produced into a short spine-like process, concave toward the apex of the segment. Between this and the apex the segment is produced into a narrow, triangular hyaline lamina, tapering from the broad upper part to the inner apical angle. Marginal spine long and curved, concave toward the apex of the segment and inserted very near the outer apical angle. Terminal hook long and very slender, with two sharp angles dividing it approximately into thirds; upper third rather thick as

compared with the remainder; lower two thirds very minutely spinose; tip sometimes slightly recurved.

Inner ramus of right fifth foot one-segmented, narrowing but slightly toward the tip. It reaches almost to the middle of the last segment of the outer ramus, but not to the hook-like process. Apex rounded; unarmed or very delicately hairy.

Outer ramus of the left fifth foot two-segmented. First segment irregularly trapezoidal; small and inconspicuous, with a delicately hairy cushion-like process on the inner margin. Last segment consisting of two digitiform processes, forming a forcipate structure. Seen from behind, the upper process is smooth, the base slightly swollen. It is a little longer than the other and about one and a half times as long as the preceding segment, tapering gradually from the thickened part to an obtuse point. The lower process (seen from behind) is about equally broad at the base and at the beginning of the last third, whence it narrows quite suddenly to form an obtuse point. It is provided within and at the apex with four or five small teeth.

Inner ramus of left fifth foot paddle-shaped, considerably broadest at the apex; reaching almost to the tip of the outer ramus; either smooth or very delicately hairy.

Length of female, 1.2 mm.; of male, 1.1 mm.

Most of the specimens examined were taken from Lake Maitland, Florida, from material kindly loaned me by Mr. Adolph Hempel.

The above was prepared as a description of a new species, but when I saw Professor Marsh's slides there was no longer any doubt as to the identity of *mississippiensis* and this Florida form. Prof. Marsh ('94) figures the furca of the female as perfectly smooth within, while in all of the specimens from Florida, as well as in those which he kindly loaned me, they are distinctly, though not heavily, setose within. The inner rami of the fifth pair of feet in the male, however, differ considerably—probably a varietal difference, since in a few of my specimens they approached the form shown in his figures. In the Florida specimens I fail to find the asymmetry in the

abdominal spine mentioned by Marsh, but since the specimens from the two localities differ in other respects it is not unlikely that this difference also may exist.

Found by Professor Marsh in collections from small lakes and ponds in Mississippi, and by the writer in material collected from a number of Florida lakes in March, 1896, by Mr. Adolph Hempel. Professor Marsh states that in collections made in Mississippi in January and February, 1893, *D. mississippiensis* was the only Diaptomus found; but in the Florida collections this species occurred in connection with *D. albuquerquensis* Herrick, the two being about equal in numbers. In general appearance these two species are very similar, but they are widely different in the details of their structure.

Diaptomus tyrrelli Poppe.

Diaptomus tyrrelli, Poppe, '88, p. 159.
Diaptomus tyrrelli, de Guerne et Richard, '89b, p. 39, Pl. I., Fig. 17, 18; Pl. IV., Fig. 26.
Diaptomus fresnanus, Lilljeborg, *in litt.**
Diaptomus tyrrelli, Herrick and Turner, '95, p. 76, Pl. X., Fig. 9.

"Of medium size. Cephalothorax widest at the middle and at the lateral lobes of the last segment. Last two thoracic segments confluent above, and the last, seen from above, produced obliquely into large lateral processes, almost ovate, acuminate posteriorly, with a rather large mucro. First abdominal segment almost as long as the rest of the abdomen, somewhat dilated anteriorly, and provided with long mucronate lateral processes. Second and third abdominal segments rather short, with a vestige of a transverse suture anteriorly. Furcal rami short, sparsely hairy, and almost one and a half times as long as broad.

"First pair of antennæ in the female, reflexed, reach almost to, sometimes to the end of, the furca; composed of twenty-five segments. Antepenultimate article of the prehensile antenna of the male wholly unarmed, or minutely and scarcely perceptibly armed.

*The description given herewith is that of *D. fresnanus* Lilljeborg, sent by him to de Guerne and Richard, and published by them under the name of *D. tyrrelli*.

"Outer ramus of the fifth pair of feet in the female biarticulate; unguiform process of the second segment almost parallel to the first segment, slightly curved within and minutely ciliate on the inner margin, the last cilia spine-like. Inner ramus simple and slender, about equal to the first segment of the outer ramus; armed at the outer margin and near the apex with two medium-sized spines; apex obtuse and finely hairy.

"Right fifth foot in the male slender and of medium size. First segment of the outer ramus with a small hyaline lamella near the inner apical angle. Second segment comparatively small and strongly curved; the outer marginal spine at about the middle. Terminal hook slightly sigmoid; inner margin smooth. Inner ramus minute and simple, not reaching the end of the first segment of the outer ramus.

"Second segment of the outer ramus of the left foot of the same pair almost triangular; inner margin slightly sinuate and ciliate and armed with two obtuse processes (one apical, the other lateral). Inner ramus indistinctly two-segmented extending about to the middle of the second segment of the outer ramus; minutely hairy within and at the apex.

"Length of female 1.9 mm.; of male 1.8 mm." *

"This Diaptomus is distinguished from all its related forms by the large lateral lobes of the last thoracic segment. These lobes, seen from above, are acuminate, but seen from the side, the posterior extremity is obtuse and armed with two spines.

"The first abdominal segment is remarkable on account of its long, strong, pointed processes.

"The female of this species slightly resembles *D. ambiguus* Lillj., from Behring Isle, but the lateral projections of the first abdominal segment are wanting in the latter. *D. tyrrelli* differs from most other American species in the absence of a prolongation on the antepenultimate article of the male prehensile antenna.

"The first specimens of this copepod were collected in Summit Lake, in the Rocky Mountains, at a height of 5,300 feet, and sent to Herr S. A. Poppe by Mr. J. B. Tyrrell, of Ottawa, Canada.

*Lilljeborg's description from de Guerne et Richard, '89b.

"The description given was sent to us by Prof. Lilljeborg as that of a new species described by him under the name of *D. fresnanus*. It was established from specimens found by G. Eisen at Centreville, near Fresno, Cal. *D. tyrrelli* here reaches a size somewhat greater than that which it has at Summit Lake, where it is only 1.5 mm. long."*

Owing to the kindness of Herr Poppe I was enabled to examine specimens of *D. tyrrelli*, but found nothing to add to the above description. I failed to obtain specimens from Dr. Lilljeborg, and so am unable to say whether or not there are minor differences to be found in individuals from the two localities in which they have hitherto been found.

Diaptomus clavipes n. sp. (Pl. XXXIV., Fig. 1–3; Pl. XXXV., Fig. 1, 2.)

Body of about the same width throughout, except at the head and at the last thoracic segment, where it narrows slightly. Last two thoracic segments confluent, the last one with slightly rounded posterior angles, armed on each side with a short blunt spine. In the male the body is less strongly bifid than in the female, and the spines are smaller. There is but slight difference in the length of the abdominal segments (Pl. XXXV., Fig. 2), the second segment being longest and about equal to the furcal rami. The first segment is asymmetrical and armed on each side with a thick blunt spine, the one on the right side being the more conspicuous; in the male the segment is unarmed. Furcal rami hairy within; furcal setæ long, slender, and covered with delicate hairs.

Antennæ 25-segmented, extending beyond the furcal setæ. Geniculate antenna of the male (Pl. XXXIV., Fig. 2) greatly swollen from the twelfth to the eighteenth segments inclusive. The armature of the segments is as follows: 1 and 7 have a sense-club and a long spine; 2, two long spines, a sense-club, and a sense-hair; 3, a sense-club and a long seta; 4 and 6, a long spine; 5, a sense-club and a short seta; 8, a short and a long spine; 9, a short spine, a long seta, and a

*De Guerne et Richard, '89b.

sense-club; 10 and 11, two long spines, one much thicker than the other, and a process; 12, a long spine, a short spine, and a sense-club; 13, a long spine and a process; 14, a long spine, a long seta, and a sense-club; 15, a process, a long spine, a short seta, and a sense-club; 16, a process, a long spine, a long seta, and a sense-club; 17, a plate-like process, a long and a short spine; 18, a plate and a short spine; 19, 20, and 21 (usually completely ankylosed but sometimes with sutures indistinctly visible), a very long spine, a long seta, and a short cuticular process; 22 and 23 (completely ankylosed), a narrow hyaline lamina (bisected by a sense hair) and two setæ; 24, two setæ; and 25, two long setæ and two short ones, a sense hair, and a sense-club.

Fifth pair of feet in the male (Pl. XXXV., Fig. 1) characteristic. First basal segment of the right leg produced at the inner apical angle into a process (generally blunt but sometimes spine-like) having on the posterior surface a tubercle bearing a short blunt spine. Second basal segment (Pl. XXXIV., Fig. 1) armed at the inner margin with two processes, the proximal one broad, prominent, concave toward the apex of the segment; the other, slightly above the middle of the segment, a mere sharp triangular point. At the outer apical angle is a slight indentation from which springs a delicate hair, and from the inner apical angle arises the inner ramus. First segment of the outer ramus irregular, about one and a half times as long as broad, with a small sharp triangular point on the inner margin at about the beginning of the distal fifth. On this segment is a structure which is not, to my knowledge, found in any other Diaptomus. This is a hook arising from the middle of the posterior aspect, and reaching to the end of the segment. It is sickle-shaped, perfectly smooth, and although supplied with muscles does not seem to be movable. Second segment subquadrate, about twice as long as wide. The marginal spine is short, almost straight, about a third the length of the segment, delicately serrate within. Terminal hook very stout, as long as the two preceding segments, tapering gradually, and slightly recurved at the tip; armed for the distal two thirds of the inner margin with strong teeth.

Inner ramus of the right fifth foot short, about the same breadth throughout, almost reaching the middle of the first segment of the outer ramus; armed at the tip with a number of strong blunt spines.

Second basal segment of the left fifth leg subquadrate, the inner margin distinctly tuberculate, the outer apical angle with a delicate hair. First segment of the outer ramus subquadrate, about a fourth longer than broad; provided at the inner margin with a narrow hyaline lamina, produced at the inner apical angle into a delicately hairy cushion-like process. The second segment is narrow, about half as broad as the preceding; delicately hairy within, and produced at the inner distal angle into a cushion-like process densely covered with minute hairs. On the posterior side of this segment are two processes: one a long straight spine, more than half as long as the segment itself and armed at the inner margin with very strong hairs or spinules, largest at the base and decreasing in size toward the tip; the other a short, thick, blunt process, perfectly smooth, about a third the length of the spine.

Inner ramus of left fifth leg very long and narrow, arcuate (the concavity toward the outer ramus), about one eighth as broad as long, reaching beyond the end of the first and almost to the middle of the second segment of the outer ramus. It is broadest at the base and at the apex, armed at the tip with a number of strong blunt spinules, and tuberculate its entire length.

Second basal segment of the fifth pair of feet in the female (Pl. XXXIV., Fig. 3) trapezoidal, with the longest base forming the inner margin. From the outer margin springs the usual delicate hair. The first segment of the outer ramus is subquadrate, not quite twice as long as broad. Second segment subconical, almost straight, a little shorter than the preceding segment; the third segment wanting, represented by two sharp slender spines, the outer more than twice as long as the inner.

Inner ramus of fifth foot of female, one-segmented, longer than the first segment of the outer ramus and of uniform

width; delicately hairy both within and without; apex bluntly rounded and armed with two spines, the inner long, sharp, sinuously curved, the outer also sharply pointed but only about half as long as the inner.

