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The Fresh Water Copepoda of the Canadian Arctic Expedition 1913-18

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The collections of the Canadian Arctic Expedition were of especial interest from the standpoint of geographical distribution, as the localities included a region from which no previous collections had been made. Copepoda have been collected in Iceland, Greenland, Newfoundland, Alaska, and lakes in the province of Saskatchewan, but the region north of Saskatchewan is practically unexplored, so far as entomostraca are concerned. If it is assumed, as is generally done, that with the retreat of the ice of the glacial period, there was a migration towards the north of the species adapted to the conditions of cold water, we should expect to find, so far as North America is concerned, the more primitive forms in the arctic or sub-arctic regions. These forms might continue further south as a *fauna relictæ*, where altitude made a suitable environment, but where climatic conditions were radically changed, changes in structure would occur which might result in the formation of new species. That this has actually occurred in North America is very probable, as has been indicated in Marsh, 1907, pp. 384 and following. Therefore collections from an unexplored region of the northern part of the continent are of particular interest, and it is to be hoped that further collections can be made both in the Arctic and in the region immediately south, of which practically nothing is known.

All the specimens were collected by Mr. Frits Johansen, naturalist on the expedition, in various lagoons, ponds, and lakes along the Arctic coast; especially at the two winter headquarters of the expedition, Camden bay, Alaska, and Dolphin and Union strait, Canada. At the other places only shorter visits were made in the summer time.

Genus *Limnocalanus*.

Limnocalanus johanseni, n. sp.

Plate I, Figs. 1-8.

The first segment of the cephalothorax is nearly one-half the length of the cephalothorax. The front is armed with two projections. The last cephalothoracic segment is rounded on the sides and each side is armed with a small spine, which may be sharp, as in Pl. I, fig. 1, or blunted, as in Pl. I, fig. 2.

The abdomen of the female, Pl. I, fig. 3, consists of three segments: the first segment is somewhat expanded laterally and is about twice as long as the second; the third segment is slightly longer than the second. The branches of the furca are three times as long as wide and are about half again as long as the third segment; they are ciliated on their internal margins, and have the typical armature of setæ.

The male abdomen, Pl. I, fig. 4, consists of five segments, of which the first three are about equal in length; the fourth and fifth are somewhat shorter and about equal to each other. The length of the furcal branches is about three and one-half times the breadth, and about equals the two preceding segments. The furcæ are ciliated on the internal margins.

The antennæ of the female when reflexed reach the second abdominal segment. The cephalothoracic appendages of the female are like those of *L.*

macrurus. Pl. I, fig. 5, shows the first foot, and Pl. I, fig. 6 shows the fourth foot. Pl. I, fig. 7 shows the fifth foot of the female.

The left male fifth foot, shown in Pl. I, fig. 8, is like that of *L. macrurus*. The exopodite of the right male fifth foot consists of three segments; the second segment has the customary spinous prolongation from the inner distal angle, and a hook-like spine on the outer distal angle. The third segment, situated just within the outer spine, is one-third to one-half the width of the second segment, is digitate, curved towards the inner margin of the foot, pointed at the extremity, and bears upon its dorsal surface a curved spine. It is distinctly separated from the second segment by a joint.

Average length exclusive of furcal setæ: females 2.99 mm., males 2.6 mm.

This species was found only in the collections made at Collinson point, Alaskan Arctic coast, October 10, 1913, as a limnetic form under 10 inches of ice in a pond 4 feet deep on the coastal tundra. It is to be presumed that more extensive collections may show a wide distribution in the northern waters.

Limnocalanus johanseni is readily distinguished from *L. macrurus* by the much shorter furcal rami which are armed only with fine cilia on the inner border and not covered with small spines or coarse hairs as in the former species.

Four species of *Limnocalanus* have been described, *macrurus* Sars, *sinensis* Poppe, *sarsii* Daday, and *grimaldii* Guerne. *Sinensis* and *sarsii* are quite different from the other species in the structure of the male fifth feet, and Ekman (1905) has made the genus *Gigantella* for *sarsii*, while Burckhardt (1913) has proposed the genus *Sinocalanus* for *sinensis* with the species *sinensis* Poppe, *dörrii* Brehm, and *mystrophorus* Burckhardt. In *macrurus* and *grimaldii* the structure of the male fifth feet is almost the same and in both the third segment of the right exopodite is indicated by a small tubercle on the second segment. The existence of a distinct third segment in *johanseni* separates this species definitely from the others.

Genus *Eurytemora*.

Specimens of *Eurytemora* were found in the collections made at the following localities: Teller, Bering strait, Alaska, August 3, 1913; Martin point, Arctic coast of Alaska, July 28, 1914; Herschel island, Yukon territory, Canada, August 13, 1914; Bernard harbour, September 23, 1915; Bernard harbour, Oct. 6, 1915; Bernard harbour, Nov. 28, 1915; Bernard harbour, July 3, 1916; Bernard harbour, July 14, 1916. Most of the material was so immature that it was impossible to make specific determinations. In the collection of September 23, 1915, from a brackish pond 4 feet deep, at Bernard harbour, however, there was a large number of mature specimens of both sexes. It is from these that the following description is made.

Eurytemora canadensis, n. sp.

Plate I, figs. 9-12. Plate II, figs. 1, 2, 4, and 7.

FEMALE.—The cephalo-thorax is oval in outline, the greatest width being forward of the middle. The last segment extends backward somewhat on the sides of the first abdominal segment, but is not produced laterally; the outer border of this segment is armed with a few minute hairs. The outline of the cephalothorax is shown in Pl. I, fig. 9, and the outer border of the last segment in Pl. I, fig. 12. The first segment of the female abdomen, shown in Pl. I, fig. 11, is somewhat expanded laterally, being about a third wider in the middle than at the ends. The first and third segments are of about the same length, and are one and one-half times the length of the second. The furcal rami are slender, about equal in length to the first two abdominal segments, and are ciliate on both inner and outer margins, except on that part of the outer margin distad of the lateral seta; these hairs are not only on the margin, but are present on

the body of the furcæ. Pl. II, fig. 1 shows the furca enlarged. The antennæ have the typical structure of the genus and extend nearly or quite to the fourth cephalothoracic segment. The structure of the swimming feet is typical. Pl. I, fig. 10 shows the fourth foot. It is somewhat interesting that in the case of the individual from which this was drawn the companion fourth foot had five setæ on the terminal segment of the endopodite instead of the regular number, six. The second segment of the fifth foot has a seta about midway of its outer margin. The third segment is about one and a half times as long as the first and bears a long spine at about midway of its outer border and another at its outer distal angle; the inner distal angle is prolonged into an unguiform process, which projects at an angle of forty-five degrees with the axis of the segment; the distal border of this process is armed with a variable number of teeth, as many as eleven having been counted. The fourth segment is one-half as long as the third and bears a spine at its inner distal angle and a long terminal spine. Pl. II, fig. 2 shows the fifth foot.

MALE.—The form of the male cephalothorax is like that of the female, but is somewhat narrower and more elliptical than oval in outline. The cephalothoracic appendages, with the exception of the fifth feet, are those typical of the genus. The abdomen, Pl. II, fig. 4, is slender, the segments being about equal to each other in length. The furcal rami equal in length the three preceding segments; the inner margin is ciliate and the outer very sparsely so; the hairs are much finer than those on the female furca and are comparatively few in number; the fifth foot is shown in Pl. II, fig. 7. The right foot is distinctly four segmented. The left foot terminates in two finely ciliated prominences.

Length, exclusive of furcal setæ: males 1.95 to 2.1 mm., females 1.9 to 2.25 mm.

It is very probable that some of the immature forms collected in other localities belong to this species. The single individual collected at Herschel island, however, was not *E. canadensis*, and does not correspond to any other described species. In the absence of more material it does not seem wise to attempt a description of it.

Granting that the immature individuals were probably *E. canadensis*, it appears, from the fact that most of those collections were made earlier than this one of September 23, that this species matures in the late fall.

Hetercope septentrionalis Juday and Muttkowski.

Plate II, figs. 3, 5, 6, 8-13.

