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No. 65 CONTRIBUTIONS TO THE COPEPOD FAUNA OF NEBRASKA AND OTHER STATES

BY A. S. PEARSE.

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WITH FIVE PLATES.

UNDER THE DIRECTION OF HENRY B. WARD.

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While various problems are taken up in the following paper, the chief one treated has been that of the geographical distribution of the Copepoda of Nebraska and adjacent territory. One hundred and ninety-five Birge net collections have been examined. These were from the following localities: Nebraska (168), Council Bluffs, Iowa (5), northeastern Colorado (4), Spokane, Washington (10), Ontario, Canada (11), Costa Rica (2). It will be seen that the majority of the material comes from Nebraska.

This state has great diversity of soil, water and other conditions which tend to modify the aquatic life. The surface slopes to the southeast and the altitudes range from an average of 5,000 feet on the west to 1,000 feet on the east. There are no bodies of water of great size or depth in the state. Some of the lakes in the northwestern part are a mile or more in length. Many of the ponds and lakes vary in size from year to year, depending largely upon the rainfall. The soil throughout the state is more or less sandy, grading from coarse sand and gravel in the west to fine silt in the east. In the center of the state it is blown about by winds and forms the shifting sandhills of that region. The collections from Council Bluffs, Iowa, and eastern Colorado are practically in Nebraska, as the former locality is only across the Missouri River, and the latter collections were made only a few miles over the state boundary.

The three Muskoka lakes (Ontario, Canada) form a chain about forty miles in length, and thirty miles wide. They are very deep, and the bottom is of solid granite. Mud lake is near Muskoka lake. It is about two hundred yards in diameter and has a mud bottom. This lake is filled with pond lilies, and other aquatic plants, and the shore is a thick carpet of bog moss.

Spokane, Washington, is separated from the other localities by two mountain chains. The collections from this place were made in and around the city, and were all from small pools. The material from Costa Rica was collected at altitudes of 8500 and 9500 feet.

The amount of work previously done upon the Copepoda of the western United States has not been large. Lilljeborg (de Guerne and Richard, 89) described eight new species of Calanidae from Oregon, California and Wyoming. S. A. Forbes (93) listed eight species (seven new) from the Yellowstone National Park. Schacht (97) described *Diaptomus clavipes* from Iowa and extended the range of other species. In the same year Brewer described *Diaptomus saltillinus* and listed sixteen other species from the vicinity of Lincoln, Nebraska. Beardsley (02) notes the occurrence of seven species in Colorado. The latest contribution was by C. D. Marsh, who described a new species of *Canthocamptus* (*idahoensis*) from Idaho. In the present paper the range of *Diaptomus oregonensis, D. sanguineus, D. saltillinus, Epischura lacustris, Cyclops edax, C. fuscus, Canthocamptus illinoiensis* have been significantly extended, and three new species have been described. The results for Nebraska agree with those of Brewer except in the case of *Diaptomus eiseni,* which he found once at Lincoln, and which was not present in any of the material examined in the preparation of this paper, although collections were made in the same pool and at the same time of year at which he collected. The writer is in doubt as to whether Brewer's species was *eiseni* or some new species.

The table showing the occurrence in the different months of the year is not complete, and several gaps could doubtless be filled by more careful collections for the winter months and July and August, when few dredgings were made.

Prof. A. E. Beardsley of Greeley, Colorado, kindly sent specimens of *Canthocamptus minutus* from that locality for examination. Dr. Wolcott gave the writer free access to his collections from Nebraska, Colorado and Costa Rica, and Dr. H. B. Ward loaned his collections and those of the University of Nebraska. The latter contained specimens from Nebraska and Washington. Dr. Ward has also given invaluable council and loaned literature without which the work would have been almost impossible.

Genus Diaptomus Westwood

Diaptomus sicilis Forbes

This species has not been before reported from Nebraska, although it is common in the north central states and the Yellowstone National Park. It was found in collections from Cherry county, in Dewey and Big Alkali lakes. (June, 1902.) It also occurred in the material from Muskoka lakes, Ontario.

Diaptomus sanguineus Forbes

This is a common species in Nebraska during the spring months. As Schacht has pointed out it is subject to striking variations. This species was common in one bottle of material from Spokane, Washington. This is the first record of its occurrence on the Pacific slope.

Diaptomus pallidus Herrick

This minute species is common in eastern Nebraska during the summer and early autumn months.

Diaptomus oregonensis Lilljeborg

One specimen was found in a dredging taken in Mud lake near Beaumaris, Ontario.

Diaptomus siciloides Lilljeborg

(Plate XIII, fig. 5; Plate XIV, figs. 7, 8)

This species was common in the collections from Lincoln, Omaha and Cherry county in Nebraska, and Council Bluffs in Iowa.