Length of female, 1.37 mm.; of male, 1.28–1.68 mm.

Found (not very abundantly) in material from West Okoboji Lake, Iowa, very kindly loaned me by Prof. L. S. Ross, of Drake University, Des Moines, Iowa.

This species is very similar to Dr. Forbes's *D. piscinæ* and *D. leptopus*, but the details of structure will serve at once to distinguish it from them. The hook on the first segment of the right fifth foot of the male is very characteristic, as are also the processes on the inner margin of the second basal segment of the same leg. *D. claripes* offers such a mass of peculiar details that it is distinguished with ease from all other species heretofore described.

The name *claripes* was chosen because of the club-like inner rami of the fifth pair of legs of the male, the inner ramus of the left leg especially resembling an Indian war-club.

A very curious fact in regard to the distribution of this species was noted. East and West Okoboji lakes are united by a very deep, somewhat narrowed channel, but are so nearly one lake that no account of the division is taken by Rand & McNally in their atlas. Although there is nothing whatever to hinder free migration from one part of the lake to the other, not an individual was found in material from E. Okoboji, taken the same day and under the same circumstances as that from W. Okoboji in which the specimens were found.

SPECIES INSUFFICIENTLY DESCRIBED.

Diaptomus caroli Herrick.

Diaptomus caroli, Herrick and Turner, '95, p. 69.

This species name occurs once in the description of *D. sicilloides* (Herrick and Turner '95), but although I have searched diligently in Herrick's writings for an original description or even a previous reference to this species, I have been unable

to find a word in addition to the following. Speaking of *D. siciloides*, he says: "This species approaches *D. sicilis* Forbes and *D. caroli* Herrick very closely, and is said also to resemble *D. gracilis* Sars. From *caroli* it may be at once distinguished by reason of the fact that the third joint of the outer ramus of the fifth foot of the female is obsolescent." The "*D. caroli* Herrick" would lead one to suppose that it had been described before; but, although this work contains the names and short descriptions of all the other species, *D. caroli* is not among them. I doubt, therefore, whether I am justified in putting it even under the head of "insufficiently described" species.

Diaptomus longicornis var. **similis** Herrick.

Diaptomus longicornis var. *similis*, Herrick, 1884, p. 141, Pl. Q, Fig. 5–7.

Diaptomus similis, Herrick and Turner, '95, p. 58.

Something has already been said in regard to this doubtful species under the head of *D. leptopus*. First mentioned in Herrick's "Final Report," as one of two varieties,—the other being the true *leptopus* as acknowledged by him ('95a),—it is not mentioned again except in the description of *D. franciscanus*, where he says "The form of the fifth feet chiefly separates this species from *Diaptomus similis* Herrick." This species cannot stand until a more complete description is written.

DISTRIBUTION OF THE AMERICAN SPECIES OF DIAPTOMUS.

D. sicilis Forbes is one of the most common species in the Great Lakes, and has been found in Wisconsin, Michigan, Minnesota, and Yellowstone Park. In Illinois it is recorded from Cedar Lake and Fox Lake.

D. piscinæ Forbes has been recorded only from Yellowstone Park, and I now add Portage Slough, Manitoba, Can.

D. lintoni Forbes has been found only in Yellowstone Park.

D. leptopus Forbes is found in Massachusetts, Wisconsin, Minnesota, and Illinois.

D. sanguineus Forbes is very common throughout central and southern Illinois, and has been recorded from New York, Wisconsin, Minnesota, and Alabama.

D. stagnalis Forbes is also a common species, and is recorded from Minnesota, Illinois, Ohio, Kentucky, and Alabama.

D. shoshone Forbes has never been found outside of Yellowstone Park.

D. *pallidus* Herrick is an exceedingly common species in central Illinois and has been recorded from Ohio, Wisconsin, and Minnesota.

D. albuquerquensis Herrick was first described from Albuquerque, N. M., and is also found in Florida.

D. novamexicanus Herrick has only been recorded from Albuquerque, N. M.

D. oregonensis Lilljeborg is a very common species in Illinois, occurring generally with *D. siciloides* Lillj. and *D. pallidus* Herrick. It is also common in Wisconsin and is found in Michigan, Minnesota, and Oregon.

D. siciloides Lilljeborg is found in immense numbers at Havana, Ill. I have found it also in Iowa and Indiana collections, and it was originally described from L. Tulare, Fresno, Cal.

D. minutus Lilljeborg is probably the common species in the northern tier of states. It has been found in Yellowstone Park, in the Great Lakes, and in Wisconsin, Michigan, Newfoundland, Greenland, and Iceland.

D. franciscanus Lilljeborg has been found only by G. Eisen, near San Francisco, Cal.

D. eiseni Lilljeborg is also a California species.

D. signicauda Lillj., one of the most peculiar of American species, is recorded only from the Sierra Nevadas.

D. trybomi Lilljeborg is recorded only from Multnomah Falls, Oregon.

D. ashlandi Marsh seems to be the most widely distributed of American forms, having been found in the Great Lakes, in Indiana, Michigan, Wisconsin, Oregon, Idaho, Washington, and in Yellowstone Park.

D. reighardi Marsh has been recorded only from New Lisbon, Wisconsin.

D. mississippiensis Marsh is common in Mississippi, and has been found in Florida in connection with *D. albuquerquensis* Herrick.

D. tyrrelli Poppe was described by the author of the species from Summit Lake, and by Lilljeborg, under the name *D. fresnanus*, from Fresno, near Centreville, Cal.

D. claripes n. sp. is described in this paper from West Okoboji Lake, Iowa.

GENERAL BIBLIOGRAPHY* OF THE GENERA DIAPTOMUS, EPISCHURA, LIMNOCALANUS, AND OSPHRANTICUM.

This bibliographical list has been prepared principally in furtherance of Dr. Schmeil's purpose to compile a complete bibliography of the Copepoda of the world. To this end the list published by him in his Monograph (Schmeil, '96) has been critically reviewed and in some instances corrected, and a number of additions have been made. New species described since the publication of de Guerne and Richard's Revision ('89b) are noted in connection with the articles containing the original descriptions.

All articles except those marked with an asterisk are in the library of the Illinois State Laboratory of Natural History or in that of the University of Illinois.

Apstein, C.

'92. (See Article II.)

'96. Das Süsswasserplankton. Methode und Resultate der quantitativen Untersuchung. 201 pp., 113 Abbild., 5 Tab. Kiel u. Leipzig. Review, Zool. Centralbl., III. Jahrg., No. 22, pp. 764–769.

Aurivillius, C. W. S., u. Cleve, P T.

'96. Das Plankton des Baltischen Meeres. Bihang till K. Svenska Vet.-Akad. Handl., Bd. XXI., Afd. IV., No. 8, pp. 1–83, Taf. I., II.; Abstract, Zool. Centralbl., IV. Jahrg., 1897, No. 16, pp. 546–550.

Baird, W.

'50. (See Article II.)

Barrois, Th.

'91. Sur trois Diaptomus nouveaux des environs du Caire. Rév. Biol. du Nord de la France, T. III., Nos. 6, 7, 8.

*'95. Contribution à l'étude de quelques lacs de Syrie. Rev. Biol. du Nord de la France, T. VI., No. 6, pp. 224–240; Abstract, Biol. Centralbl., XV. Bd., Nr. 24, pp. 869–873.

*'96. Recherches sur la faune des eaux douces des Açores. Mém. Soc. sci., agr., arts, Lille, Sér. V., Fasc. VI. 172 pp., 3 cartes; Abstract, Zool. Centralbl., III. Jahrg., No. 18, pp. 609–611.

Birge, E. A.

'95. On the Vertical Distribution of the Pelagic Crustacea of Lake Mendota, Wis., during July, 1894. Biol. Centralbl., XV. Bd., Nr. 9, pp. 353–355.

*As the bibliographical list published in connection with the preceding paper, Article II. of this series, contains a large number of titles identical with those of this bibliography, these duplicate titles are not reprinted here, but reference is made, under the author's name and the year of publication, to the bibliographical list of the preceding article.—S. A. Forbes.

'95a. Plankton Studies on Lake Mendota. I. The Vertical Distribution of the Pelagic Crustacea during July, 1894. Trans. Wis. Acad. Sci., Arts, and Letters, Vol. X., pp. 421–484, Pls. VII.–X.

'95b. Turkey Lake as a Unit of Environment, and the Variation of its Inhabitants: Cladocera.† Proc. Ind. Acad. Sci., 1895, No. 5. p. 245.

'97. The Vertical Distribution of the Limnetic Crustacea of Lake Mendota. Biol. Centralbl., XVII. Bd., Nr. 10, pp. 371–375.

Blanchard, R.

'90. Sur une matière colorante des Diaptomus, analogue à la carotine des végétaux. Compt. Rend. de l'Acad. des Sci., Paris, T. CX., pp. 292–294.

'90a. Sur une carotine d'origine animale, constituant le pigment rouge des Diaptomus. Mém. de la Soc. zool. de France, T. III., p. 113.

Blanchard, R., et Richard, J.

'90. (See Article II.)

'91. (See Article II.)

'97. Sur la faune des lacs élevés des Hautes-Alpes. Mém. de la Soc. zool. de France, T. X., pp. 43–61.

Brady, G. S.

'68. (See Article II.)

'78–'80. (See Article II.)

'86. Notes on Fresh-water Entomostraca from South Australia. Proc. Zoöl. Soc. London, 1886, pp. 82–84. 3 Pls.

'86a. Notes on Entomostraca collected by Mr. A. Haley in Ceylon Journ. Linn Soc. London, Zoöl., Vol. XIX., pp. 293–317, Pl. XXXVII., Fig. 21–26.

'91. (See Article II.)

Buchholz, R.

*'74. Crustaceen. Die zweite deutsche Nordpolfahrt in den Jahren 1869 u. 1870, Bd. II., pp. 262–398. 15 Pls.

Bundy, F. W.

'82. A List of the Crustacea of Wisconsin. With Notes on some New or Little-known Species. Trans. Wis. Acad. Sci., Arts, and Letters, 1877–81, Vol. V., pp. 176–184.

Cajander, A. H.

'69. Bidrag till kännedom om sydvestra Finlands Krustaceer. Not. Sällsk. pro Fauna et Flora Fennica Förh., Heft X., pp. 373–376.

†Reference to *Diaptomus* and to *Epischura lacustris*.

Chambers, V. T.

'81. Two New Species of Entomostraca. Journ. Cincinnati Soc. Nat. Hist., Vol. IV., pp. 47, 48. 2 Pls.

Chyzer, C.

'58. Über die Crustaceenfauna Ungarns. Verh. d. K.-K. zool.-bot. Gesellsh. Wien, Bd. VIII., p. 505.

Claus, C.

'58. (See Article II.)

'63. (See Article II.)

'76. (See Article II.)

*'77. Die Schalendrüse der Copepoden. Sitzungsber. Akad. Wien, Math. Nat. Cl., LXXIV. Bd., I. Abth., pp. 717–721. 1 Pl.

'88. Über den Organismus der Nebaliden und die systematische Stellung der Leptostraken.† Arb. zool. Inst. Univ. Wien, VIII. Bd., pp. 1–148. Taf. I.–XV.

'93. (See Article II.)

'93a. (See Article II., '93b.)

'93b. (See Article II., '93c.)

'95. Über die Wiederbelebung im Schlamme eingetrockneter Copepoden und Copepoden-Eier. Zugleich ein Beitrag zur Kenntniss von *Microcyclops diaphanus* (Fisch.) = *minutus* (Cls.). Arb. Zool. Inst. Univ. Wien, T. XI., 1 Heft, pp. 1–11, Taf. I., II.