This species was described by Juday and Muttkowski in 1915, pp. 27-30, fig. 4, A, B, C, D, E, and F, fig. 5, A, B, and C, fig. 6, A and B, from material collected at St. Paul island, Alaska, and, as stated by them, undoubtedly differs from the species previously described. The forms collected by the Canadian Arctic Expedition differ only in certain minor details which should be considered as variations within species limits. The female abdomen is shown in Pl. II, fig. 3. The processes of the genital area of the first abdominal segment are described and figured by Juday and Muttkowski as "trilobate." The specimens examined in these investigations have shown much variability in the form of these processes. They have been found trilobate as shown in Pl. II, fig. 10, indistinctly trilobate as in Pl. II, fig. 11, and bilobate, as in Pl. II, fig. 12. In the fifth foot of the female shown in Pl. II, fig. 5, the teeth of the inner margin of the terminal segment are distinctly serrate.

The abdomen of the male is shown in Pl. II, fig. 6. The external spines of the right exopodite of the second foot are distorted, as in the figure of Juday and Muttkowski. This is shown in Pl. II, fig. 9. The spine of the first segment of the right exopodite is shown in Pl. II, fig. 13. The fifth feet of the male, shown

in Pl. II, fig. 8, differ from the preceding description only in the somewhat greater length of the right foot.

This species was collected in ponds on Herschel island, Yukon Territory, August 14, 1914, and again July 30, 1916.

Genus *Diaptomus*.

Diaptomus bacillifer Kölbel.

Plate III, figs. 1-5.

Up to the present time no species of *Diaptomus* found on the American continent has been considered identical with those of Europe or Asia. Therefore a good deal of care was used to make certain that the identification of this species was correct. The determination is based on the original description of Kölbel, 1884, supplemented by the later descriptions, especially those of Sars and Schmeil.

Kölbel gave as the length 1.5 to 2 mm. Sars, 1903, states that the female are 1.8 mm. and the males 1.4 mm. De Guerne and Richard, 1889, make the length from 1 mm. to 1.5 mm. Of the specimens of these collections, one set of four females averaged 1.31 mm. Another set of five females averaged 1.45 mm. Five males averaged 1.295 mm. These measurements correspond very well to those of the European individuals. In our specimens the antennæ extended to the end of the first abdominal segment and in some cases nearly reached the furca. Kölbel says that the antennæ reach "über die furca." DeGuerne and Richard make the antennæ almost reach the furca. Sars, 1903, says that the antennæ reach to about the middle of the genital segment, but Sars, 1898, says that the antennæ reach the end of the first abdominal segment. The last cephalothoracic segment is produced backward on the sides, and each wing is armed with two minute spines, as shown in Pl. III, fig. 1. The abdomen of the female, shown in Pl. III, fig. 2, in its general form corresponds very closely to the figure in Sars 1903. The first segment is longer than the remainder of the abdomen including the furcæ, is moderately dilated on the sides, decidedly dilated in front, and bears a small acute spine on each side, these spines ordinarily being slightly turned backward. The second segment of the abdomen, in our specimens, was about one-half the length of the third; these proportions differ slightly from those of the European specimens, but no more than what might be considered a reasonable variation; moreover, such measurements are never very exact. The furcal rami are nearly as long as the two preceding segments. Kölbel states that they are as long as the last segment and one-half the preceding; he also says that the furcal rami are ciliated on both the inner and outer borders; this was true of some of our specimens, but in others, as in the one figure in Pl. III, fig. 2, only the inner border was ciliated.

The fifth foot of the female, Pl. III, fig. 3, has a weak spine on the first basal segment, and a delicate seta on the second segment. The exopodite is three-segmented. The second segment bears a spine on its outer distal angle, and the third segment is terminated by two spines, the inner being somewhat the stouter. The endopodite is one-segmented in our specimens. In the figures of Kölbel, 1884, and Sars, 1903, it is two-segmented. In the figure of DeGuerne and Richard it is one-segmented. Apparently the endopodite may be either one or two segmented. The length of the endopodite is stated by Schmeil, 1893, to be variable. Sars, 1898, states that it is less than one-half of the first segment of the exopodite, and in 1903 he says that it is much shorter than that segment. In our specimens it was about one-half the length of the segment.

The appendage of the antepenultimate segment of the right antenna of the male is straight and about equals in length the penultimate segment. This

is shown in Pl. III, fig. 5. Schmeil, 1893, has shown that there may be much variation in the length of this appendage.

The male fifth foot is shown in Pl. III, fig. 4. The second basal segment of the right foot has the small lateral seta near the distal end of the segment; from about midway of the inner border projects a hyaline lamella, which extends over the central third of the segment. The first segment of the right exopodite is sharply produced at its outer distal angle. The second segment is not quite twice as long as its greatest width. The lateral spine is straight, acute, nearly as long as the segment, and placed just beyond the middle. The terminal hook is sickle-shaped and slender. Some authors say that there is a projection or spine on the dorsal surface of the second segment of the exopodite; this is shown by Kölbel, but not by Sars, 1903. Schmeil, 1893, says that it is variable, being sometimes present and sometimes absent. The second basal segment of the left fifth foot of the male has the small lateral hair well towards the end of the segment. At about the middle of the inner border is a small hyaline lamella, and from the inner distal angle extends distally a cuticular, tooth-like projection. The terminal segment of the left foot has a digitiform process and a curved spine. The endopodites are indistinctly two-segmented. Kölbel and Sars, 1903, say that the endopodites are one-segmented, but DeGuerne and Richard, 1889, in their figure, make them indistinctly two-segmented. DeGuerne and Richard state that the left endopodite of the male fifth foot is not separated by a joint, and the figure of Sars, 1903, shows the same condition. Kölbel, however, figures a joint, as does Sars, 1898.

It is in the structure of the second basal segments of the male fifth feet that we find the characteristics which are most diagnostic of this species of *Diaptomus*. They were not figured fully by Kölbel, but they appear in the later authors with a rather surprising lack of variability. This lack of variability is the more surprising because of the marked resemblance in the general structure of the male fifth feet in *D. bacillifer* Kölbel, *D. laticeps* Sars, *D. salinus* Daday, *D. acutilobatus* Sars, *D. wierzejskii* Richard, *D. hircus* Brady, and *D. similis* Baird, as defined by Richard.

D. bacillifer has been found in Scotland, Norway, many places in the Alps, Asia Minor, Syria, the Caucasus, India, Central Asia, Siberia, and in islands north of Siberia. It is a stenothermal cold-water form, and is found in the far north in bodies of water near the sea level, and farther south in lakes in the higher mountains.

In the collections of the Canadian Arctic Expedition it was found only in the gathering made on October 6, 1915, from a pond one foot deep a hundred feet above sea level on a ridge at Bernard harbour. Some *Diaptomi* collected on St. Paul island, Alaska, by Professor Parker, were sent to the author some time ago, and proved to be of this species. Apparently then, it encircles the world in the general neighbourhood of the Arctic circle, and probably will be found in many of the bodies of water in northern Canada. It seems strange that it has not appeared in the collections which have been made in Iceland and Greenland.

D. bacillifer has the distinction of having a wider distribution than any other species of the genus.

***Diaptomus arcticus*, n. sp.**

Plate III, figs. 6-9 and 13.

This large and conspicuous species is closely related to *D. shoshone*, so closely in fact, that it can only be distinguished from that species by details of the structure of the abdomen and fifth feet.

The first abdominal segment of the female is dilated laterally and in front and bears on either side a blunt spine. This is shown from the side in Pl. III, fig. 6. The antennæ equal in length the cephalothorax. In the fifth foot,

shown in Pl. III, fig. 8, the spine of the first basal segment is rather large. The second basal segment bears the customary lateral seta. The exopodite consists of three segments. The second segment bears a small spine at its outer distal angle; the hook is of the ordinary form. The third segment, which is distinctly separated from the second bears two spines. The endopodite is one-segmented, as long as the first segment of the exopodite, and is terminated with two rather long spines.

The antepenultimate segment of the right male antenna, shown in Pl. III, fig. 7, bears a nearly straight appendage, which is as long as the penultimate segment. In the male fifth foot, Pl. III, fig. 9, the spines of the first basal segments are small. The second basal segment of the right foot is about equal in length and breadth; it bears a minute hyaline cuticular appendage near its inner proximal angle, and near the inner distal angle a pronounced process which is serrate on its outer border. This is shown from the ventral side, enlarged, in Pl. III, fig. 13. The endopodites are two segmented. The left foot reaches nearly to the end of the second segment of the exopodite of the right foot.