Diaptomus clavipes Schacht

(Plate XIII, fig. 6)

This large species was very common in the collections from eastern Nebraska and Council Bluffs, Iowa. Schacht's figure of the male fifth foot shows the characteristic hook in the proper position, but in his description he places this hook on the first segment of the outer ramus. In his description of the female fifth foot he notes the presence of two spines on the second segment of the outer ramus—"the outer more than twice as long as the inner." In his figure he shows the inner spine the longer. He also describes the inner ramus

of this foot as "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 half as long as the inner." In all the specimens here examined the second segment of the outer ramus in the female is armed with three spines, the inner one longest and plumose. The inner ramus is armed with several small thick spines and two long plumose spines, which are almost half the length of the ramus. These points agree with Brewer's description and figure of *D. nebraskensis* in every particular.

Diaptomus saltillinus Brewer

(Plate XIV, figs. 9, 10)

This species is apparently not common, as it occurs in only three of the dredgings; two from Lincoln and one from Stamford, Nebraska. The specimens agree with Brewer's description in every respect except the second joint of the outer ramus of female fifth foot, which he says is provided with "two small spines and a short seta." The specimens here examined are armed with a long and a short spine.

Diaptomus wardi n. sp.

(Plate XIII, figs. 1–4)

A rather large species one-fourth to one-third as wide as long. Cephalothorax rather stout and broadest about the middle; all the segments distinct, the first longer than the second and these two together making about one-half the cephalothorax. Lateral lobes of the last thoracic segment seen from above obtuse posteriorly and armed with a minute spine at the inner and outer angles. First abdominal segment shorter than the remainder of abdomen and broader than the following segments. Second segment of abdomen much shorter than third. Furcal rami short, about one and one-half times longer than broad, and ciliate on the inner margin in the male. (The number of specimens of the female was so few that no satisfactory examinations of the furca could be made.)

First pair of antennae reflexed extend about to the furca; composed of twenty-five articles. Ante-penultimate article of right male antenna provided with a long blunt process which surpasses the distal end of the ultimate article.

The outer ramus of the fifth pair of feet in the female three-seg-

mented, the third segment small but distinct and bearing two small spines. The basal segment bears a short thick spine at its outer distal angle. The unguiform process of the second segment of this ramus is rather arcuate, denticulate within and roughened on the outer margin. In addition to the two spines on the third segment this segment has a minute spine. The inner ramus is simple and almost equal to the first segment of the outer ramus, is ciliated at the apex, and bears two long equal spines.

Right fifth foot of male rather robust. The basal segment is provided with a small spinous process near its inner proximal angle. Second segment of the outer ramus short, being about one and one-fourth times as long as broad, and bearing the marginal spine at the distal angle. Terminal hook long, usually sigmoid, very minutely denticulate on the inner margin and tapering toward the apex. Inner ramus narrow and barely reaching the middle of the second segment of outer ramus, one-segmented and ciliate at tip.

The second segment of the left male fifth foot is triangular, and ends in a short obtuse process. The inner side is expanded, ciliated and a strong sharp spine projects a little below the middle of this margin. The inner ramus is simple, slender and ciliated at the tip.

Length of female, 2.16 mm.; of male, 1.60 mm.

This species resembles *D. franciscanus* Lilljeborg and *D. sicilis* Forbes. It differs from the former in the armature of the male antenna and the form of the male fifth foot. From the latter it differs in the structure of the female fifth foot, the size, and the shape of the male fifth foot. Both these species have two-jointed inner rami in the male fifth foot while in *D. wardi* they are simple.

The specimens upon which this description is based were from the collections of Prof. H. B. Ward, for whom the species is named, and were collected by Edward Butler at Spokane, Washington.

Genus EPISCHURA Forbes

Epischura lacustris Forbes

This species was present in small numbers in the material from Mud lake near Beaumaris, Ontario.

Genus Cyclops O. F. Müller

Cyclops leuckarti Claus

This species is apparently sparingly distributed throughout Nebraska. A few were also found in the material from Mud lake, Ontario.

Cyclops edax Forbes

A new species for Nebraska. It is apparently rare, as it occurred only once at South Bend. It was also present in the material from Muskoka lakes, Ontario.

Cyclops viridis var. *insectus* Forbes

As E. B. Forbes says (97) this is at best an unsatisfactory species and with further study other forms will perhaps be separated. All the specimens here examined agree with the characters ascribed to the variety, although all were preserved specimens, except those from Omaha, and the character of the receptaculum seminis was not distinguishable. This is by far the most abundant species in Nebraska, being found in almost every locality examined. It also occurred in the collections from northeastern Colorado; Muskoka lakes, Ontario; Council Bluffs, Iowa; and Spokane, Washington.

Cyclops biscuspidatus Claus

It seems rather strange that although this species was common at Lincoln none was identified at Omaha, where the number of dredgings was much greater. From the results in working over these collections it appears that it is of local occurrence, although it has a wide range. This species was also found at Council Bluffs, Iowa, which is only across the river from Omaha. In all these localities the nature of the pools examined was practically the same.

Cyclops fuscus Jurine

(Plate XIV, fig. 12)

A rare species, although it is probably found throughout the state.

Cyclops albidus Jurine

(Plate XIV, figs. 11, 13)

A very common species throughout the state. In two specimens examined the hyaline plate on the ultimate antennal segment was

found to be finely serrate throughout its entire length, except for a slightly deeper notch about the middle of the plate. All other specimens were as figured by Schmeil. This species was also present in the material from northeastern Colorado; Muskoka lakes, Ontario; laguna del Derrumbo, volcano Irazu, Costa Rica; and Council Bluffs, Iowa.