'95a. Über die Maxillarfüsse der Copepoden und die morphologische Deutung der Cirripedien-Gliedmassen. Arb. Zool. Inst. Univ. Wien, T. XI., 1 Heft, pp. 49–63, Taf. VIII.

Cragin, F. W.

'83. (See Article II.)

Daday, E. v.

'84. Catalogus Crustaceorum faunæ Transylvaniæ. (e collectione Musei transylvanici, collegit et determinavit). [Latin title of Hungarian article.] Orv. Természettud. Értesitö, Vol. IX., pp. 161–187

'85. (See Article II., 85a.)

'85a. Ujállatfajok Budapest édesvízi faunájaból. Term. füz., Vol. IX., p. 127, Pl. XI.

'85b. (See Article II., '85.)

*'90. Conspectus Diaptomorum faunæ hungaricæ. Math. naturw. Berichte a. Ungarn, Bd. XIII., pp. 114–143, Pls. IV.–VI.

*'90a. Übersicht der Diaptomus-Arten Ungarns. Math. naturw. Berichte a. Ungarn, Bd. XIV., pp. 177–180.

†Futterung mit Farbstoffen an Diaptomus, pp. 99, 101.

'91. Adatok Magyarország édesvízi mikroskopos faunájának ismeretéhez. Term füz., Vol. XIV., pp. 16–31, Pl. I. Also in German: Beiträge zur Mikropischen Süsswasserfauna Ungarns, Ibid., pp. 107–123.

'91a. Az eddig pontosan ismert Diaptomus-fajok meghatározó tablázata. Tabella synoptica specierum generis Diaptomus hucusque recte cognitarum. [Article in Hungarian and Latin.] Term. füz., Vol. XIV., pp. 32–51.

'97. Beiträge zur Kenntniss der Microfauna der Tátra-Seen. Term. füz., Vol. XX., pp. 149–196.

Dahl, Fr.

*'94. Die Copepodenfauna des unteren Amazonas. Ber. d. naturf. Gesellsch. zu Freiburg, i. B., Bd. VIII., pp. 10–23, Taf. I., Fig. 1–4. *Diaptomus kensenii* n. sp.

'95. Neueres über Morphologie und Ethologie der Copepoden. Zool. Centralbl., II. Jahrg., No. 22 u. 23, pp. 673–678.

De Kay, J. E.

'44. Crustacea. Nat. Hist. New York, Zoölogy, Part VI., pp. 1–65. Pls. I.–XIII.

Eusébio, J. B.

'88. Recherches sur la faune des eaux du Plateau Central. La Faune pélagique des lacs d'Auvergne. Rev. d'Auvergne (Clermont-Ferrand) [*Fide* Schmeil]. Separate, pp. 1–29, Pl. I., Fig. 10.

Fellows, C. S.

'87. A description of *Ergasilus chautauquaensis*, a New Species of Copepoda, and a List of other Entomostraca found at Lake Chautauqua in August, 1886. Proc. Am. Soc. Microscopists, 1887. 4 pp., 1 Pl.

Férussac, D. de

*'06. Mémoire sur deux nouvelles éspèces d'Entomostracés et d'Hydrachnes (*Cyclops müller*i [= *Diaptomus cœruleus*] and *Cypris reniformis*). Ann. Mus. hist. nat., T. VII., p. 213.

Fischer, S.

*'51. Beiträge zur Kenntniss der in der Umgegend von St. Petersburg sich findenden Cyclopiden. Bull. Soc. Imp. des Naturalistes de Moscou, T. XXIV., Pt. II., pp. 409–438, Pls. IX., X.

*'53. Beiträge zur Kenntniss der in der Umgegend von St. Petersburg sich findenden Cyclopiden. Fortzetzung. Bull. Soc. Imp. des Naturalistes de Moscou, T. XXVI., Pt. II., No. 1, pp. 74–100, Pls. II., III.

Forbes, S. A.

'76. (See Article II.)

'78. The Food of Illinois Fishes. Bull. Ill. State Lab. Nat. Hist., Vol. I., No. 1, pp. 71–89.

'78a. On the Crustacea eaten by Fishes. Bull. Ill. State Lab. Nat. Hist., Vol. I., No. 2, p. 87.

'80. The Food of Fishes. Bull. Ill. State Lab. Nat. Hist., Vol. I., No. 3, pp. 18–65; Rep. Ill. State Fish Comm., 1884, pp. 90–127.

'80a. On the Food of Young Fishes. Bull. Ill. State Lab. Nat. Hist., Vol. I., No. 3, pp. 66–79.

'82. On the First Food of the Young White Fish. American Field, Mar. 11, 1882.

'82a. (See Article II.)

'82b. (See Article II., '82.)

'83. The Food of the Smaller Fresh-water Fishes. Bull. Ill. State Lab. Nat. Hist., Vol. I., No. 6, pp. 65–95; Rep. Bd. Ill. State Fish. Comm., 1886, pp. 114–138.

'83a. The First Food of the Common White-Fish (*Coregonus clupeiformis* Mitch.). Bull. Ill. State Lab. Nat. Hist., Vol. I., No. 6, pp. 95–109; Rep. Bd. Ill. State Fish Comm., 1886, pp. 139–149.

'87. (See Article II.)

'90. (See Article II. '90a.)

'90a. (See Article II. '90.)

'93. (See Article II.)

Forel, A. F.

'78. Faunistische Studien in den Süsswasserseen der Schweiz. Zeitschr. f. wiss. Zool., Bd. XXX., Suppl., pp. 383–391.

'82. Die pelagische Fauna der Süsswasserseen. Biol. Centralbl., II. Bd., Nr. 10, pp. 299–305; Translation, Ann. Mag. Nat. Hist., Vol. X., p. 320.

Francé, R. H.

'94. Zur Biologie des Planktons. Vorläufige Mitteilung. Biol. Centralbl., XIV. Bd., Nr. 2, pp. 33-38.

Frič (Fritsch), A.

'72. (See Article II.)

'95. Über Parasiten bei Crustaceen und Räderthieren der süssen Gewässer. Bull. Internat'n'l d'Acad. des Sci. de l'Empéreur Frangois Joseph I, Classe des Sci. Math. et Nat., pp. 1–7.

'95a. (See Article II. '95.)

Fritsch (Frič), A., u. Vávra, V.

'92. (See Article II.)

'94. (See Article II.)

Fric, J. A.

'82. (See Article II.)

Gadeau de Kerville, H.

'88. Les Crustacés de la Normandie: éspèces fluviales, stagnales et terrestres; prémière liste. Bull. de la Soc. des Amis des Sci. nat. de Rouen, 1888, 1re Sem., pp. 133–158.

Garbini, A.

'93. Primi Materiali per una Monografia Limnologica del Lago di Garda. III. Limnofauna. Estr. dal Vol. LXIX., Ser. III., dell' Accad. Agric., Arti, e Comm. di Verona, pp. 28, 37, 49.

'94. (See Article II.)

'95. Fauna Limnetica e Profonda del Benaco. Boll. Mus. di Zool. ed Anat. comp. della Univ. di Torino, Vol. X., No. 198, pp. 2, 4, 5.

'95a. Appunti di Carcinologia Veronese. I. Elenco dei Crostacei veronesi. Estr. dal Vol. LXXI., Ser. III., Fasc. I., dell'Accad. di Verona, p. 3.

'95b. Appunti di Carcinologia Veronese. II. Considerazione ecologiche e corologiche. Estr. dal Vol. LXXI., Ser. III., Fasc. 1, dell' Accad. di Verona, pp. 9, 14.

'95c. Distribuzione e Intensita della Fauna atesina. Estr. dal Vol. LXXI., Ser. III., Fasc. II., dell' Accad. di Verona, p. 10.

Gerstäcker, A.

'54. Bericht über die Leistungen in der Naturgeschichte der Crustaceen, Arachniden, und Myriapoden während des Jahres 1852 und 1853. Arch. f. Naturgesch., XX. Jahrg., Bd. 2, pp. 72–108.

'63. Copepoda. Handbuch der Zoologie, pp. 402, 403. Leipzig.

'66–'79. Copepoda. Bronn's Klassen und Ordnungen des Thierreichs, V. Bd., I. Abtheil., pp. 590–806.

Giesbrecht, W.

'81. Vorläufige Mitteilung aus einer Arbeit über die freilebenden Copepoden des Kieler Hafens. Zool. Anz., XIV. Jahrg., No. 83, pp. 254–258.

'82. Die freilebenden Copepoden der Kieler Föhrde. IV. Ber. d. Komm. z. w. Unters. d. deutsch. Meere in Kiel, pp. 87–168, Taf. I–XII.

'92. Systematik und Faunistik der pelagischen Copepoden des Golfs von Neapel und der angrenzenden Meeres-abschnitte. XIX. Monograph. der Fauna und Flora des Golfs von Neapel. 831 pp., 54 Pls. Berlin.

'93. Mitteilungen über Copepoden. 6. Zur Morphologie der Maxillipeden. Mitteilungen a. d. zool. Stat. zu Neapel, Bd. XI., Heft I., pp. 83–102.

'95. Mitteilungen über Copepoden. 7. Zur Morphologie des weiblichen Abdomens. Mitteilungen a. d. zool. Stat. zu Neapel. Bd. XI., Heft IV., pp. 631–648.

Gissler, C. F.

'81. Variations in a Copepod Crustacean. Am. Nat., Vol. XV., pp. 689–698.

'81a. Note regarding Change of Color in *Diaptomus sanguineus*. Am. Nat., Vol. XV., p. 742.

Grobben, C.

'80. Die Antennendrüse der Crustaceen. Arb. Zool. Inst. Univ. Wien, Bd. III., pp. 93–110, Taf. IX.

'92. Zur Kenntniss des Stammbaumes und des Systems der Crustaceen. Sitzungsber. der K. Akad. der Wissensch. in Wien, Math.-naturw. Classe, Bd. CI., Abt. I., Jan., 1892, pp. 1–38.

Gruber, Aug.

'78. Über Bildung und Wirkung der Spermatophoren bei *Diaptomus gracilis* und *Heterocope robusta*. Dissertation. Promotionsschrift zur Erlangung der Doktorwürde, der philosoph. Facult. der Univ. Leipzig vorgelegt. 34 pp., 2 Pls. Leipzig.

'78a. Die Bildung der Eiersäckchen bei den Copepoden. Zool. Anz., I. Jahrg., No. 11, p. 247.

Guerne, J. de

'86. Description du *Centropages grimaldii*, Copépode nouveau du golfe de Finlande. Bull. de la Soc. zool. de France, T. XI., pp. 276–285.

'87. Sur les genres Ectinosoma Boeck et Podon Lilljeborg, à propos de deux Entomostracés (*Ectinosoma atlanticum* G. S. Brady et Robertson, et *Podon minutus* G. O. Sars) trouvés a la Corogne dans l'estomac des sardines.† Bull. de la Soc. zool. de France, T. XII., p. 29.

Guerne, Jul. de, et Richard, J.

'88. Sur la distribution géographique du genre *Diaptomus*. Compt. rend. de l'Acad. des Sci., 2 juillet, 1888. 3 pp.

'88a. Diagnoses de deux *Diaptomus* nouveaux d'Algérie (*D. blanchardi* et *D. lilljeborgi*). Bull. de la Soc. zool. de France, T. XIII., pp. 160–162.

'89. (See Article II., '89a.)

'89a. (See Article II., '89.)

'89b. Révision des Calanides d'eau douce. Mém. de la Soc. zool. de France. T. II., pp. 53–181. Pls. I.–IV. and 60 fig. in text.