Average length: females 3.08 mm., males 2.72 mm.

This was found in a collection from a pond on Herschel island, made on August 14, 1914.

The female can hardly be distinguished from *D. shoshone*. The only differences are the possibly heavier spines of the first segment of the abdomen and of the first basal segments of the fifth feet and the two-segmented endopodites of the fifth feet.

It is in the fifth feet of the male that the species distinction is made. The greater length of the left foot and the armature of the second basal segment of the right foot warrant us in separating *D. arcticus* from *shoshone*. Material of *D. shoshone* has been examined from Yellowstone lake, from Corona, Irwin, and Pike's peak, Colorado, from Nioche valley in the Wasatch mountains, Utah, and Lake McDonald, St. Paul's island, Alaska. In none of this material is shown the peculiar armature of the second basal segment of the male right fifth foot of *D. arcticus*; it may be noted, however, that in the specimens from Lake McDonald and Nioche valley there is, near the inner proximal angle of this segment a very minute cuticular ridge, which might be considered as a rudiment of the hyaline process found in *D. arcticus*. A constant structure in *D. shoshone*, too, is a small spine on the dorsal surface of the second segment of the exopodite at about one-third its length. This spine does not appear in *D. arcticus*.

D. wardi Pearse, is very closely related to these two forms. Juday and Muttikoswki, 1915, consider *D. wardi* a variety of *D. shoshone*, but until it is clearly shown that there are connecting forms, it would seem well to retain the species name. For the sake of comparison, the male fifth foot of *D. wardi*, from St. Paul island material, is shown in Pl. III, fig. 10. It differs from *D. shoshone* in having a distinct hyaline process near the proximal inner angle of the second basal segment, and in not having the spine of the dorsal surface of the second segment of the right exopodite, and it has no trace of the pronounced process of the inner distal angle of the second basal segment which is seen in *D. arcticus*.

Genus Cyclops.

Cyclops magnus, n. sp.

Plate III, figs. 11, 12 and 14. Plate IV, figs. 1 and 5.

This corresponds, in general structure, to others of the *viridis* type. The antennæ of the female equal in length the first segment of the cephalothorax. The abdomen is shown in Pl. III, fig. 11, and the furca enlarged, in Pl. III, fig. 14. The furca is finely ciliate on its inner border. The lateral seta is situated at three-fourths of the length of the furca. Of the terminal setæ the outer is two-

thirds the length of the furca, and the inner nearly as long as the furca. The receptaculum seminis is convex on its anterior margin. The spinous armature of the terminal segments of the exopodites of the swimming feet is represented by the formula 2, 3, 3, 3. Pl. III, fig. 12 shows a fourth foot. The first segment of the fifth foot is broad; the second segment is only slightly longer than broad, but varies somewhat in its relative dimensions; it is armed with a seta and a spine. This spine may be jointed, as in Pl. IV, fig. 1, or not separated from the segment, as in Pl. IV, fig. 5.

Length of female, exclusive of furcal setæ, 1.85 mm. to 2.4 mm.

This was found in collections from Collinson point, Alaska, made June 13, 1914, Bernard harbour, June 18, 1915; Cape Bathurst, Northwest Territories, Canada, July 26, 1916; Chantry island, Dolphin and Union strait, Canada, June 17, 1917.

Cyclops americanus Marsh.

Cyclops americanus was found in only one collection, that made in a water-hole on the tundra at Cape Bathurst, July 26, 1916, one of the collections in which *C. magnus* was also found.

DISCUSSION OF THE *viridis* GROUP.

It is not intended to enter into a detailed discussion of *viridis* and the allied species, but a brief statement should be made to justify calling *americanus* a species rather than a variety, and to show the necessity of adding another to the long list of names which have been applied to these forms. Schmeil, 1892 and 1898, brings all forms of this type under *viridis*. E. B. Forbes, 1897, in discussing American species, recognizes the species *viridis*, which includes *C. ingens* Herrick, with varieties *brevispinosis* Herrick, and *insectus* Forbes. Marsh, 1898, recognizes four varieties, *ingens* Herrick, *brevispinosus* Herrick, *parcus* Herrick, and *americanus* Marsh. *Americanus* Marsh is the *insectus* described by E. B. Forbes, and has the right of priority, as the original publication of *insectus* was in such form that the species could not be recognized. Chambers, 1912, from a study of the chromosomes, concluded that *C. viridis*, *C. americanus*, *C. parcus*, and *C. brevispinosus* should be considered as distinct species. The recent work of the author has lead him to think that it would be much more convenient to consider them as species and avoid the use of a trinomial nomenclature, for these forms have characteristic habitats, and it is yet to be shown that they actually grade into each other.

The differences between these species may be tabulated as follows:—

	Recep. sem.	Furca.	Sp. ter. seg. sw. ft.	Sp. ter. seg. fifth ft.
<i>C. viridis</i>	Ant. margin concave.	Ciliated.	2, 3, 3, 3	Not separated by joint.
<i>C. americanus</i>	Ant. margin convex..	Not ciliated..	3, 4, 4, 4	Separated by joint.
<i>C. parcus</i>	Ant. margin convex..	Not ciliated..	2, 3, 3, 3	Separated by joint.
<i>C. brevispinosus</i> ..	Ant. margin convex..	Not ciliated..	3, 4, 4, 4	Separated by joint.
<i>C. magnus</i>	Ant. margin convex..	Ciliated.	2, 3, 3, 3	Either with or without joint

It may be added that *brevispinosus* is a slender form, the spines of the swimming feet are unusually broad, the terminal segment of the endopodite of the fourth foot has a spine on its outer margin instead of the usual seta, and the outer terminal seta of the furca is reduced to a short broad spine.

The original description by Herrick of *ingens*, in 1882, shows a figure of the receptaculum seminis with a concave anterior border. This, with very

little doubt, makes it a synonym of *gigas* Claus, which was distinguished from *viridis* only by its size. E. B. Forbes considers *ingens* as synonymous with *viridis*. It might be assumed as probable that the form of the arctic collections which has been called *magnus* was *ingens* or *gigas*, but the form of the receptaculum seminis precludes this determination, and has made the use of a new name necessary.

Something might be said in regard to the use of the spines of the swimming feet in specific determinations. Schmeil considers these of no value because of what he considers their great variability. It is true that variations may be found. I have found in the same collection one with the formula for the terminal segments of the swimming feet 2, 3, 3, 3, and another 3, 4, 4, 4. I have even found an individual with the right fourth foot differing from the left; yet these variations are so rare that they may almost be considered as abnormalities. Practically all the individuals from a collection will have the same armature, and this condition is so constant as to characterize the collection. It is a characteristic to be reckoned with in any specific description.

It may be added that the true *C. viridis* appears to be very rare in America. It is not clear that Forbes had it at all. Chambers, 1912, states that he had it from Edgewater, N.J. In our collections the only positive evidence was from a collection near Green Bay, Wisconsin, and one from Polk county, Florida; these specimens were typical in the armature of the swimming feet and the form of the fifth foot and of the receptaculum seminis.

Of the forms of the type of *C. viridis*, *C. americanus* is the most widely distributed in America. *C. brevispinosus* is, for the most part, a limnetic form, found in the larger bodies of water. *C. parvus* is comparatively rare. It may be an open question whether *C. gigas* is found in America; it is very possible that the indentifications of *gigas* and *ingens* by other authors should be considered as giving localities for the proposed new species, *C. magnus*; Herrick's figures were not always accurate, and little attention was paid to the form of the receptaculum seminis by the earlier authors. Probably *C. magnus* will be found to be characteristic of the colder waters.

Cyclops strenuus Fischer.

Plate IV, figs. 2, 3, and 7.

This was, perhaps, the most common form of copepod found in the collections of the expedition. It was found at Cape Bathurst, July 26, 1916, and in collections made at Bernard harbour, July 4, 1915, November 28, 1915, February 28, 1916, May 6, 1916, May 21, 1916, May 26, 1916, and June 13, 1916. In the collections of February 28 and May 6, they were immature, but egg-bearing females were found in the collection of May 21.

This species is discussed in Marsh, 1912, and its synonymy indicated. Sars, 1913, has been published since the appearance of Marsh's paper, and in that work *C. abyssorum*, *C. lacustris*, and *C. scutifer* are separated from *C. strenuus*. The characteristics which separate these species from *C. strenuus* are difficult to recognize, and do not appear to have even varietal value. In the opinion of the present author these names should be considered as synonyms.