Cyclops serrulatus Fischer

This is a very common species in Nebraska, being found in almost every locality where collections were made. It also occurred at Wray and Laird, Colorado; Muskoka lakes, Ontario; Council Bluffs, Iowa; and in lakes on the volcano Irazu, Costa Rica.

Cyclops prasinus Fischer

This is not a common species and was found in only four dredgings, and those from three localities in Nebraska, although they represented the extreme eastern and western parts of the state.

Genus CANTHOCAMPTUS Westwood

Canthocamptus illinoisensis Forbes

(Plate XVI, figs. 22–27, 30)

This species was found on two different occasions among the filaments of Vaucheria sessilis in the springs north of Florence, Nebraska.

Canthocamptus staphylinoides n. sp.

(Plate XV, figs. 14–21)

This is a large species. The abdominal segments are nearly as wide as those of the cephalothorax, and are serrated, and armed with long spines on their posterior borders except on the dorsal side.

First antennae of female reflexed reach about to the end of the first segment of the cephalothorax, and are eight-segmented. The fourth segment bears a sense club which reaches to the middle of the penultimate segment and the ultimate segment bears another slender sense club at its tip. The male first antennae are eight-segmented, and the sense clubs are both slender. The club on the fourth segment reaches to the beginning of the ultimate segment and the one

at the tip is short, being about three-fourths the length of the ultimate segment. The appendage of the second antenna is two-jointed and bears four equal ciliated spines, three on the terminal segment and one on the basal segment.

The furca are two and one-half times as long as broad, and tapered so that the distal end is a little over one-half as wide as the proximal end. A long slender hair projects from the middle of the dorsal surface. There is another ventral one behind this and another on the outside just back of the last abdominal segment. There are also small spines on the inner and outer margins, and the ventral side. The anal plate is armed with strong spines.

The swimming-feet of the female all have both rami three-jointed, except the fourth pair which have a two-jointed inner ramus. In the male all the outer rami and the inner rami of the first and third feet are three-jointed. The process on the second segment of the inner ramus of the male third foot reaches one-third its own length beyond the distal end of the third segment. The third segment is armed with two ciliated spines, one about the same length as the process on the second segment and the other three times as long as this. The second segment of the inner ramus of the male fourth foot has at the apex a thick spinous process and two long spines; on the outer margin two shorter spines and on the inner margin three minute spines.

The basal segment of the female fifth foot is triangular and armed with six spines, all plumose and long, except the second from the outside, which is small. On the projection which bears the long hair-like process on the outside are also two small spines. The second segment is elliptical and three-fourths as wide as long. It is armed with five plumose bristles, the second from the interior being more than twice the length of any of the others. The inner one is the shortest. Besides these spines there are two bristles on the inner margin.

The basal segment of the male fifth foot is armed with one long and one short spine, both ciliated; two small bristles on the inner margin and two on the process which bears the long spine on the other side. The second joint is armed with six spines, all of which are plumose, except the second from the inside, which is small and naked. The third spine from the inside is longest and the inner one,

which is attached at the proximal third of the segment, has longer and more delicate cilia than the others.

The genital plate is armed with three spines. The inner one is ciliated and the longest of the three. The middle spine is shorter than the outer one.

Length: Female, 1.10 mm.; male, .90 mm.

Perhaps this species should be considered a variety of *C. staphylinus,* which it closely resembles, especially in the form of the fifth feet. It differs, however, from this species in the length of the sense clubs of the antennae, the anal plate, the inner ramus of the male third and fourth feet, the size, and the absence of the process on the last segment of the abdomen. After a careful comparison of specimens with the figures of Schmeil (93), and Lilljeborg (02) it has here been described as a new species.

This is Brewer's *C. minutus* and is the most common harpacticid in eastern Nebraska; it occurs also in the collections from St. Michael, Nebraska. It is named from its resemblance to the species referred to above.

Canthocamptus hiemalis n. sp.

(Plate XVI, figs. 28, 29; Plate XVII, figs. 31–42)

This is a rather robust species of medium size. The posterior dorsal margin of the last thoracic segment has a row of minute spines. All the abdominal segments are bordered posteriorly by a row of spines which are longest on the sides and minute on the dorsal and ventral surfaces. The furca are short, being one and one-fourth times longer than broad, and armed with spines at the inner and outer distal angles and with two long hairs, one at the middle of the outer margin and the other from center of the dorsal side. Of the two central stylets the inner is thrice the length of the outer. The anal plate is not armed with spines and has a long bristle projecting on each side.

The first antennae in both male and female are eight-segmented. The sense clubs on the female antennae are long, the one on the fourth segment reaching almost to the distal end of the ultimate segment and the one on the ultimate segment being as long as the last four segments. The sense club on the fourth segment of the male antenna reaches to the center of the ultimate segment and is very thick. The club on the ultimate segment is short, not being

as long as the last two segments. The appendage to the second antenna is two-segmented, the basal segment having one and the second segment three plumose spines.