†Reference to *Limnocalanus grimaldii*.

'90. La distribution géographique des Calanides d'eau douce. Association française pour l'avancement des sciences fusionée avec l'Assoc. scient. de France, Congrès de Paris, Séance du 14 août, 1889. 5 pp., 1 Pl.

'90a. Diagnose d'un *Diaptomus* nouveau du Congo (*D. loveni*). Bull. de la Soc. zool. de France, T. XV., pp. 177, 178.

'90b. Description du *Diaptomus alluaudi* n. sp., recueilli par M. Alluaud dans un réservoir d'eau douce á Lanzarotte (Canaries). Bull. de la Soc. zool. de France, T. XV., pp. 198–200.

'90c. On the Fresh-Water Fauna of Iceland. Ann. and Mag. Nat. Hist., Series VI., Vol. X., pp. 340–342.

'91. (See Article II.)

'91a. Synonymie et distribution géographique de *Diaptomus alluaudi*. Bull. de la Soc. zool. de France, T. XVI., pp. 213–217.

'91b. (See Article II., '91a.)

'91c. Entomostracés recueillis par M. Charles Rabot en Russie et en Sibérie (Gouvernements de Kasau, de Perm, de Vologda, et de Tobolsk). Bull. de la Soc. zool. de France, T. XVI., pp. 232–236.

'92. Sur la faune des eaux douces de l'Islande. Compt. rend. de l'Acad. des Sci., T. CXIV., pp. 310–313.

'92a. (See Article II.)

'92b. Documents nouveaux sur la distribution géographique des Calanides d'eau douce. Assoc. franç. pour l'avanc. des Sci., Congrès de Marseille, 1891, T. XX., Plate V. 5 pp. Paris.

'92c. (See Article II., '92b.)

'93. (See Article II.)

*'94. *Diaptomus chevreuxi*, Copépode nouveau d'Algérie. Bull. de la Soc. zool de France, T. XIX., p. 176.

'96. Prémière liste des Copépodes et Cladocères d'eau douce du Portugal. Bull. de la Soc. zool. de France, T. XXI., pp. 157–159.

'96a. *D. blanci*, Copépode nouveau recueilli par M. Edouard Blanc à Boukhara (Turkestan). Bull. de la Soc. zool. de France, T. XXI., pp. 53–56. 5 Fig.

Häcker, F.

*'95. Die Vorstadien der Eireifung. Zusammenfassende Untersuchungen über die Bildung der Vierergruppen und das Verhalten der kernbläschennucleolen. Arch. f. mikr. Anat., Bd. 45, pp. 200–273; Abstract, Zool. Centralbl., II. Jahrg., Nr. 18, pp. 551–553.

Hansen, H. J.

'93. Zur Morphologie der Gliedmassen und Mundteile bei Crustaceen und Insekten. Zool. Anz., XVI. Jahrg., Nos. 420 u. 421, pp. 193–198, 201–212.

Hartog, M. M.

'80. On the Anal Respiration of the Copepoda. Quart. Journ. Micros. Sci. London, Vol. XX., pp. 244–245; Proc. Manchester Lit. and Philos. Soc., Vol. XIX., pp. 61, 62.

'82. De l' œil impair des Crustacés. Compt. rend. Acad. Paris, T. XCIV., pp. 1430–1432; Ann. Mag. Nat. Hist., Vol. X., pp. 71, 72; Archiv Zool. Expérim., Vol. X., pp. 7, 8.

'88. (See Article II.)

Hartwig, W.

'93. (See Article II.)

'94. (See Article II.)

'97. Zur Verbreitung der niederen Crustaceen der Provinz Brandenburg. Forschungsber. a. d. Biol. Stat. zu Plön, Theil V., pp. 115-149. Stuttgart.

Heller, C.

'71. (See Article II.)

Herrick, C. L.

'77. A New Cyclops.† Geol. and Nat. Hist. Surv. of Minn., 5th Ann. Rep., pp. 238–239. 2 Figs.

'79. (See Article II.)

'79a. Fresh-water Entomostraca. Am. Nat., Vol. XIII., pp. 620–629. 4 Pls.

'82. (See Article II., '82a.)

'83. (See Article II.)

'83a. (See Article II.)

'84. (See Article II.)

'87. (See Article II.)

'95. Micro-Crustacea from New Mexico. Zool. Anz., XVIII. Jahrg., Nr. 467, pp. 40–47. 2 Taf.
[*D. albuquerquensis* and *D. novamexicanus*.]

Herrick, C. L., and Turner, C. H.

'95. (See Article II.)

Hoek, P. P. C.

'76. (See Article II.)

*'77-'78. Zur Entwickelungsgeschichte der Entomostraken. II. Zur Embryologie der freilebenden Copepoden. Niederl. Arch. f. Zool. Bd. IV., pp. 55–74, Taf. V.–VI.

'78. (See Article II.)

Imhof, O. E.

'83. (See Article II.)

†Diaptomus sp. ?

'84. Resultate meiner Studien über die pelagische Fauna kleiner und grösserer Süsswasserbecken in der Schweiz. Zeitschr. f. wiss. Zool., Band XL., pp. 154–178.

'84a. (See Article II., '84.)

'85. (See Article II., '85a.)

'85a. Über die blassen Kolben an den vorderen Antennen der Süsswasser-Calaniden. Zool. Anz., VIII. Jahrg., Nr. 197, p. 353.

'85b. (See Article II., '85.)

'86. (See Article II.)

'86a. (See Article II., '86b.)

'87. Über die microscopische Thierwelt hochalpiner Seen (600–2780 m. ü. M.). Zool. Anz., X. Jahrg., Nos. 241 u. 242, pp. 13–17, 33–42 ; Abstract, Am. Nat., Vol. XXI., p. 671.

'87a. (See Article II.)

'87b. (See Article II.)

'88. Fauna der Süsswasserbecken. Zool. Anz., XI. Jahrg., Nos. 275 u. 276, pp. 166–172, 185–190.

'88a. (See Article II., '88.)

'90. (See Article II., '90a.)

'90a. (See Article II., '90.)

'90b. Notizen über die Süsswasser-Calaniden. Zool. Anz., XIII. Jahrg., Nos. 349 u. 350, pp. 629–633, 654–658.

'91. Über die pelagische Fauna einiger Seen des Schwarzwaldes. Zool. Anz., XIV. Jahrg., No. 355, pp. 33–38.

'92. Zusammensetzung der pelagischen Fauna der Süsswasserbecken. Biol. Centralbl., XII. Band., Nr. 6, 7 u. 8, pp. 171–182, 200–205.

*'93. Les organismes inférieurs des lacs à la région du Rhône. Arch. des Sci. phys. et nat., octobre—décembre, 1893.

'94. Fauna hochgelegener Seen. Seen der Rocky-Mountains, Nord-Amerika. Von S. A. Forbes. Biol. Centralbl., XIV. Bd., Nr. 8, pp. 287–293.

'95. (See Article II.)

'96. Die Binnengewässer-Fauna der Azoren ; Referat nach de Guerne und Barrois. Biol. Centralbl., XVI. Bd., Nr. 18, pp. 683–688.

Jurine, L.

'20. (See Article II.)

Kafka, Josef.

'92. (See Article II.)

Kerville, H. (See **Gadeau de Kerville, H.**)

King, R. L.

*'55. On Australian Entomostracans. Papers and Proc. Roy. Soc. Van Diemen's Land, Vol. III., Pt. I.

Koch, C. L.

'35–'41. Deutschlands Crustaceen, Myriapoden, und Arachniden, Heft. XXI., XXXV. Regensburg.

Koelbel, C.

'85. Carcinologisches. Sitzungsber. d. K. Akad. d. Wiss. Wien, Math.-naturw. Klasse., Bd. XC., 1 Abteil., pp. 312–323, Pl. I., Fig. 1–5.

Kortchaguine, A. N.

*'87. Fauna der Umgebung Moskaus. I. Crustaceen [German title of Russian article]. (Arb. aus. d. Laborat. d. Zool. Mus. der Univ. Moskau.) Schriften der Gesellsch. v. Freunden d. Naturwissensch. zu Moskau, Bd. LII.

Ladenburger, R.

'84. Zur Fauna des Mansfelder Sees. Zool. Anz., VII. Jahrg., Nr. 168, pp. 299–302.

Lauterborn, R.

'94. Über die Winterfauna einiger Gewässer der Oberrheinebene. Mit Beschreibungen neuer Protozoen. Biol. Centralbl., XIV. Bd., Nr. 11, pp. 391–398.

'94a. Beiträge zur Süsswasserfauna der Insel Helgoland. Wissenschaftliche Meeresuntersuchungen, "Neue Folge," Bd. I., Heft 1, pp. 216–221.

Leydig, Fr.

'59. Bemerkungen über den Bau der Cyclopiden. Arch. f. Naturg. XXV. Jahrg., I. Bd., pp. 194-207, Taf. IV.

Lilljeborg, W.

'53. (See Article II.)

'63. Beskrifning öfver twa arter Crustaceer af ordingarne Ostracoda och Copepoda. Öfv. af K. Vet.-Akad. Förhandl., Årg. XIX., p. 391.

'87. On the Entomostraca collected by Mr. Leonhard Stejneger, on Bering Island, 1882-83. Contributions to the Natural History of the Commander Islands. Proc. U. S. Nat'n'l Mus., 1887, pp. 154–156.

'88. Descriptions de deux éspèces nouvelles de Diaptomus du nord de l'Europe. Bull. de la Soc. zool. de France, T. XIII., pp. 156–158.

Lubbock, J.

*'53. On two New Species of Calanidæ, with Observations on the Spermatic Tubes of *Pontella*, *Diaptomus*, etc. Ann. Mag. Nat. Hist., Vol. XII., pp. 115–124, 159–165, Pls. V., VI.

*'54. On the Fresh-water Entomostraca of South America. Trans. Entom. Soc. N. S., T. III.

*'56. On some Entomostraca collected by Dr. Sutherland in the Atlantic Ocean. Trans. Entom. Soc. London, Vol. IV., Part II., pp. 8–39, Pls. II.–XII.

*'57. Description of eight New Species of Entomostraca found at Weymouth. Ann. Mag. Nat. Hist., Vol. XX., pp. 401–410, Pls. X., XI.

*'60. On Some Oceanic Entomostraca collected by Capt. Toynbee. Trans. Linn. Soc. London, Vol. XXIII., pp. 295, 296; Ann. Mag. Nat. Hist., Vol. XI., pp. 488, 489.

'63. (See Article II.)

Maitland, R. T.

*'74. Naamlijst van Nederlandsche Schaldieren. Tijdschr. Nederl. Dierk. Vereen., 1 Deel, pp. 228–269.

Marenzeller, E. v

'73. Über *Diaptomus amblyodon* n. sp. Verh. d. K.-K. zool.-bot. Gesellsch. Wien, Bd. XXIII., p. 593, Taf. VI.

Marsh, C. D.

'91. (See Article II.)

'92. (See Article II.)

'93. (See Article II.)

'93a. (See Article II.)

'94. On two New Species of Diaptomus. Trans. Wis. Acad. Sci., Arts, and Letters, Vol. X., pp. 15–17, Pl. I.
[*D. mississippiensis* and *D. birgei*, n. sp.]

'95. (See Article II.)

'97. On the Limnetic Crustacea of Green Lake. Trans. Wis. Acad. Sci., Arts, and Letters, Vol. XI., pp. 179–224, Pls. V.–XIV.

Milne-Edwards, H.

'34–'40. (See Article II.)