The specimens of this expedition correspond very closely, in structure, to those found in other localities. Pl. IV, fig. 2, shows the abdomen; Pl. IV, fig. 3, a furcal branch, and Pl. IV, fig. 7, a fifth foot.

The hyaline lamella of the terminal segments of the antennæ was not evident in these specimens. The cuticular ridge of the furca was not universally present. Moreover, the inner margin of the furca was ciliated in some individuals but not in others. The receptaculum seminis is of the typical circular form. Sars, 1913, states that the egg sacks are oval in form, while in the figure of Schmeil, 1892, they are elliptical. In the specimens of this expedition they were spherical.

The Cayuga lake specimens had spherical egg sacks. It may be noted that this is also true of *C. abyssorum* Sars. In all the individuals the formula for the spines of the terminal segments of the exopodites of the swimming feet was 3, 4, 3, 3.

The females from Bernard harbour which were measured varied in length, exclusive of the furcal setæ, from 1.625 mm. to 1.9 mm., thus not differing much from those found in the United States.

Although *C. strenuus* is widely distributed as a cold-water form, in Greenland, Europe, Asia, and Northern Africa, it had not been noted on the American continent until the publication by Marsh in 1912, pp. 249-253, where it is stated that it had been found in collections made by Dr. Evermann in Rock pond, Axton, N.Y. Brehm, 1911, and Stephensen, 1913, p. 76, reported it in Greenland. The author has also found it in a collection in the United States National Museum labelled as from "small, clear lake northern New York. From New York State Museum, through W. B. Van Name." He has also found it in collections from Cayuga lake, N.Y., and in the contents of fish stomachs collected in Oneida lake, N.Y. A revision of some of the notes on Green lake, Wisconsin, makes it probable that it is also an inhabitant of that body of water. Doubtless it is widely distributed in America, but is not, generally speaking, found in large numbers.

Cyclops vicinus Uljanin.

In a tundra pond at Collinson point on June 13, 1914, were collected a number of specimens of *Cyclops* which were at first called *C. strenuus*. It was noted, however, that while agreeing with *C. strenuus* in all other ways, the spine formula for the terminal segments of the exopodites of the swimming feet was 2, 3, 3, 3. This spine formula is true of *C. vicinus* Uljanin as described by Lillejeborg, 1901, and Sars, 1913. The other differences as pointed out by these authors, appear to be only variations. Schmeil, 1892, says that the spine formula of *C. strenuus* may be 3, 4, 3, 3, or 2, 3, 3, 3, or 3, 3, 3, 3. Schmeil, too, as remarked before, has stated that he does not consider the spinous armature of the swimming feet as sufficiently constant so that it may be considered a diagnostic characteristic of a species. In the author's experience, however, while there has been found some variation in this spinous armature, in the collections from any given locality, the number of spines has been found practically constant. In all the specimens of the *strenuus* type examined from the Collinson point collection the formula was 2, 3, 3, 3; while in all the specimens from Cape Bathurst and Bernard harbour the formula was 3, 4, 3, 3.

C. kolensis Lillj. and *C. miniatus* Lillj. have the same spine formula for the swimming feet as *C. vicinus*, and the author can see no good reason for separating them from *C. vicinus*.

Cyclops capillatus Sars.

Plate IV, figs. 4, 6, 8-11.

1863.	<i>Cyclops capillatus</i>	Sars, pp. 248-9.
1884	"	Herrick p. 156.
1895	"	Herrick and Turner, p. 115.
1898	"	Schmeil, p. 152, Pl. XIII, fig. 1.
1901	"	Lillejeborg p. 54, Pl. IV, figs. 1-4.
1913	"	Sars, pp. 43-4, Pl. XXIV.

This species was first described by Sars in 1863, and practically all the published knowledge of the form is in the works of Sars and Lillejeborg. Herrick and Herrick and Turner simply republished the Latin description given by Sars, and stated that the species occurred only in Scandinavia. Schmeil figures the fifth foot, and, in a few words confirms the identity of the species.

It has been found only in Scandinavia, in bodies of water in the north of Sweden, and in lakes north of Kristiania, in Norway. Lilljeborg states that it is mostly found in small bodies of water, and is rare. In the collections of the Canadian Arctic Expedition it occurred in only one locality, a lake at Konganevik (Camden bay), Arctic Alaska, in a gathering made June 26, 1914. Only a few individuals were found.

The correspondence with the descriptions of Sars and Lilljeborg was very close. The antennæ, shown in Pl. IV, fig. 9, are composed of twelve segments, and about equal in length the first cephalothoracic segment. In the abdomen, shown in Pl. IV, fig. 4, the second, third, and fourth segments nearly equal each other in length, and together are somewhat shorter than the first segment. The branches of the furca, Pl. IV, fig. 10, are five times as long as broad and the lateral seta is placed just distad of the middle. The last abdominal segment is armed on its posterior border with fine spines. The formula for the spines of the terminal segments of the exopodites of the swimming feet is 3, 4, 4, 4. The fifth foot, Pl. IV, fig. 8, resembles that of the *viridis* group, but the second segment is shorter and cylindrical; its length and width are about the same. The form of the receptaculum seminis is shown in Pl. IV, fig. 11.

The length of the females measured varied from 1.55 mm. to 2.55 mm. In the original description in 1863 Sars states the length as about 2 mm., and Lilljeborg, in 1901, says the length of the females is from 1.8 to 2.1 mm.

This species is readily distinguished by its short 12-segmented antennæ, its elongated furca with the lateral seta about midway of its length, the fifth foot, and the receptaculum seminis.

The finding of this species is of a good deal of interest, for it has hitherto been known only from Scandinavia, and there was a rare form. It may be expected that future collections will show that it occurs in the lands intervening between the Scandinavian peninsula and the Arctic shore of North America.

DISCUSSION OF THE COPEPOD COLLECTIONS WITH REFERENCE TO DISTRIBUTION.

Of the species of these collections, *C. americanus* is very widely distributed, and its occurrence in the Arctic has no significance. *C. magnus* is probably a cold-water form.

The genus *Eurytemora* is widely distributed in brackish water. It is interesting that it was found in a new species.

The only account published previously of the presence of the genus *Heterocope* in America, was by Juday and Muttkowski in their description of *H. septentrionalis*, and it would appear that it may be rather widely distributed across the American continent. In Europe, and Asia the genus is found most commonly towards the north and in larger bodies of water, but it extends to central Europe.

Limnocalanus macrurus is the only species of this genus which has hitherto been found on the American continent. Brehm, 1911, also reports *L. macrurus* in Greenland. It will be interesting from future collections to find out how widely *L. johanseni* is distributed.

Diaptomus bacillifer is new to America, and, as already stated, while distinctly a cold-water form, is probably the most widely distributed species of the genus.

Diaptomus arcticus is a new form very closely related to *D. shoshone* and *D. wardi*, and it will be interesting to know the geographical limits of the three species.

The occurrence of *Cyclops strenuus* on the borders of the Arctic ocean, with the former records of its presence in lakes in New York, makes it probable that it may be found anywhere in North America north of the latitude of New York.

Cyclops vicinus is new to America, but very likely will be shown to have the same distribution as *C. strenuus*.

Cyclops capillatus has before this only been known from Scandinavia.

Taking the material as a whole, it is noticeable that it bears a striking resemblance to the fauna of northern Europe and Asia, but that the two faunas are not identical. Even in the circumpolar regions, the entomostracan fauna of the eastern and western continents are differentiated from each other. This is due, doubtless, to the lack of continuity in land surfaces, for, as shown elsewhere, copepods are largely dependent on water carriage for their distribution, so that fresh water copepods will be limited in their distribution to the opportunities offered by contiguous bodies of fresh water.

SUMMARY OF LOCALITIES OF COLLECTIONS.

(ARRANGED FROM WEST TO EAST.)

Teller, Alaska.

Eurytemora sp.

Camden bay (Konganevik, Collinson point), Martin point, Alaska.

Limnocalanus johanseni, n. sp.

Eurytemora sp.

Cyclops magnus, n. sp.

Cyclops vicinus Uljanin.

Cyclops capillatus Sars.