The swimming-feet in the female all have two-segmented inner rami and three-segmented outer rami, except the first, which has both rami with three segments. In the male the second and fourth feet have two-segmented inner rami and three-segmented outer rami; and the first and third feet have both rami three-segmented.

In the fifth feet of the female the basal segment is twice as long as the second segment and bears six slender plumose spines, of which the fourth from the inside is the longest. The process on the outside is armed with three small spines in addition to the usual slender hairs. The second segment bears five spines, of which the second from the inside is longest. The two inner spines are ciliated; the middle one is naked and the two outer ones are ciliated on the outside.

In the male fifth foot the basal segment is only a little longer than the terminal one and is not quite twice as broad as long. It bears two ciliated spines; the inner of which is almost twice the length of the outer. There are three spines on the outside process of this segment. The second segment is armed with six spines of which the third from the inside is the longest. The inner spine is naked, the next one ciliated on the inside, the next ciliated on both sides and the outer three are ciliated on the outside.

The genital plate bears three spines. The inner is half the length of the outer, which is a little shorter than the middle one. The inner spine is much stronger than the other two.

Length: Female 0.77 mm.; male, 0.55 mm.

This species resembles *C. minutus* Claus. The material from which this description was made was collected at Child's Point near Bellevue, Nebraska, January 31, 1903, and although collections were made at this place on other occasions no specimen of this species was found.

KEY TO THE NORTH AMERICAN SPECIES OF CANTHOCAMPTUS, BASED UPON THE CHARACTERISTICS OF THE MALE

A. Fifth foot bearing four[1] spines on basal segment,
C. northumbricus var. *americanus.*

B. Fifth foot bearing three spines on basal segment, *C. illinoisensis.*

C. Fifth foot bearing two spines on basal segment,

a. Second segment of fifth foot slender (four times as long as broad) and bearing four spines and a bristle. *C. idahoensis.*

b. Second segment of fifth foot bearing six spines,

1. Spines on anal plate bifid, *C. minutus* (*C. minnesotensis* Herrick).
2. Anal plate without spines, *C. hiemalis.*
3. Spines on anal plate not bifid, *C. staphylinoides.*

[1] Herrick (95) says the fifth foot of the American form agrees exactly with the figures of Brady; then he figures the male fifth foot with three spines on the basal segment. He also says the first antennae are nine-segmented, but he figures them with eight segments.

GEOGRAPHICAL DISTRIBUTION AND OCCURRENCE IN DIFFERENT MONTHS OF THE YEAR

LOCALITY, MONTH	Canthocamptus hiemalis	Canthocamptus staphylinoides	Canthocamptus illinoisensis	Cyclops edax	Cyclops prasinus	Cyclops bicuspidatus	Cyclops viridis var. insectus	Cyclops fuscus	Cyclops albidus	Cyclops serrulatus	Cyclops leuckarti	Epischura lacustris	Diaptomus wardi	Diaptomus oregonensis	Diaptomus saltillinus	Diaptomus sicilioides	Diaptomus sanguineus	Diaptomus pallidus	Diaptomus clavipes	Diaptomus sicilis
Omaha, Nebraska		+			+		+	+	+	+						+	+	+	+	
Florence, Nebraska			+																	
Bellevue, Nebraska	+	+					+	+	+	+										
South Bend, Nebraska				+			+		+	+										
Weeping Water, Nebraska							+		+	+										
Ashland, Nebraska							+													
Lincoln, Nebraska		+				+	+		+	+					+	+	+	+		
Wayne, Nebraska							+				+						+			
Council Bluffs, Iowa						+	+		+	+						+			+	
St. Michael, Nebraska		+					+	+	+	+									+	
Swan lake, Holt county, Nebraska							+													
Stamford, Nebraska							+			+	+				+					
Orleans, Nebraska							+				+									
Cherry county, Nebraska					+	+	+		+		+					+				+
Hyannis, Nebraska							+		+											
Sioux county, Nebraska							+		+											
Wray, Colorado							+		+	+										
Laird, Colorado									+	+										
Muskoka lakes, Ontario, Canada				+			+		+	+	+	+		+						+
Spokane, Washington						+	+						+				+			
Volcano Irazu, Costa Rica									+	+										
January	●	●	●			●			●											
February																				
March																				
April		●			●	●	●		●	●			●				●	●		
May		●				●	●		●						●	●	●	●	●	
June					●	●	●		●	●	●					●	●			
July				●			●		●	●	●	●				●				●
August							●		●	●	●				●		●			
September		●		●			●	●	●	●	●					●		●	●	
October		●			●		●	●	●	●										
November							●		●	●										
December		●						●		●										

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EXPLANATION OF PLATES

Plate XIII

Fig. 1. *Diaptomus wardi.* Female fifth foot. × 365.
Fig. 2. *Diaptomus wardi.* Male left fifth foot. × 365.
Fig. 3. *Diaptomus wardi.* Male fifth feet. × 205.
Fig. 4. *Diaptomus wardi.* Terminal segments of male right antenna. × 205.
Fig. 5. *Diaptomus siciloides.* Female fifth foot. × 365.
Fig. 6. *Diaptomus clavipes.* Fifth foot, female.