'38. Extrait d' un Mémoire sur la distribution géographique des Crustacés. Compt. rend. des Séances de l'Acad. des Sci. 9 pp.

Moniez, R.

'87. (See Article II.)

'89. (See Article II., '89a.)

Mrázek, A.

'91. (See Article II.)

'93. Příspěvky k poznáni sladkovodnich Copepodů [Contributions to the Knowledge of Fresh-water Copepoda]. Věstník Král. České Spol. Náuk. Třída math.-přír., 1893. 74 pp., 8 Pls.; Abstract, Zool. Centralbl., I. Jahrg., pp. 593, 594.

'93. (See Article II., '93c.)

'95. (See Article II.)

*'96. Zur Entwickelungsgeschichte einiger Taenien.† Sitzungsber. d.k. böhm. Gesellsch. Wiss. Math.-nat. Classe. 16 pp., 1 Pl.; Abstract, Zool. Centralbl., IV. Jahrg., No. 15, pp. 522, 523.

Müller, O. F.

1792. (See Article II.)

Nicolet.

*'48–'49. Crustaceos. In Gay, C., Historia fisica y politica de Chile etc., Zoologia, Vol. III., pp. 288–292.

Nordqvist, O.

'86. (See Article II.)

'87. (See Article II.)

'88. Die Calaniden Finlands. Bidrag till Kännedom af Finlands Natur och Folk. Utgifva af Finska Vetensk.-Soc., Heft 47, pp. 192–275. 10. Pls.

'89. Über einen Fall von androgyner Missbildung bei *Diaptomus gracilis* G. O. Sars. Arch. f. Naturgesch. LV. Jahrg., pp. 241–243, Taf. XII.

'90. (See Article II.)

Norman, A. M.

'86. Museum Normanianum; or a Catalog of the Invertebrata of Europe and the Arctic and North Atlantic Oceans, pp. 22, 23.

Ouchakoff, N.

*'55. *Pontie* de Wacarino. Bull. de la Soc. imp. des natural. de Moscou, T. XXVIII.

Pavesi, P.

'79. (See Article II.)

'79a. (See Article II.)

'83. (See Article II.)

Pickering, C.

'44. Generic Description of *Scopiphora vagans*. Nat. Hist. N. Y., Zoöl., Part VI., Crustacea, p. 62.

Pitard, E.

*'97. Sur le Plankton du lac de Joux. Arch. Sci. phys. et nat., 4ème pér., T. III. 3 pp.

*'97a. Sur le Plankton du lac Brenet. Arch. Sci. phys. et nat., 4ème pér., T. III. 2 pp.

Poggenpol, M. J.

'74. (See Article II.)

†Contains reference to *Diaptomus*.

Poppe, S. A.

'84. Bemerkungen zu R. Ladenburger's: Zur "Fauna des Mansfelder Sees" in No. 168 des Zoologischen Anzeigers. Zool. Anz., VII. Jahrg., No. 176, pp. 499, 500.

'86. Ein neuer *Diaptomus* aus dem Hirschberger Thal. Zeitschr. f. wiss. Zool., Bd. 43, pp. 285–289, Taf. X., Fig. 1–12.

'88. Diagnoses de deux espèces du genre *Diaptomus* Westwood. Bull. de la Soc. zool. de France, T. XIII., pp. 159, 160.

'89. (See Article II.)

'89a. (See Article II.)

'91. Ein neuer Diaptomus aus Brasilien. Zool. Anz., XIV. Jahrg., No. 368, pp. 248–250. 3 Fig.
[*D. deitersi* n. sp.]

Poppe, S. A., u. Mrázek, A.

'95. Entomostraken des Naturhistorischen Museums in Hamburg. 1. Die von Herrn Dr. F. Stuhlmann auf Zanzibar und dem gegenüberliegenden Festlande gesammelten Süsswasser-Copepoden. 2. Taf. 2. Entomostraken von Süd-Georgien. 1 Taf. 3. Die von Herrn Dr. H. Driesch auf Ceylon gesammelten Süsswasser-Entomostraken. I Taf. Beiheft zum Jahrb. der Hamburgischen wissenschaftl. Anstalten. XII. 20 pp.

Poppe, S. A., et Richard, J.

'90. (See Article II.)

'92. Description du *Diaptomus schmackeri* n. sp., recueilli par M. Schmacker dans le lac Tahoo (Chine). Bull de la Soc. zool. de France, T. XVII., pp. 149–151. 6 Fig.

Rath, O. v.

'91. (See Article II.)

Rehberg, H.

'80. (See Article II., '80a.)

'80a. (See Article II., '80b.)

Richard, J.

'87. (See Article II.)

'87a. Sur la faune pélagique de quelques lacs d'Auvergne. Compt. rend. d'Acad. des Sci., 14 novembre et 12 décembre, T. CV., pp. 951–953.

'88. Entomostracés nouveaux ou peu connus. Bull. de la Soc. zool. de France, T. XIII., p. 156.

'88a. (See Article II., '88.)

*'89. Anomalie de l'antenne droite chez *Diaptomus cœruleus* Fisch., mâle. Bull. de la Soc. zool. de France, T. XIV., pp. 38, 39.

'89a. Note sur les pêches effectuées par M. Ch. Rabot dans les lacs Enara, Imandra, et dans le Kolozero. Bull. de la Soc. zool. de France, T. XIV., pp. 100–109.

'89b. Description du *Mesochra blanchardi*, Copépode nouveau des Sebkhas algériennes. Bull. de la Soc. zool. de France, T. XIV., pp. 317–321.

'90. (See Article II., '90c.)

'90a. Sur les Entomostracés et quelques autres animaux inférieurs des lacs de l'Auvergne. Rev. des Sci. Nat. Appliquées, 37e Ann., 1re Sem., No. 10, pp. 472–481. 10 Fig.

'90b. (See Article II., '90a.)

'90c. (See Article II., '90b.)

'90d. Note préliminaire sur le système nerveux de quelques éspèces de *Diaptomus*. Bull. de la Soc. zool. de France, T. XV., pp. 212–219.

'91. (See Article II.)

'91a. (See Article II.)

'91b. Recherches sur le système glandulaire et sur le système nerveux des Copépodes libres d'eau douce, suivies d'une révision des éspèces de ce groupe qui vivent en France. Ann. Sci. nat. zool., T. XII., pp. 113–270, Pl. V.–VIII.

'92. Free Fresh-water Copepoda. Ann. Sci. Nat., Vol. XII., pp. 113–270; Abstract, Journ. Roy. Micr. Soc., 1892, p. 478.

'93. Copépodes recueillis par M. le Dr. Théod. Barrois en Égypte, en Syrie et en Palestine (Mars—Juin, 1890). Rev. Biol. du Nord de la France, 5e ann., No. 10, juillet, 1893. 36 pp., 51 Fig.

'94. Entomostracés recueillis par M. E. Modigliani dans le Lac Toba (Sumatra). Ann. del Mus. Civ. di Storia Nat. di Genova, Ser. II.a, Vol. XIV. (XXXIV.), Oct., 1894, pp. 565–578, Fig. 9–14.
[*Diaptomus doriai* n. sp.]

'95. (See Article II., '95a.)

'95a. (See Article II., '95b.)

'97. Sur quelques Entomostracés d'Eau douce des environs de Buenos Aires. Anales del Mus. Nac. de Buenos Aires, T. V., pp. 321–332, Fig. 1–6.
[*Diaptomus bergi* n. sp.]

'97a. Entomostracés recueillis par M. le Directeur Steindachner dans les lacs de Janina et de Scutari. Ann. d. K. K. Naturhist. Hofmus., Bd. XII., Heft 1, pp. 63–66, Fig. 1–4.
[*Diaptomus steindachneri* n. sp.]

'97b. Entomostracés de l'Amerique du Sud recueillis par MM. U. Deiters, J. von Ihering, G. W. Müller et G. O. Poppe. Mém. de la Soc. zool. de France, T. X., pp. 263–301, Fig. 1–45.

'97c. Sur deux Entomostracés d'Eau douce recueillis par M. Chaffanjon en Mongolie. Bull. du. Mus. d'hist. nat., 1897, No. 4, pp. 131–135, Fig. 1–5.
[*Diaptomus chaffanjoni* n. sp.]

Rückert, J.

*'94. Zur Eireifung bei Copepoden. Merkel-Bonnet's Anat. Hefte, I. Abt., XII. Heft, pp. 261–351, Taf. XX.–XXV.; Abstract, Zool. Centralbl., II. Jahrg., No. 10, pp. 291–295.

Russki.

*'89. Le faune pélagique du lac de Kabane. [French title of Russian work.] Trav. Soc. imp. des nat. de l'Univ. de Kasan, T. XIX.

Sars, G. O.

'62. (See Article II.)

'63. (See Article II.)

'64. (See Article II.)

'86. Crustacea. II. Den norske Nordhavs-Expedition 1876–78, pp. 76–79. Christiana.

'89. On some Fresh-water Ostracoda and Copepoda raised from dry Australian mud. Forh. i Vidensk.-Selskab. i Christiania, pp. 1–77, Pl. I.–VIII. (Pls. I. and II. colored.)

'95. On some South African Entomostraca raised from dried mud. Vidensk.-Selskab. Skrifter, I. Math.-naturw. Klasse, 1895, Nr. 8, pp. 1–55. 8 Pls.
[*Paradiaptomus lamellatus*, n. gen. and n. sp.]

'96. On a new Fresh-water Ostracod, *Stenocypris chevreuxi*, G. O. Sars, with notes on some other Entomostraca raised from dried mud from Algeria. Arch. f. Math. og Naturvid. Kristiania. 27 pp., 3 Pls.

'97. Pelagic Entomostraca of the Caspian Sea. Extrait de l'Annuaire du Musée Zoologique de l'Academie Impériales des Sci. de St.-Pétersbourg, 1897. 73 pp., 8 Pls.

Schmeil, O.

'89. Über den Diaptomus des salzigen Sees (*Diaptomus richardi* n. sp.). Zool. Anz., XII. Jahrg., No. 323, pp. 646–649.

'91. (See Article II.)

'92. Deutschlands freilebende Süsswasser-Copepoden. I. Teil: Cyclopidæ. Bibliotheca Zoologica, Heft 11. 191 pp., 8 Pls.

'94. (See Article II.)

'94a. Einige neue Harpacticidenformen des Süsswassers. Zeitschr. f. Naturwissensch., Bd. LXVII., pp. 341–350.

'95. Neue Spaltfusskrebse der Fauna der Provinz Sachsen. Zeitschr. f. Naturwissensch., Bd. LXVIII., pp. 126–130.

'96. Deutschlands freilebende Süsswasser-Copepoden. III. Teil: Centropagidæ. Abt. I. u. II. Bibl. Zool. Heft 21, Lfg. I. u. II., Taf. I.–XII., 3 Fig. in Text: Abstract, Biol. Centralbl., XVI. Bd., Nr. 23, pp. 845–847.

'97. Deutschlands freilebende Süsswasser-Copepoden. Nachtrag. Bibl. Zool. Heft 21, Nachtrag. pp. 145–188, Taf. XIII., XIV.

Scott, T.

*'94. *Diaptomus serricornis* Lilljeborg, in Lochs in Barra and North Uist. Ann. Scot. Nat. Hist., Oct., pp. 258, 259.

Scourfield, D. J.

'93. (See Article II.)

'94. Entomostraca and the Surface-film of Water. Journ. Linn. Soc., Vol. XXV., Zoölogy, No. 158, pp. 1–19, Pls. I., II.

'95. A Preliminary Account of the Entomostraca of North Wales. Journ. Quekett Micr. Club, Vol. VI., Ser. II., No. 37. pp. 127–143, Pl. VIII.