Calocalanus sp.

Canthocamptus sp.

Herschel island, Yukon Territory.

Eurytemora sp.

Diaptomus arcticus, n. sp.

Cyclops magnus, n. sp.

Heterocope septentrionalis Juday and Muttk.

Cape Bathurst, Northwest Territories.

Cyclops magnus, n. sp.

Cyclops americanus Marsh.

Cyclops strenuus Fischer.

Bernard Harbour, Northwest Territories.

Eurytemora canadensis, n. sp.

Diaptomus bacillifer Kölb.

Cyclops magnus, n. sp.

Cyclops strenuus Fischer.

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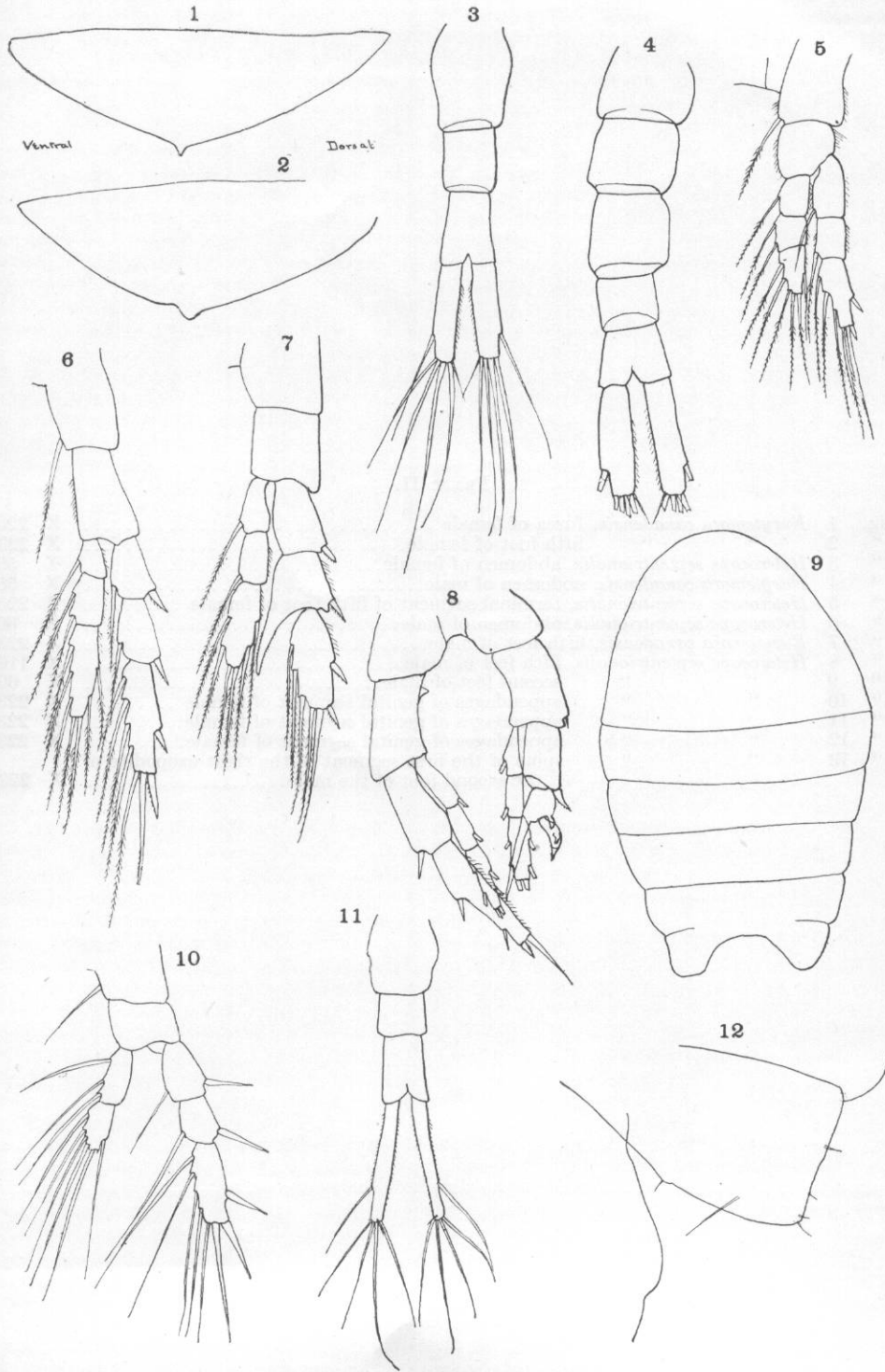
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PLATE I.

Fig. 1	<i>Limnocalanus johanseni</i> ,	last segment of cephalothorax.....	X	223
" 2	"	last segment of cephalothorax.....	X	223
" 3	"	abdomen of female.....	X	55
" 4	"	abdomen of male.....	X	55
" 5	"	first swimming foot of female.....	X	110
" 6	"	fourth " ".....	X	110
" 7	"	fifth foot of female.....	X	110
" 8	"	fifth feet of male.....	X	110
" 9	<i>Eurytemora canadensis</i> ,	cephalothorax of female.....	X	55
" 10	"	fourth foot.....	X	223
" 11	"	abdomen of female.....	X	55
" 12	"	angle of last segment of cephalothorax of female.....	X	223

PLATE I



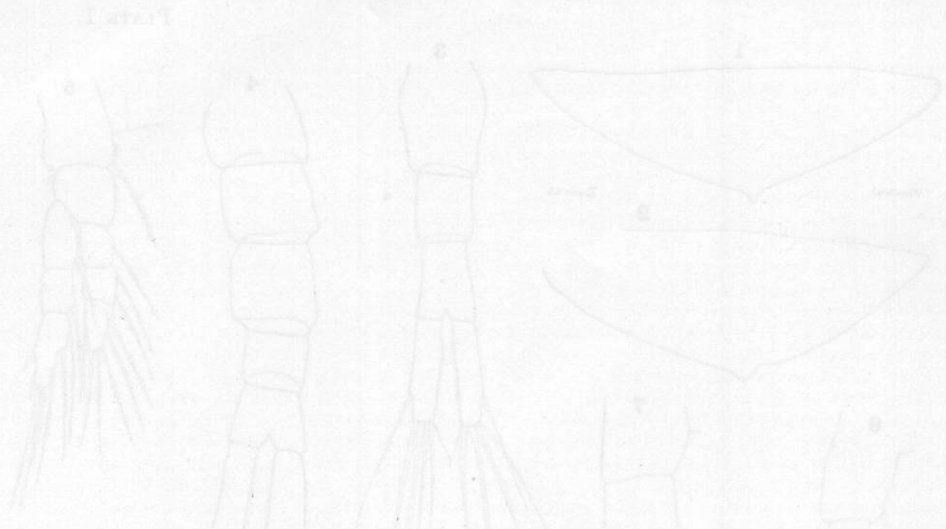


PLATE II.

Fig. 1	<i>Eurytemora canadensis</i>	furca of female.....	X	223
" 2	"	fifth foot of female.....	X	223
" 3	<i>Hetercope septentrionalis</i>	abdomen of female.....	X	55
" 4	<i>Eurytemora canadensis</i>	abdomen of male.....	X	55
" 5	<i>Hetercope septentrionalis</i>	terminal segment of fifth foot of female.....	X	223
" 6	<i>Hetercope septentrionalis</i>	abdomen of male.....	X	60
" 7	<i>Eurytemora canadensis</i>	fifth feet of male.....	X	223
" 8	<i>Hetercope septentrionalis</i>	fifth feet of male.....	X	110
" 9	"	second feet of male.....	X	60
" 10	"	appendages of genital segment of female.....	X	223
" 11	"	appendages of genital segment of female.....	X	223
" 12	"	appendages of genital segment of female.....	X	223
" 13	"	spine of the first segment of the right exopodite of the second foot of the male.....	X	223