Plate XIV

Fig. 7. *Diaptomus siciloides.* Male fifth feet. × 205.
Fig. 8. *Diaptomus siciloides.* Terminal segments of male right antenna. × 87.
Fig. 9. *Diaptomus saltillinus.* Female fifth feet. × 365.
Fig. 10. *Diaptomus saltillinus.* Terminal segments of male right antenna. × 365.
Fig. 11. *Cyclops albidus.* Terminal segments of female antenna. Lamina serrated the entire length. × 205.
Fig. 12. *Cyclops fuscus.* Terminal joint of female antenna. × 365.
Fig. 13. *Cyclops albidus.* Terminal joints of female antenna. × 365.

Plate XV

Fig. 14. *Canthocamptus staphylinoides.* Female, fifth foot. × 365.
Fig. 15. *Canthocamptus staphylinoides.* Spermatophore. Female. × 365.
Fig. 16. *Canthocamptus staphylinoides.* Male, fifth foot and genital plate. × 365.
Fig. 17. *Canthocamptus staphylinoides.* Anal plate and furca. × 205.
Fig. 18. *Canthocamptus staphylinoides.* Inner ramus of male, fourth foot. × 365.
Fig. 19. *Canthocamptus staphylinoides.* Inner ramus of male, third foot. × 365.
Fig. 20. *Canthocamptus staphylinoides.* Male, first antenna. × 205.
Fig. 21. *Canthocamptus staphylinoides.* Female, first antenna.

Plate XVI

Fig. 22. *Canthocamptus illinoisensis.* Anal plate, female. × 365.
Fig. 23. *Canthocamptus illinoisensis.* Inner ramus of third foot, male. × 365.
Fig. 24. *Canthocamptus illinoisensis.* Terminal segments of first antenna, male. × 365.
Fig. 25. *Canthocamptus illinoisensis.* Female, fifth foot. × 365.
Fig. 26. *Canthocamptus illinoisensis.* Genital plate. × 365.
Fig. 27. *Canthocamptus illinoisensis.* Male, fifth foot. × 365.
Fig. 28. *Canthocamptus hiemalis.* Female, first antenna. × 365.
Fig. 29. *Canthocamptus hiemalis.* Male, first antenna. × 365.
Fig. 30. *Canthocamptus illinoisensis.* Dorsal side of furca, female. × 365.

Plate XVII

Fig. 31. *Canthocamptus hiemalis.* Female, fifth foot. × 365.
Fig. 32. *Canthocamptus hiemalis.* Spermatophore. Male. × 365.
Fig. 33. *Canthocamptus hiemalis.* Male, fifth foot. × 365.
Fig. 34. *Canthocamptus hiemalis.* Anal plate, female. × 365.
Fig. 35. *Canthocamptus hiemalis.* Inner ramus of second foot, male. × 365.
Fig. 36. *Canthocamptus hiemalis.* Inner ramus of third foot, male. × 365.
Fig. 37. *Canthocamptus hiemalis.* Inner ramus of fourth foot, male. × 365.
Fig. 38. *Canthocamptus hiemalis.* Inner ramus of second foot, female. × 365.
Fig. 39. *Canthocamptus hiemalis.* Inner ramus of third foot, female. × 365.
Fig. 40. *Canthocamptus hiemalis.* Inner ramus of fourth foot, female. × 365.
Fig. 41. *Canthocamptus hiemalis.* Dorsal side of furca, female. × 365.
Fig. 42. *Canthocamptus hiemalis.* Genital plate. × 365.