'97. Verzeichniss der Entomostraken von Plön. Forschungsber. a. d. Biol. Stat. zu Plön, Theil V., pp. 180–183. Stuttgart.

Seligo, A.

'90. (See Article II.)

Siebold, C. Th.

*'39. Beiträge zur Naturgeschichte der wirbellosen Thiere. II. Über das Begattungsgeschäft des *Cyclops castor*. Neueste Schrift. Nat. Ges. Danzig, Bd. III., Heft 2, pp. 36–50, Taf. 2, Fig. 41–44. (Übersetzt in: Ann. Sci. Nat. Paris, T. XIV., pp. 26–38, Taf. V. Nach Giesbrecht.) [*Fide* Schmeil.]

Sowinsky, W.

'91. (See Article II.)

*'91a. Sur la nouvelle éspèce du genre *Diaptomus*, trouvée dans le lac Ribnoye-Ozero près de la ville Stawropol. [French title of Russian article.] Mém. de la Soc. des natural. de Kiew, T. XI., Part I. 4 pp., 1 Fig. in text.

Steck, Th.

'93. Beiträge zur Biologie des grossen Moosseedorfsees. Mitt. d. naturf. Gesellsch. in Bern, Jahrg. 1893, pp. 20–73.

Stuhlmann, F.

'91. Beiträge zur Fauna central-afrikanischer Seen. Zool. Jahrb., Abteil. f. System., Bd. V., pp. 924–926.

Székely, B.

*'82. Tanulmányok a *Diaptomus* petefejlödésének elsö phasisairól a blastoderma fellépesétig. Kolozsvárt.

Thallwitz, J.

*'91. Die Süsswasser-Calaniden Deutschlands. Nat. Rundschau. Bd. VI., pp. 131, 132. Berlin.

Turner, C. H.

'92. (See Article II.)

Ulianin, W. N.

*'74. Cladoceren und Copepoden einiger Seen des centralen Russlands. Schriften d. Gesellsch. v. Freunden der Naturwissensch., etc., zu Moskau, Bd. X., Abt. II., pp. 78–81.

'75. Crustaceen von Turkestan. Reise A. P. Fedtschenko's in Turkestan. [German title of Russian article.] Schrift. de Gesellsch. v. Freunden der Naturwissensch., etc., zu Moskau, Bd. XI., Abt. VI., Copepoden, pp. 22–41, Taf. VI.–XII.

Underwood, L. M.

'86. (See Article II.)

Vejdovský, F.

'82. Thierische Organismen der Brunnengewässer von Prag. 66 pp., 8 Pls. Prag.

Villepoix, R. M. de

'88. (See Article II.)

Vosseler, J.

'86. (See Article II.)

'89. (See Article II.)

'91. Die Krebsfauna unserer Gewässer. In Zacharias's "Die Thier- und Pflanzenwelt des Süsswassers," Bd. I., pp. 323-380. 6 Fig. Leipzig.

Weber, Max.

'92. On the Fresh-water Crustacea of the Indian Archipelago with Observations on the Fauna of Fresh-water in General. Ann. Nat. Hist., Ser. 6, Vol. XIV., pp. 237–253.

'92a. Die Süsswasser-Crustaceen des Indischen Archipels, nebst Bemerkungen über die Süsswasser-Fauna im Allgemeinen. Zool. Ergeb. einer Reise in Niederländ. Ost-Ind., pp., 528-571, Taf. XXX. Leiden.

Westwood, J. O.

*'36. Cyclops. Partington's Cyclopedia. Nat. Hist.

Wierzejski, A.

'82. Materyjaly do fauny jezior tatrzańskich. [Materials for the Fauna of the Karpathian Lakes.] Copepoden. Sprawozd. Kom. fiz. Akad. Umiej., T. XVI., pp. 233, 234, Taf. III.

*'83. Zarys fauny stawów tatrzańskich. Pamiętn. Tow. tatrz., T. VIII. Krakau.

'87. O Krajowych skorupiakach z rodziny Calanidæ. [On the native Copepoda of the Family Calanidæ.] Rozpr. i Sprawozd. Wydz. mat.-przyr. Akad. Umiej. Krakow, T. XVI. 13 pp., 1 Pl.

'95. Przegląd fauny skorupiaków galicyjskich. [Review of the Crustacean Fauna of Galicia.] (See Article II. for citation.)

Wille, N.

'96. Mitteilungen aus der biologischen Gesellschaft in Christiania. Biol. Centralbl., XVI. Bd., Nr. 3, pp. 124-126.

Zacharias, O.

*'85. Studien über die Fauna des Grossen und Kleinen Teichs im Riesengebirge. Zeitschr. f. wiss. Zool., Bd. XLI., pp. 483–516, Taf. XXVI.

'87. (See Article II.)

'87a. Zur Entomostrakenfauna der Umgebung von Berlin. Biol. Centralbl., Bd. VII., Nr. 5, pp. 137–139.

'87b. (See Article II.)

'88. (See Article II., '88a.)

'88a. Die Tierwelt der Eifelmaare. Biol. Centralbl., VIII. Bd., Nr. 18, p. 574.

'88b. Über die geographische Verbreitung des Genus *Diaptomus*. Biol. Centralbl., VIII. Bd., Nr. 18, p. 575.

'89. Bericht über eine Zoologische Exkursion an die Kraterseen der Eifel. Biol. Centralbl., IX. Bd., Nos. 2, 3, pp. 56–64, 76–80.

'90–'91. Über ein interessantes Kapitel der Seenkunde. Biol. Centralbl., X. Bd., Nr. 18. pp. 123–128.

'93. Fauna des grossen Plöner Sees. Forschungsber. aus der Biol. Station zu Plön, Theil I., pp. 3–13; Extract, Biol. Centralbl., XIII. Bd., Nr. 11 u. 12, pp. 377–382.

'94. Faunistische Mitteilungen. Fauna des grossen Plöner Sees. Forschungsber. aus der Biol. Stat. zu Plön, Teil. II., pp. 57–66.

'95. Über die horizontale und vertikale Verbreitung limnetischer Organismen. Forschungsber. aus der Biol. Stat. zu Plön. Theil III., pp. 118–128. Extract, Biol. Centralbl., XIII. Bd., Nr. 11 u. 12, pp. 377–382.

'95a. Statistische Mitteilungen aus der Biologischen Station am grossen Plöner See. Zool. Anz., XVIII. Jahrg., pp. 28, 70, 87, 125, 140, 190, 256, 305, 367, 414, 448.

'96. Quantitative Untersuchungen über das Limnoplankton. 64 pp. Berlin.

'97. Biologische Beobachtungen an den Versuchsteichen des Schles. Fischerei-vereins zu Trachenberg. Forschungsber. a. d. Biol. Stat. zu Plön, Theil V., pp. 10–28. Stuttgart.

Zaddach, E. G.

'44. Synopseos Crustaceorum Prussicorum Prodromus. Dissertatio Zoologica. 47 pp. Regiomonti (Königsberg).

Zenker, W.

'54. (See Article II.)

'54a. System der Crustaceen. Arch. f. Naturgesch., XX. Jahrg., Bd. I., pp. 108–118.

'54b. Critik der Erichson'schen Gliedmassentheorie. Arch. f. Naturgesch., XX. Jahrg., Bd. I., pp. 118–138.

Zograf, N.

*'96. Essai d'explication de l'origine de la faune des lacs de la Russie d'Europe. Compt. rend. des séance du troisième congrès internat. de Zool., Leyde, 16–21 sept., 1895, pp. 183–195. Leyde. Abstract, Zool. Centralbl., III. Jahrg., No. 14, pp. 481–483.

Zopf, W.

'95. Cohn's Hämatochrom ein Sammelbegriff. Biol. Centralbl., XV. Bd., Nr. 11, pp. 417–427.

Zschokke, F.

'90. (See Article II.)

'90a. (See Article II.)

'91. (See Article II.)

*'91a. Die zweite zoologische Excursion an die Seen des Rhätikon. Verhandl. Naturf. Gesellsch. Basel, Bd. IX., 2 Teil, pp. 425–508; Abstract, Journ. Roy. Micr. Soc., 1892, p. 194.

'94. Die Tierwelt der Juraseen. Rev. Suisse de Zool. et Ann. du Mus. d'hist. nat. de Génève, T. II., Liv. II., pp. 349–376, Pl. XIV.

'94a. Die Fauna hoch gelegener Gebirgsseen. Ein Beitrag zur Kenntniss der Vertikalen Verbreitung niederer Tiere. Verh. d. Naturf. Gesellsch. in Basel, Bd. XI., Heft 1, pp. 36–133, Taf. I.

'95. Die biologische Station zu Plön nach den Forschungsberichten. Teil II. u. III. Biol. Centralbl., XV. Bd., Nr. 10, pp. 408–415.

EXPLANATION OF PLATES.

Plate XXI.

Fig. 1. *Diaptomus sicilis*, fifth feet of male. × 280.
Fig. 2. Fifth feet of female of same (minus one outer ramus). × 280.
Fig. 3. Last thoracic segment and abdomen of female of same. × 140.

Plate XXII.

Fig. 1. *Diaptomus pisciнæ*, fifth feet of male.
Fig. 2. Fifth foot of female of same (Portage Slough specimen). × 280.
Fig. 3. Last thoracic segment and abdomen of female of same. × 140.
Fig. 4. Fifth foot of female (Yellowstone Park specimen). × 280.

Plate XXIII.

Fig. 1–5. *Diaptomus sanguineus*, second basal segment of right fifth foot of male. × 210.
Fig. 6–8. Terminal segments of right male antenna of same. × 210.

Plate XXIV.

Fig. 1, 2. *Diaptomus sanguineus*, first abdominal segment of female, seen from the side. × 110.
Fig. 3. Last thoracic and first abdominal segments of female of same. × 110.
Fig. 4. Fifth feet of male of same. × 210.
Fig. 5, 6. Dorsal outline of female of same, showing hump. × 110.

Plate XXV.

Fig. 1, 2. *Diaptomus sanguineus*, fifth foot of female. × 240.
Fig. 3, 4. Right fifth foot of male of same. × 210.
Fig. 5. Fifth feet of male of same (variant). × 210.

Plate XXVI.

Fig. 1. *Diaptomus shoshone*, last thoracic segment and abdomen of female. × 80.
Fig. 2. Fifth foot of female of same. × 280.
Fig. 3. Abdomen of male of same. × 128.

Plate XXVII.

Fig. 1. *Diaptomus lintoni*, fifth feet of male. × 280.
Fig. 2. *Diaptomus pallidus*, fifth foot of female. × 280.
Fig. 3. Fifth feet of male of same. × 280.
Fig. 4. *Diaptomus albuquerquensis*, fifth feet of male. × 400.

Plate XXVIII.

Fig. 1. *Diaptomus reighardi*, fifth feet of male. × 400.
Fig. 2. *Diaptomus stagnalis*, right antenna of male. × 80.

Plate XXIX.*

Fig. 1. *Diaptomus oregonensis*, fifth feet of male. × 240.
Fig. 2. Fifth foot of female of same. × 300.
Fig. 3. *Diaptomus signicauda*, fifth feet of male. × 200.
Fig. 4. Terminal segments of right antenna of male of same. × 200.
Fig. 5. Fifth foot of female of same. × 200.
Fig. 6. Last thoracic segment and abdomen of female of same. × 100.