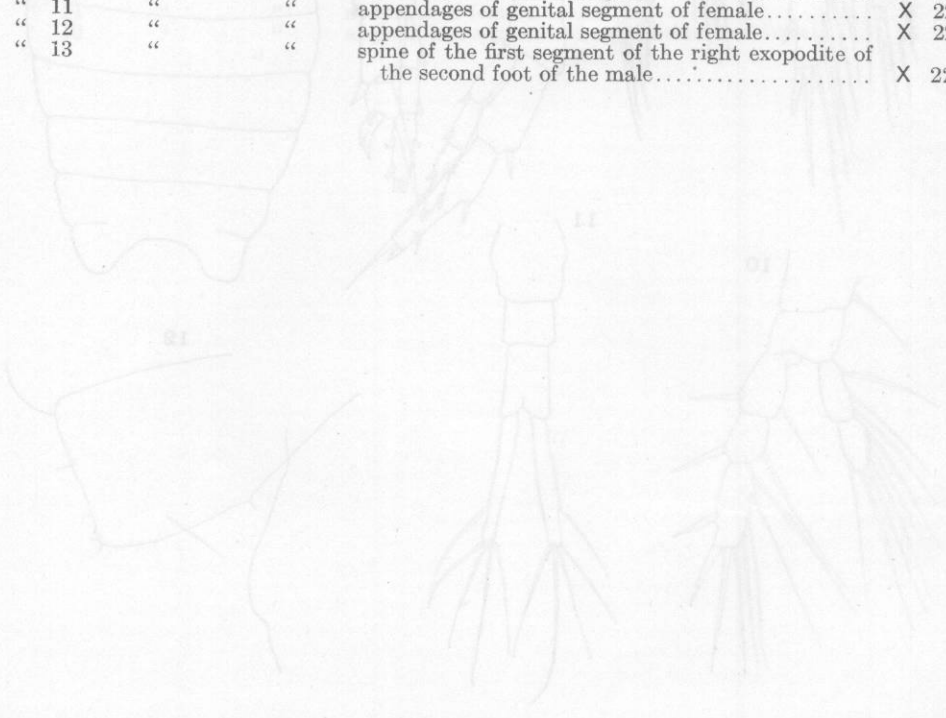


PLATE II.

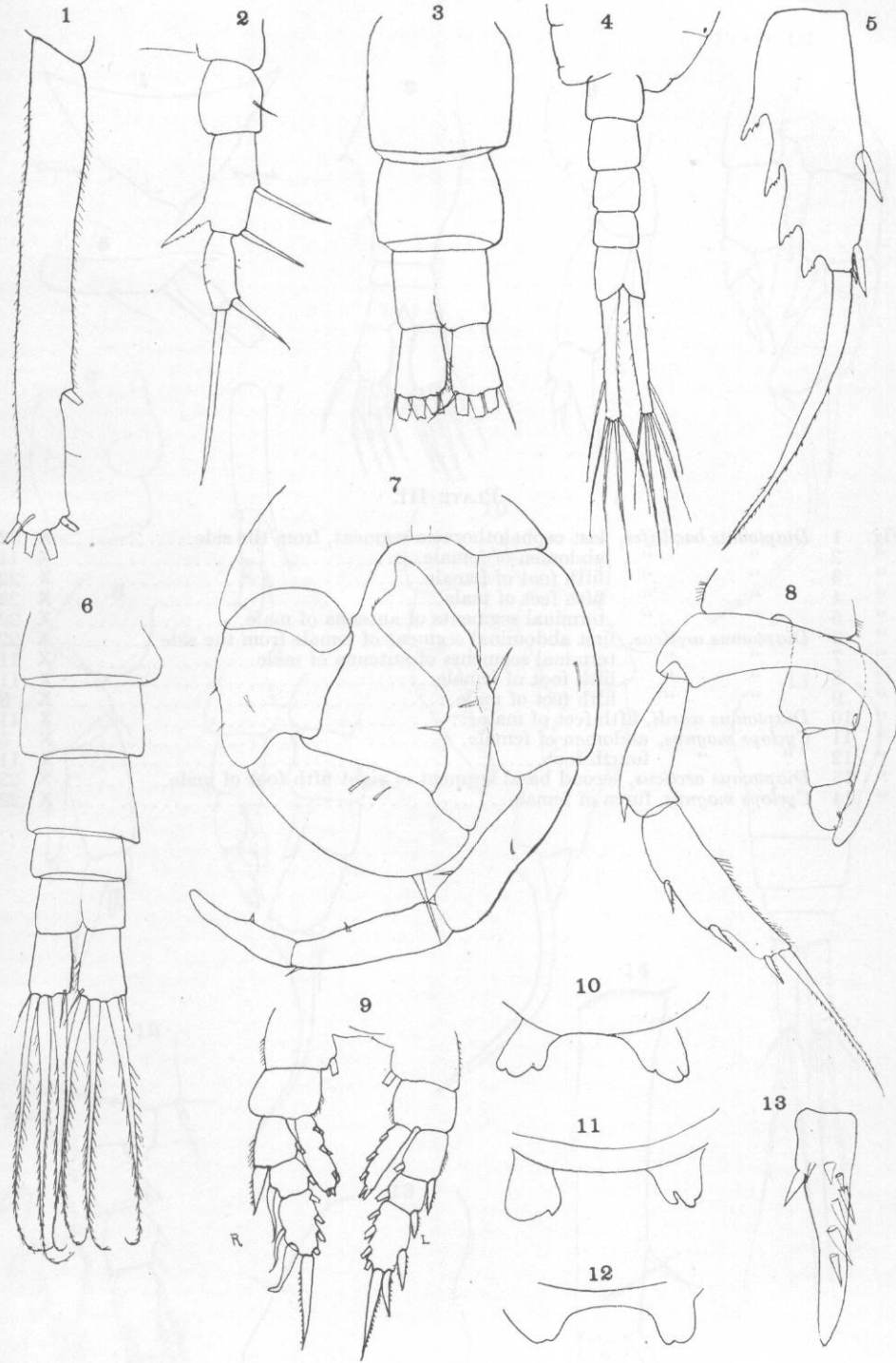


PLATE II.

Fig. 1	<i>Eurytemora canadensis</i> , furca of female.....	X	223
" 2	" " fifth foot of female.....	X	223
" 3	<i>Heterocope septentrionalis</i> , abdomen of female.....	X	55
" 4	<i>Eurytemora canadensis</i> , abdomen of male.....	X	55
" 5	<i>Heterocope septentrionalis</i> , terminal segment of fifth foot of female.....	X	223
" 6	<i>Heterocope septentrionalis</i> , abdomen of male.....	X	60
" 7	<i>Eurytemora canadensis</i> , fifth feet of male.....	X	223
" 8	<i>Heterocope septentrionalis</i> , fifth feet of male.....	X	110
" 9	" " second feet of male.....	X	60
" 10	" " appendages of genital segment of female.....	X	223
" 11	" " appendages of genital segment of female.....	X	223
" 12	" " appendages of genital segment of female.....	X	223
" 13	" " spine of the first segment of the right exopodite of the second foot of the male.....	X	223