PLATE XIII

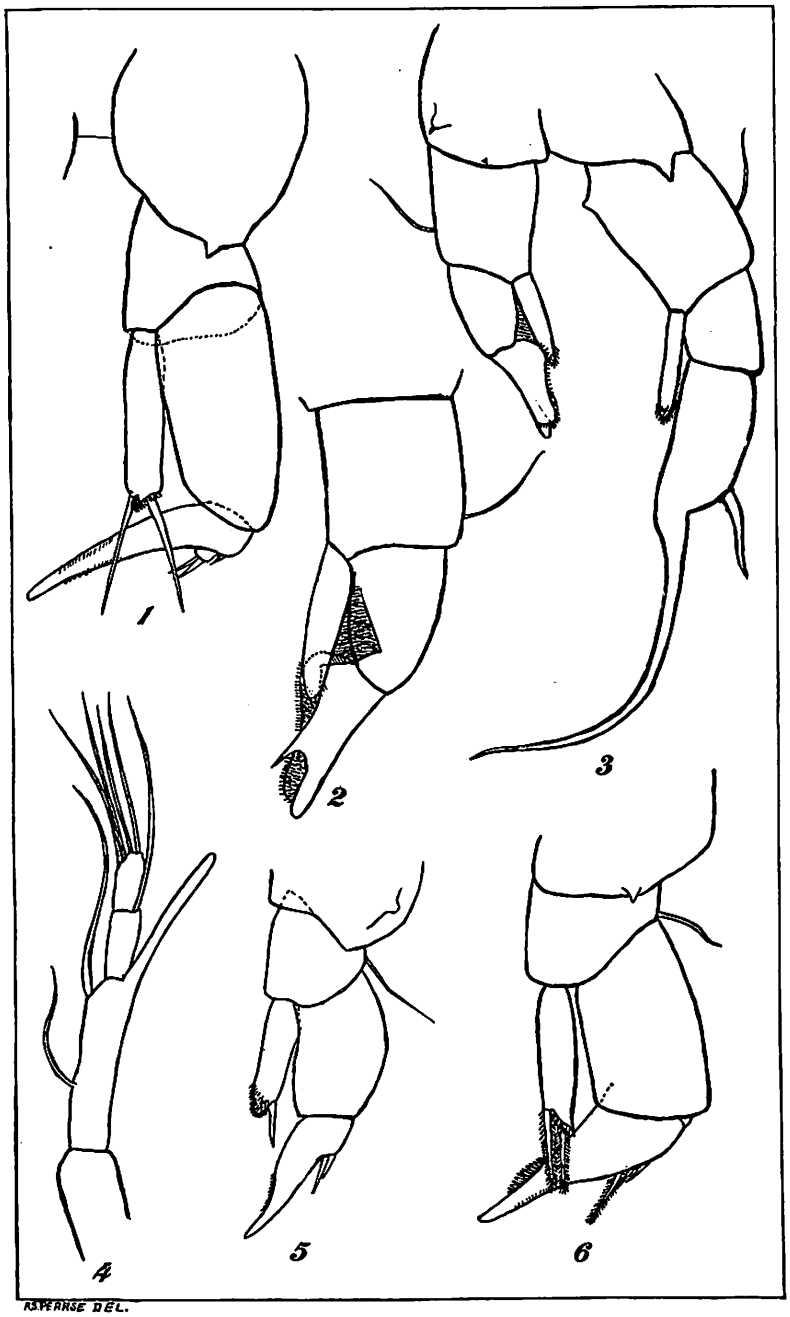


PLATE XIV

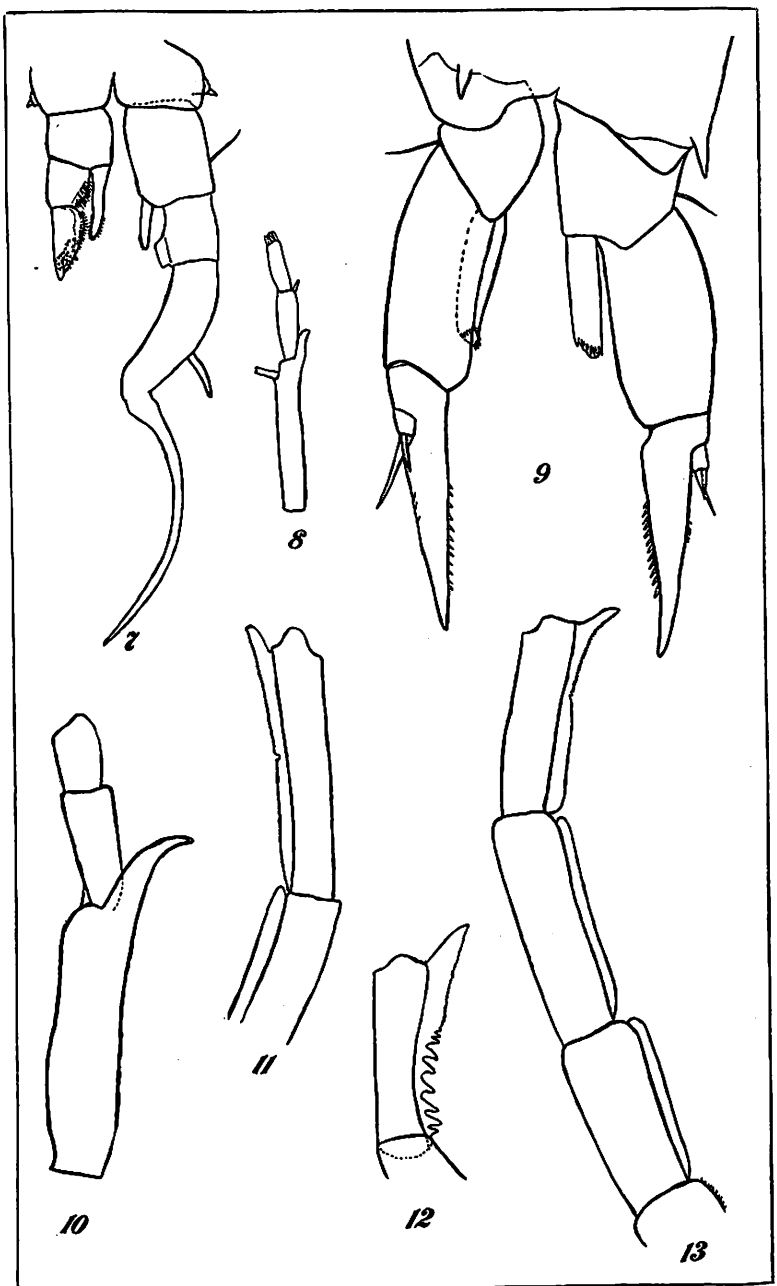