Plate XXX.*

Fig. 1. *Diaptomus franciscanus*, last thoracic segment and abdomen of female. × 40.
Fig. 2. Terminal segments of right antenna of male of same. × 200.
Fig. 3. Fifth pair of feet of male of same. × 200.
Fig. 4. Fifth foot of female of same. × 200.
Fig. 5. *Diaptomus minutus*, fifth foot of female. × 300.
Fig. 6. Fifth foot of male of same. × 300.
Fig. 7. Terminal segments of right antenna of male of same. × 300.
Fig. 8. Last thoracic segment and abdomen of female of same. × 250.

Plate XXXI.

Fig. 1.* *Diaptomus trybomi*, terminal segments of right male antenna. × 160.
Fig. 2.* Last thoracic segment and abdomen of female of same, seen from right side. × 96.
Fig. 3. The same, seen from above. × 140.
Fig. 4.* Fifth pair of feet of male of same. × 210.
Fig. 5.* Fifth foot of female of same. × 240.

Plate XXXII.

Fig. 1. *Diaptomus ashlandi*, fifth pair of feet of female (a variant). × 240.
Fig. 2. Fifth foot of female of same. × 240.
Fig. 3. Fifth pair of feet of male of same. × 240.
Fig. 4. Anterior fifteen segments of right antenna of male of same. × 240.

*After de Guerne and Richard, '89b.

Plate XXXIII.

Fig. 1. *Diaptomus mississippiensis*, last thoracic segment and abdomen of male. × 256.
Fig. 2. Fifth foot of female of same. × 256.
Fig. 3. Fifth pair of feet of male of same. × 256.
Fig. 4. Abdomen of female of same seen from below (Prof. Marsh's specimen). × 256.

Plate XXXIV.

Fig. 1. *Diaptomus clavipes*, right fifth foot of male (inner ramus wanting). × 280.
Fig. 2. Right antenna of male of same. × 140.
Fig. 3. Fifth foot of female of same. × 400.

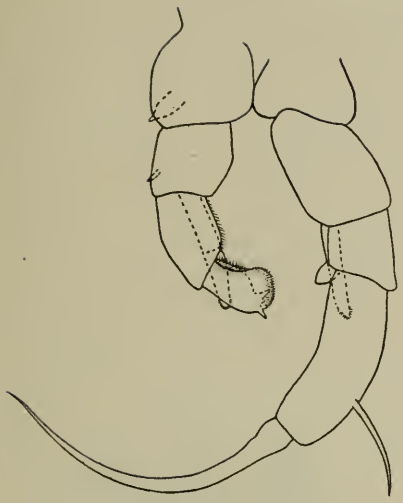
Plate XXXV.

Fig. 1. *Diaptomus clavipes*, fifth feet of male. × 280.
Fig. 2. Last thoracic segment and abdomen of female of same. × 140.

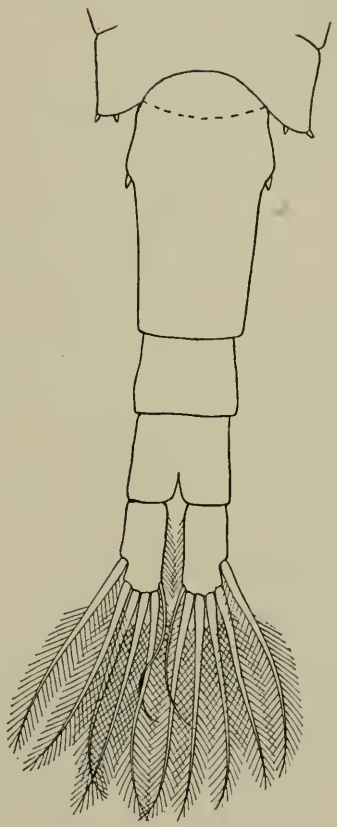
INDEX.

(Synonyms in Italics.)

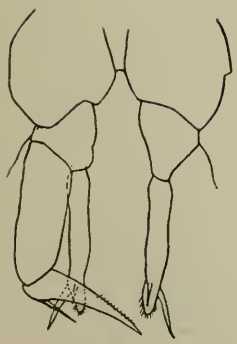
PLATE XXI.



1

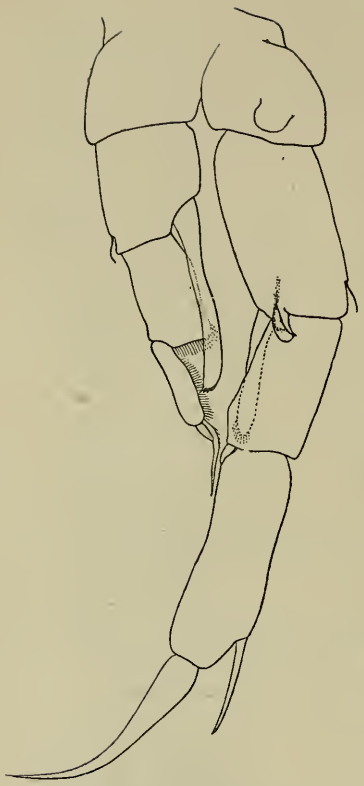


3

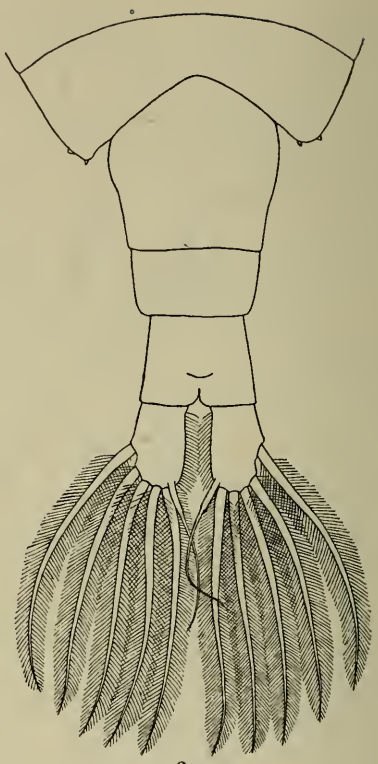


2

Plate XXII.



1



3

2

4

PLATE XXIII.

PLATE XXIV.

PLATE XXV.

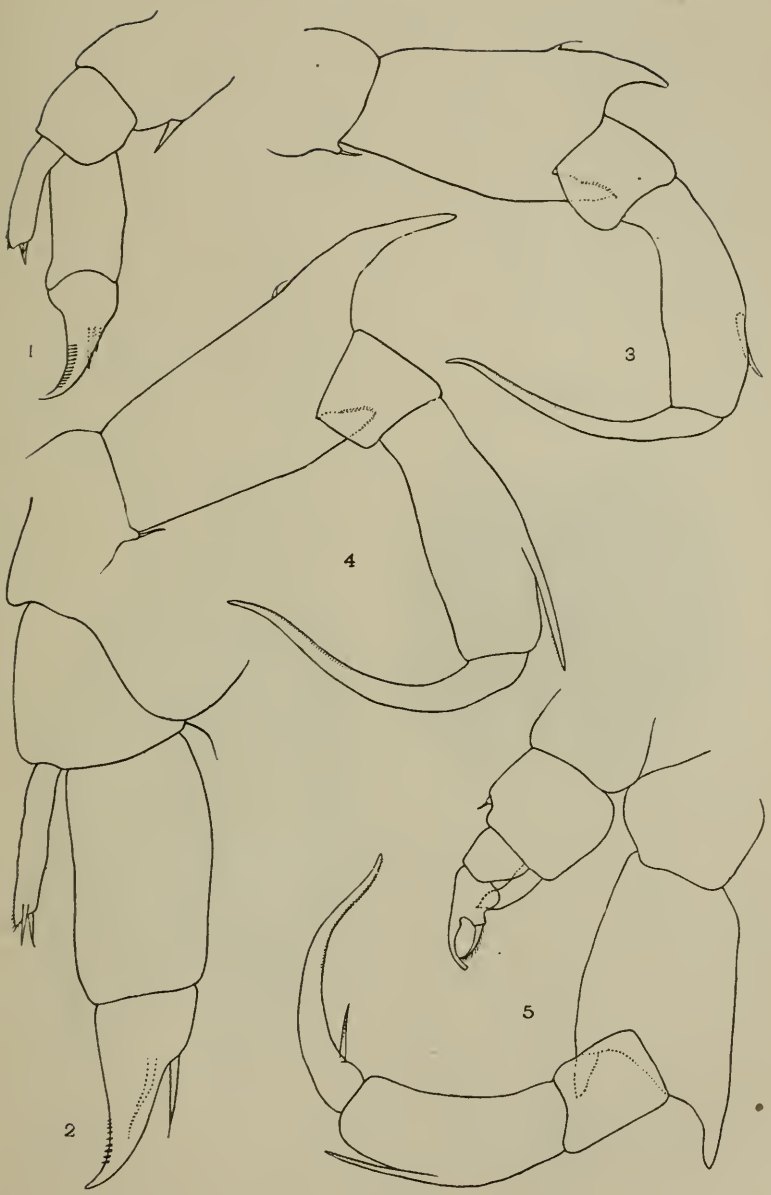
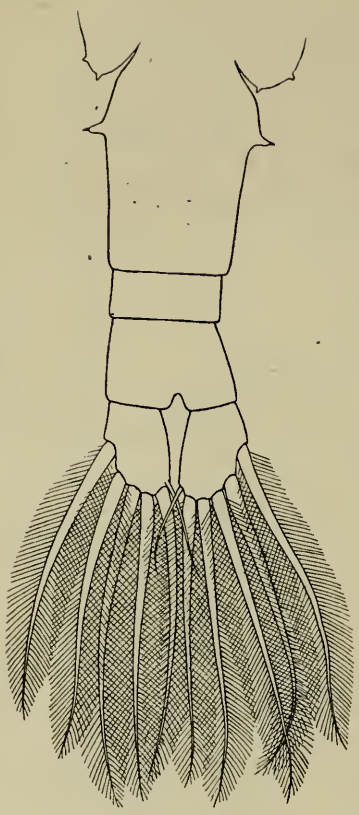
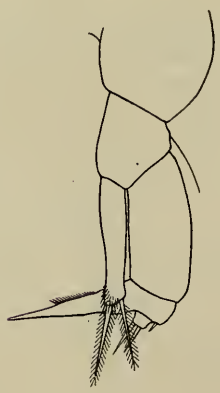


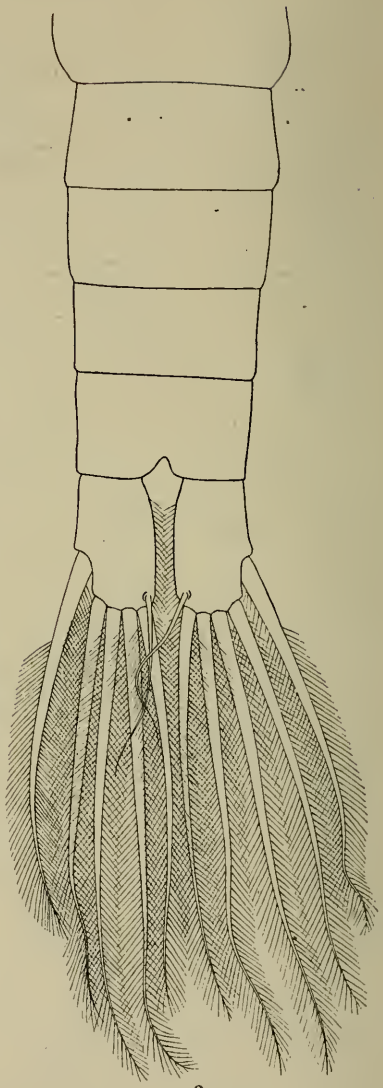
PLATE XXVI.