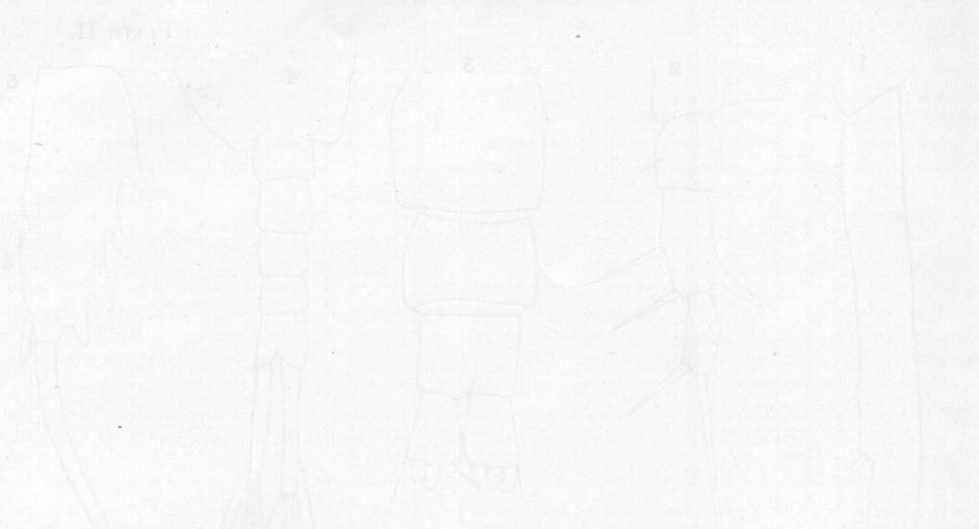
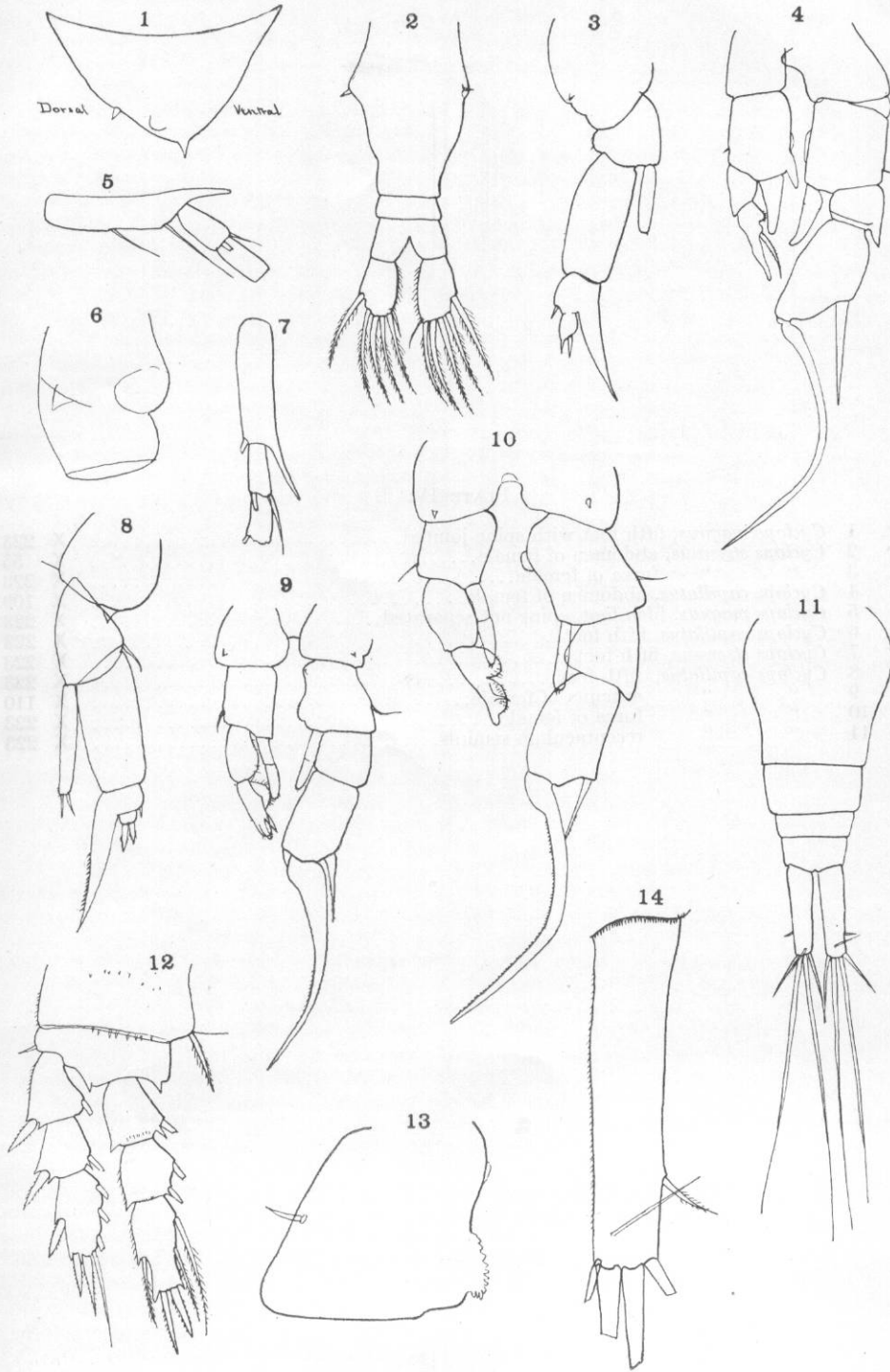


PLATE III.

Fig. 1	<i>Diaptomus bacillifer</i> ,	last cephalothoracic segment, from the side.....	X	223
" 2	"	abdomen of female.....	X	110
" 3	"	fifth foot of female.....	X	223
" 4	"	fifth feet of male.....	X	223
" 5	"	terminal segments of antenna of male.....	X	223
" 6	<i>Diaptomus arcticus</i> ,	first abdominal segment of female from the side.....	X	223
" 7	"	terminal segments of antenna of male.....	X	110
" 8	"	fifth foot of female.....	X	110
" 9	"	fifth feet of male.....	X	81
" 10	<i>Diaptomus wardi</i> ,	fifth feet of male.....	X	110
" 11	<i>Cyclops magnus</i> ,	abdomen of female.....	X	55
" 12	"	fourth foot.....	X	110
" 13	<i>Diaptomus arcticus</i> ,	second basal segment of right fifth foot of male.....	X	223
" 14	<i>Cyclops magnus</i> ,	furca of female.....	X	223

PLATE III.



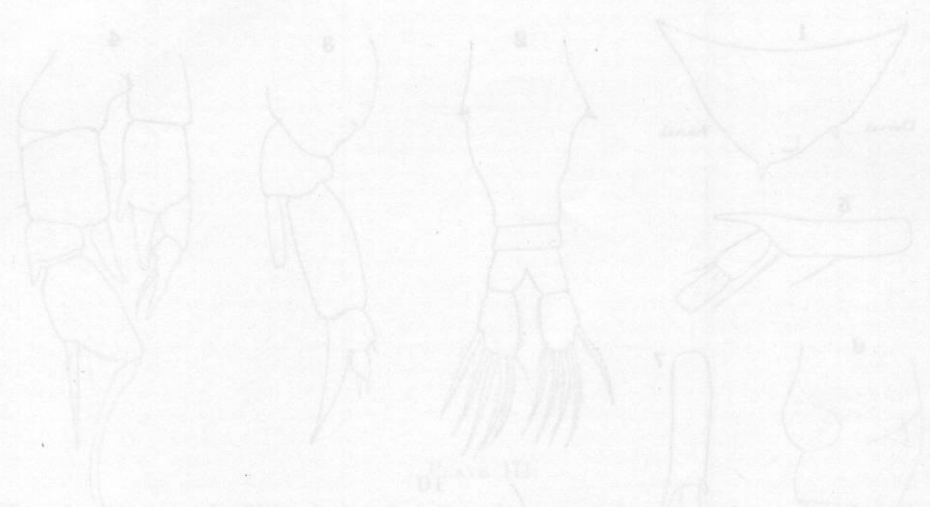


PLATE IV.

Fig. 1	<i>Cyclops magnus</i> , fifth foot with spine jointed.....	X	223
" 2	<i>Cyclops strenuus</i> , abdomen of female.....	X	55
" 3	" " furca of female.....	X	223
" 4	<i>Cyclops capillatus</i> , abdomen of female.....	X	109
" 5	<i>Cyclops magnus</i> , fifth foot, spine not separated.....	X	223
" 6	<i>Cyclops capillatus</i> , fifth foot.....	X	223
" 7	<i>Cyclops strenuus</i> , fifth foot.....	X	223
" 8	<i>Cyclops capillatus</i> , fifth foot.....	X	223
" 9	" " antenna of female.....	X	110
" 10	" " furca of female.....	X	223
" 11	" " receptaculum seminis.....	X	223

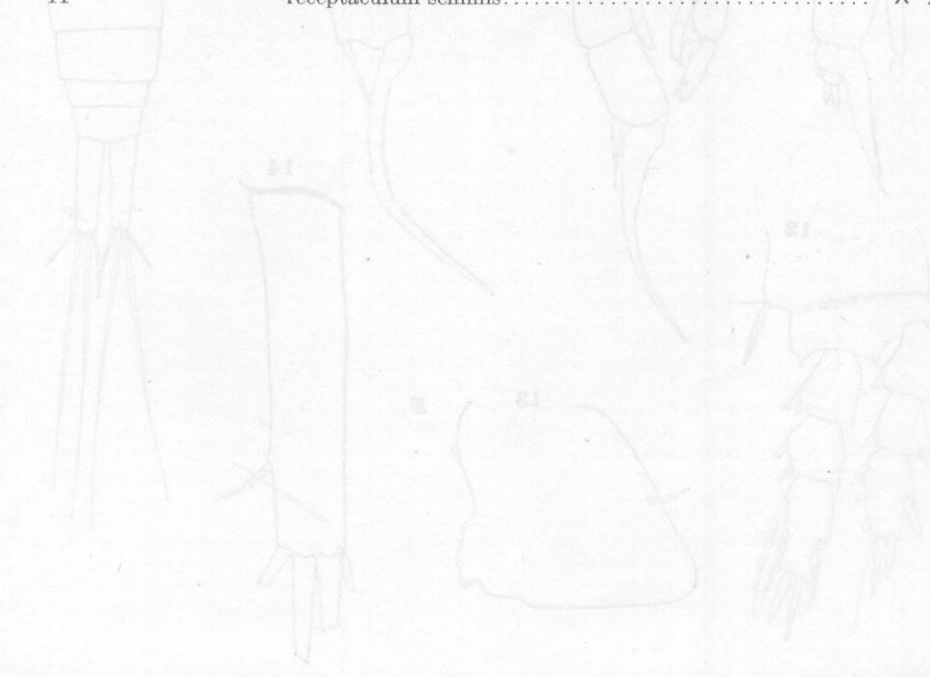


PLATE IV.