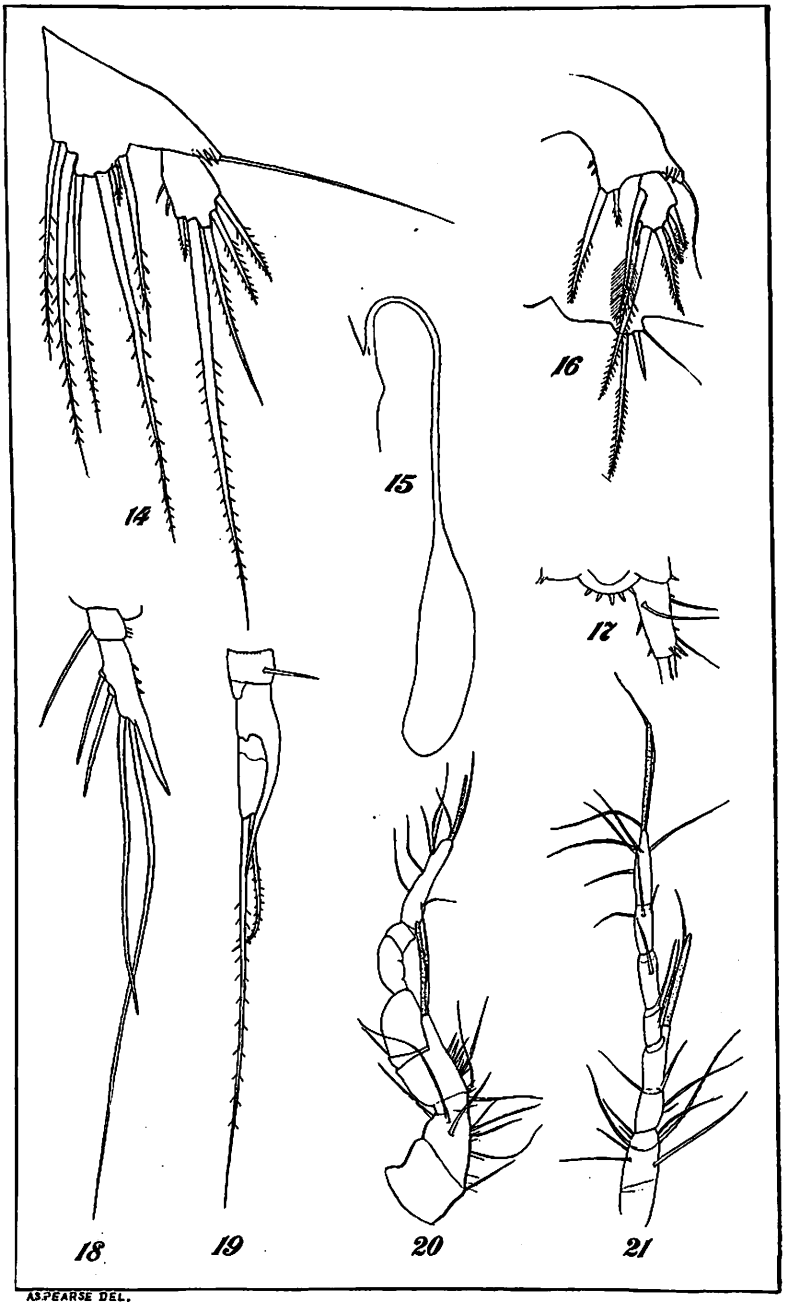


PLATE XV



ASPEARSE DEL.