1

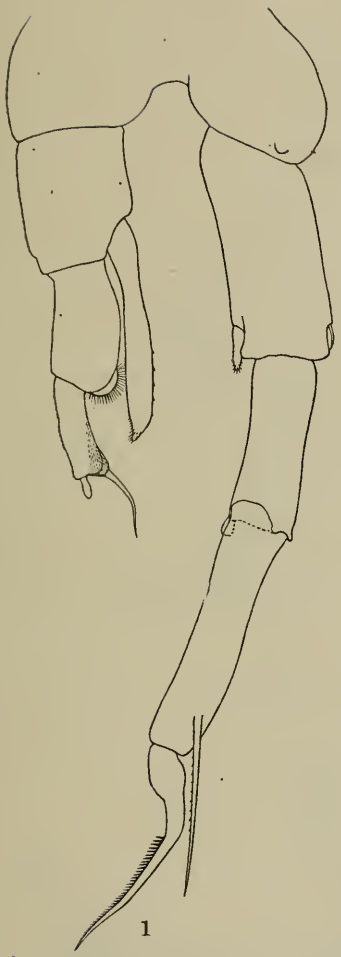


2



3

PLATE XXVII.



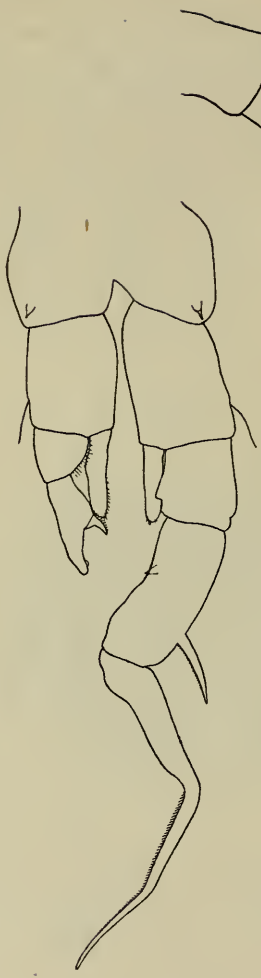
1

2

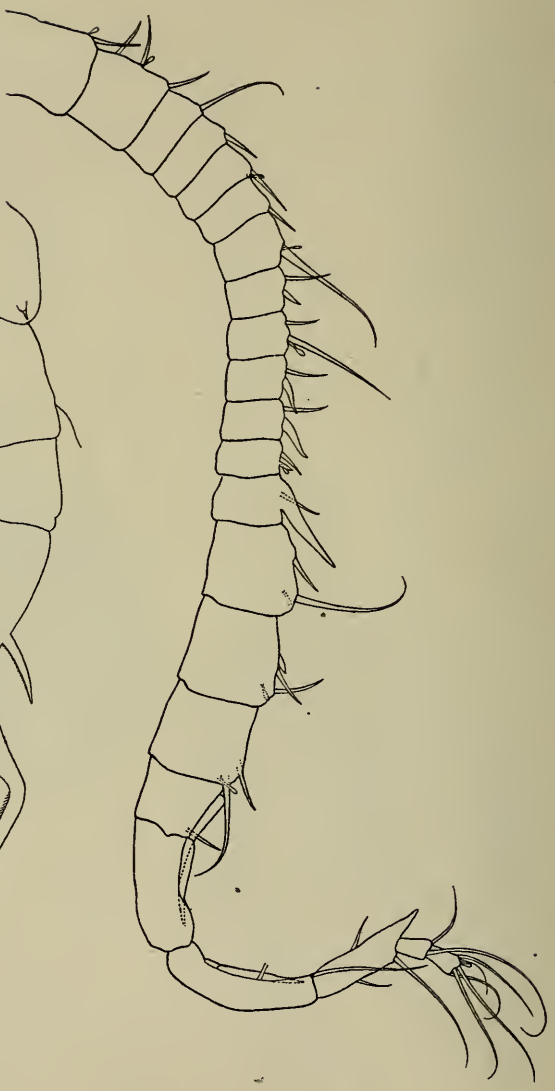
3

4

PLATE XXVIII.

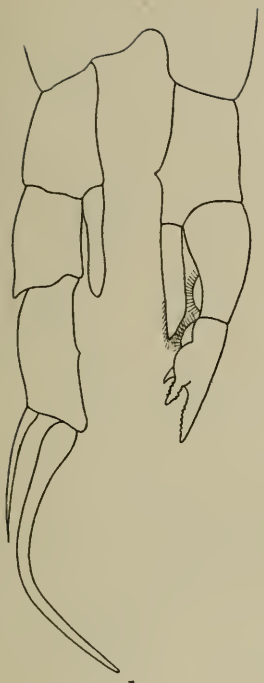


1



2

PLATE XXIX.



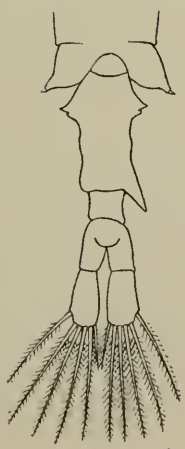
1

2

3

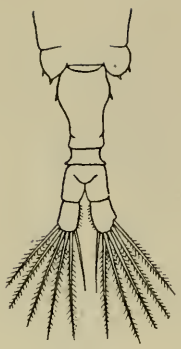
4

5



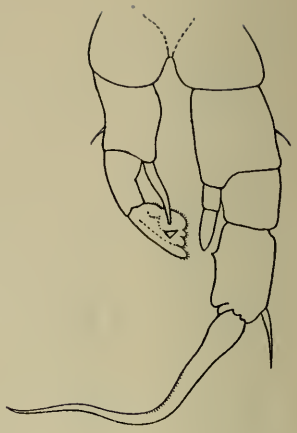
6

PLATE XXX.



1

2



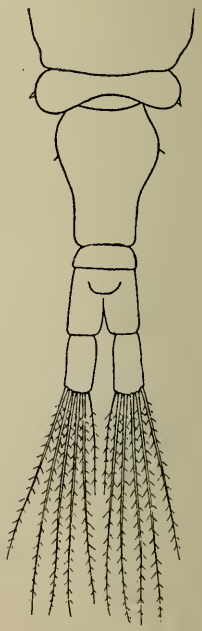
3

4

5

6

7

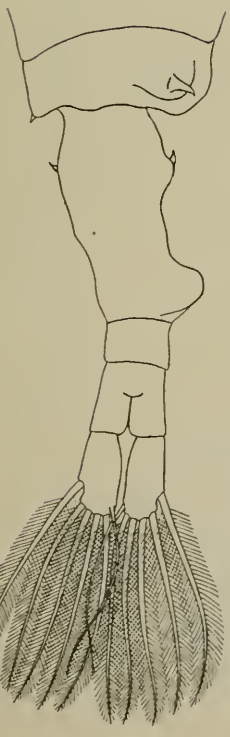


8

Plate XXXI.

1

2

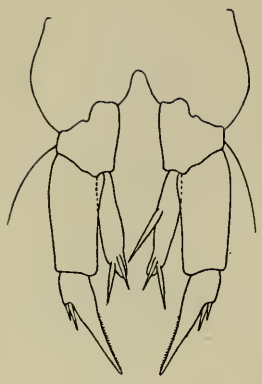


3

4

5

Plate XXXII.



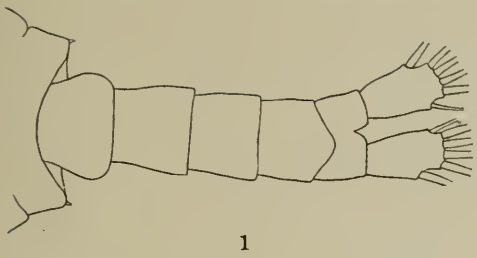
1

2

3

4

Plate XXXIII.



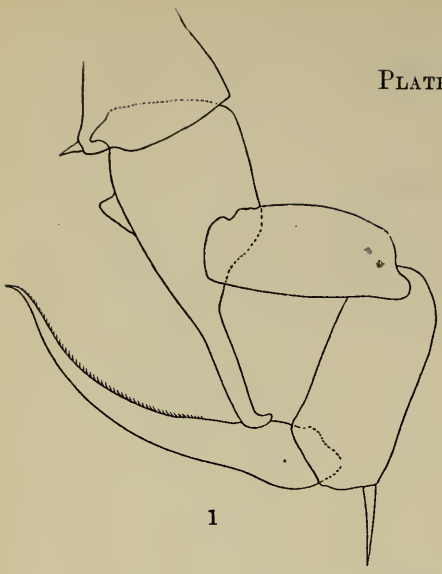
1

2

3

4

PLATE XXXIV.

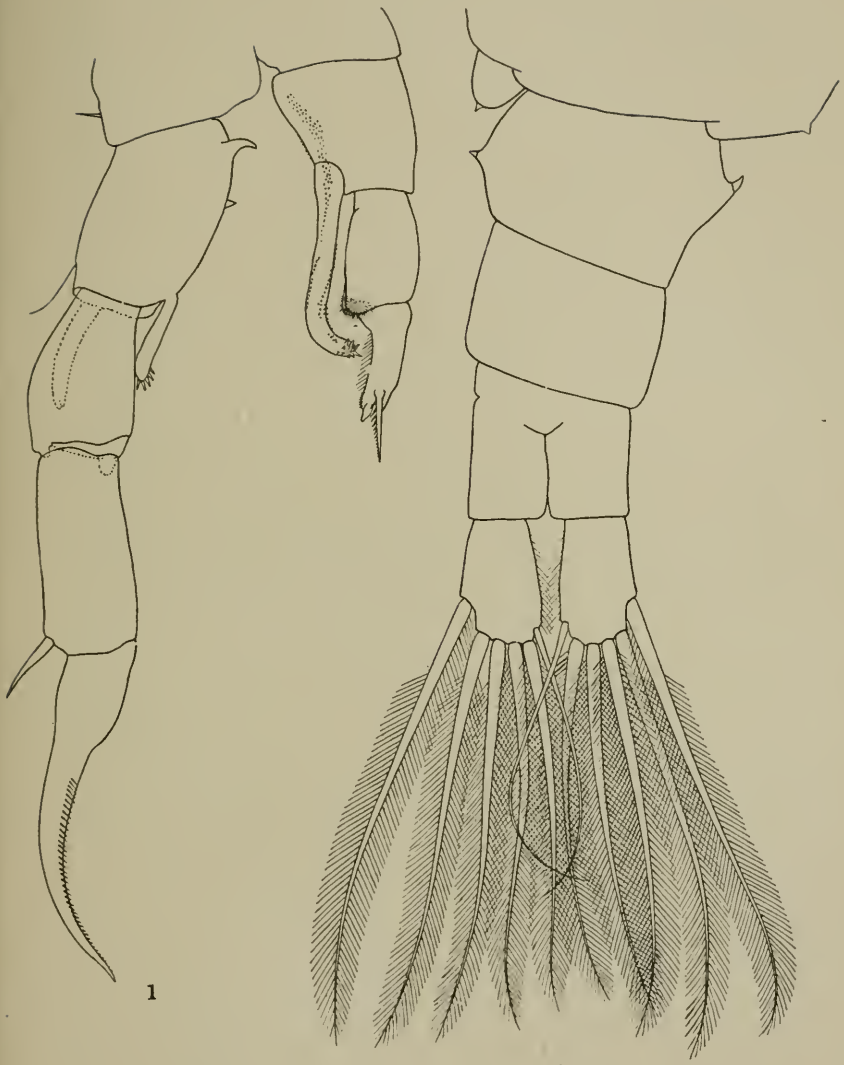


1

2

3

PLATE XXXV.



1

2