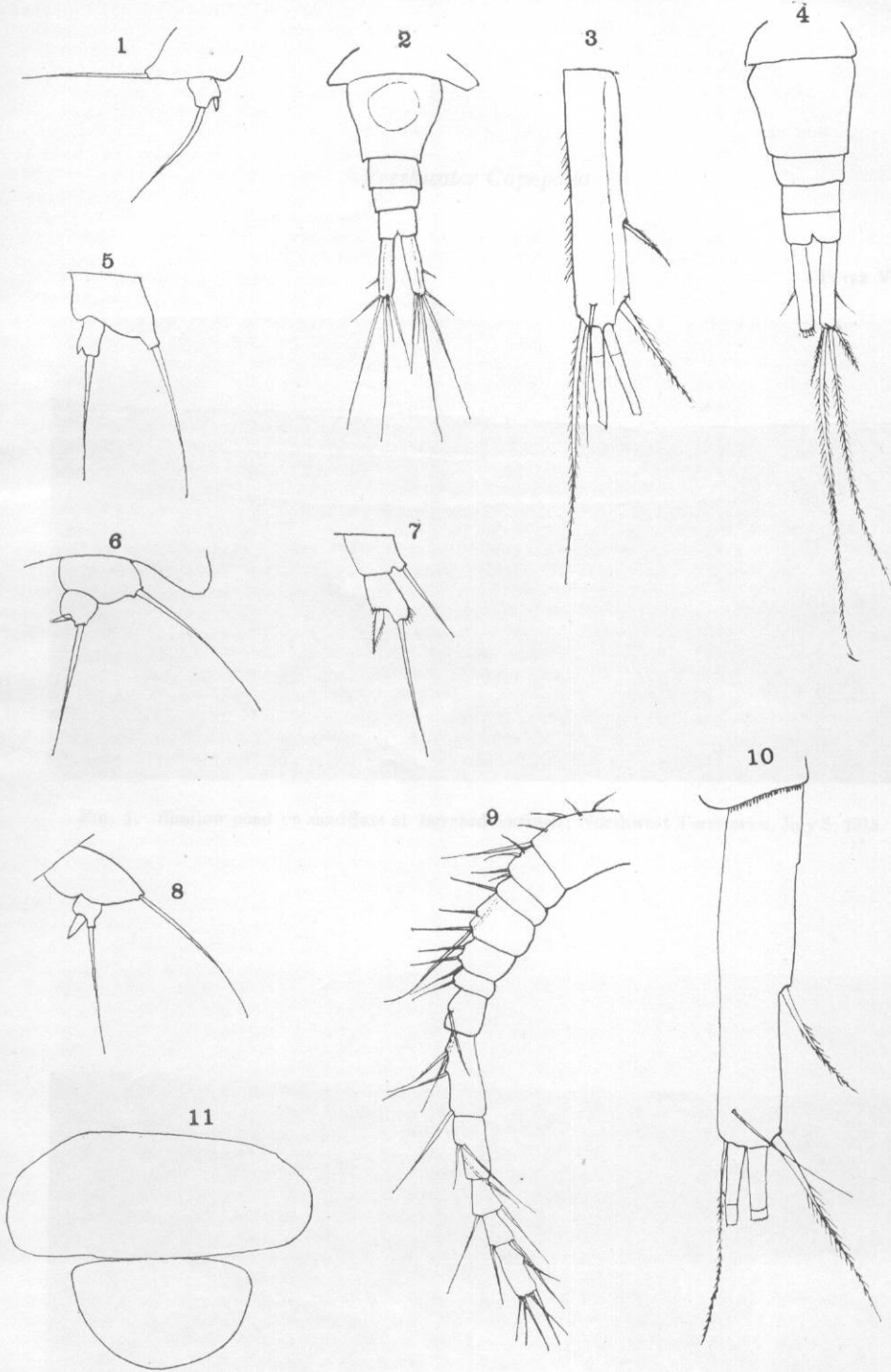


PLATE V.

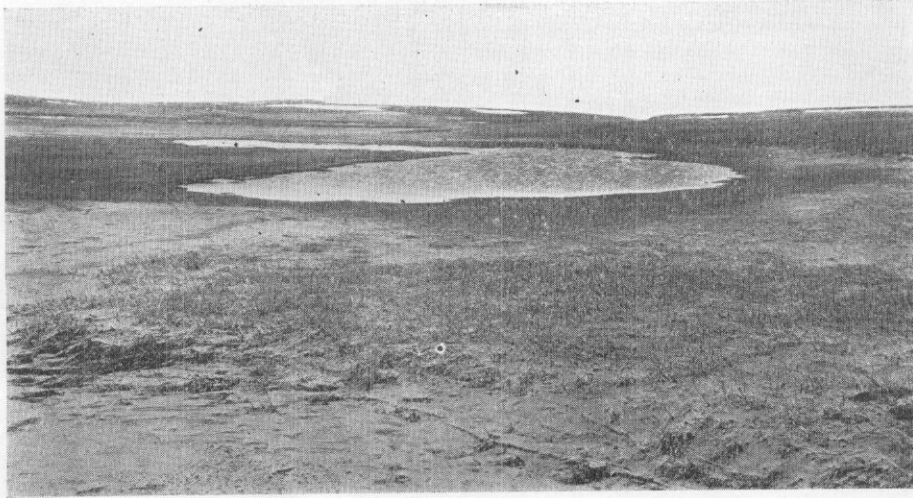


FIG. 1. Shallow pond on sandflats at Bernard harbour, Northwest Territories, July 2, 1915.

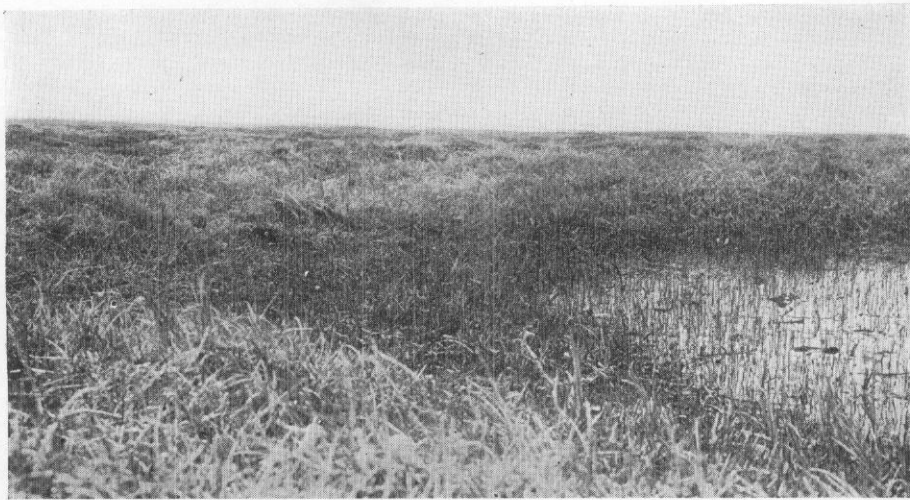


FIG. 2. Tundra pond at Konganevik, Camden bay, Alaskan Arctic Coast, July 4, 1914.