PLATE XVI

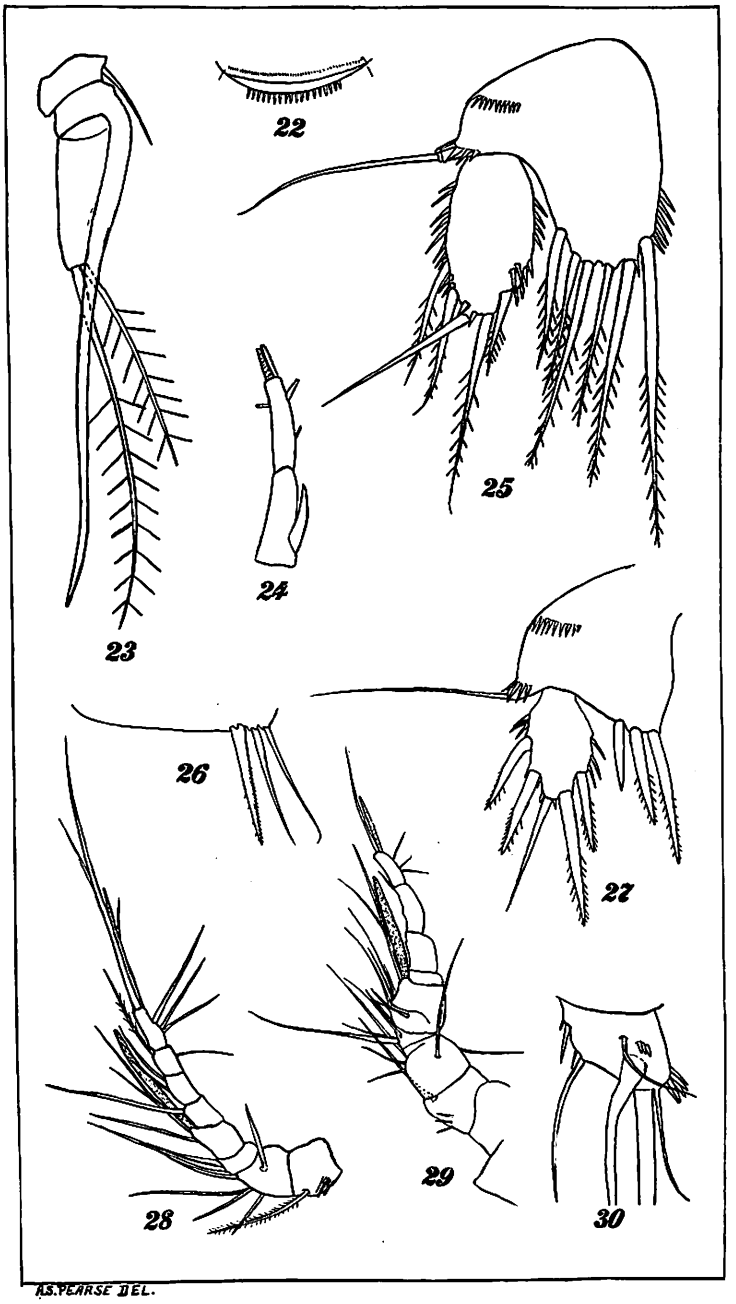
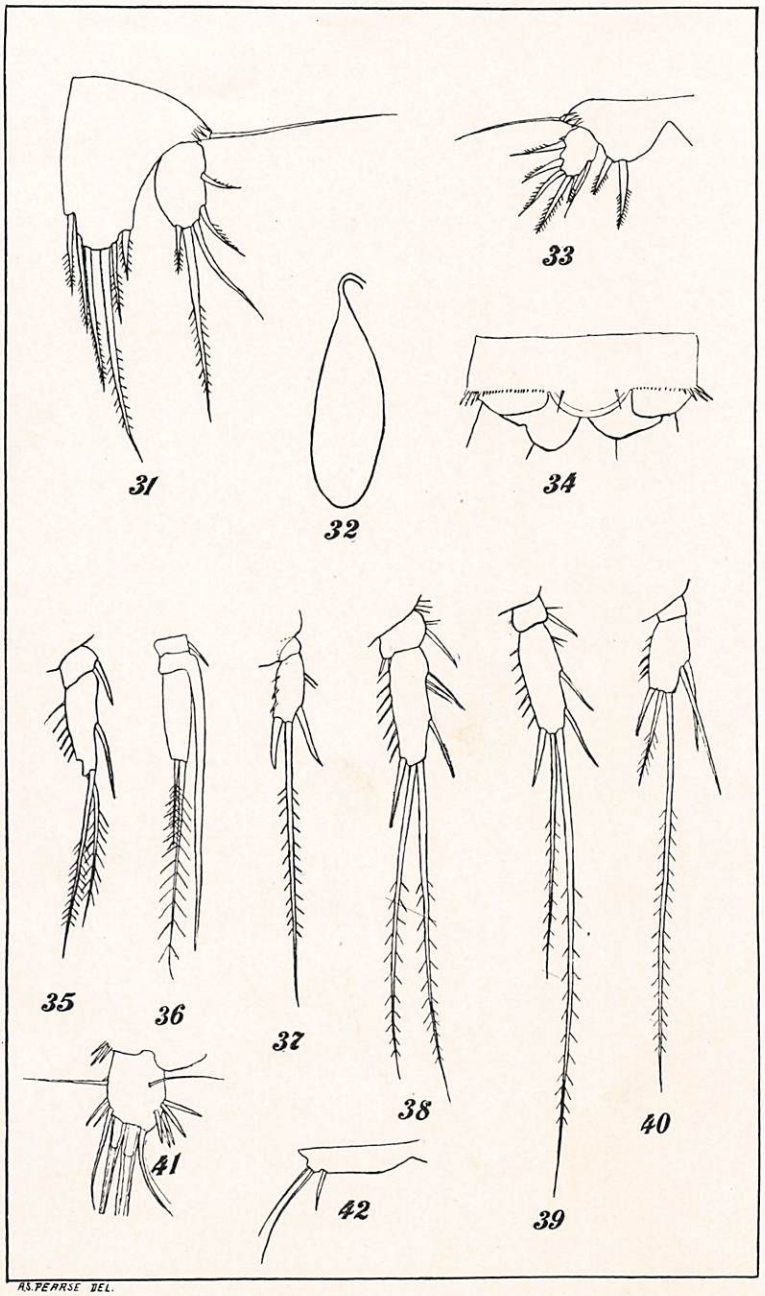


PLATE XVII



A.S. PEARSE DEL.