

Notes on the Distribution of Free-living Copepoda in
Canadian Waters

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The material upon which this contribution is based has been derived from five sources, under the authority of the Biological Board of Canada. There are several well-marked species to be described for the first time, several others not previously recorded from North America, and some new to Canada. The names of those who have procured the material are: Mr. A. H. Leim of Toronto University in connection with his work on the shad in Nova Scotia; Mr. Frits Johansen in his expedition to Hudson Bay; Dr. A. G. Huntsman from the Miramichi River, New Brunswick, and from the Quill Lakes, Saskatchewan. At the end of May, 1920, I accompanied Dr. Huntsman to the Quill Lakes, and in the same year I continued my studies on these forms at the Biological Station, St. Andrews, N.B.

Mr. Leim's collection from the Shubenacadie River includes many Ostracoda, but these belong to two species only. Copepoda, Cladocera and Ostracoda are three orders of entomostracan Crustacea, the members of which are of insignificant size and occur regularly in nearly all natural waters, their distribution depending on various factors connected not only with existing currents and water courses, but with former relations of land and water during the glacial period. A certain amount of dispersion by the agency of birds and of winds is probable, but this fact does not exclude other agencies of a more remote influence, though it undoubtedly suggests caution in drawing conclusions.

I. QUILL LAKES, SASKATCHEWAN.

The two lakes show no marked difference in their faunal characters, the bulk of the plankton being obtained from Little Quill Lake, where the facilities for collecting samples of the water and its inhabitants from a boat were greater. The water is saline, but fit to drink for cattle; when it evaporates on the mud flats a white, flocculent, insipid precipitate is left behind, known colloquially as "potash." This is derived, as I learn from Dr. D. B. Dowling, by seepage from the Cretaceous shales through the overlying boulder clay. Besides the Copepoda, some notes were made on the Cladocera, whose empty winter-egg-cases (ephippia) were strewn in windrows along the lake side.

On May 29, 1920, the surface plankton at Little Quill Lake showed the following entomostracan content:

<i>Diaptomus sicilis</i>	55 per cent.
<i>Cyclops parvus</i>	29 " "
<i>Laophonte calamorum</i> n. sp.....	1 " "
<i>Daphnia longispina</i>	15 " "

100

The *Laophonte* will be described below. Its presence is remarkable as being in accordance with some of the phytoplankton records, and because the numerous species of the family Laophontidae hitherto described are strictly marine. In the ponds or "sloughs" beside the lakes there were abundant swarms of *Diaptomus sicilis*, sufficiently dense to constitute a pabulum for a flock of Wilson's Phalaropes. These birds alighted upon the water and commenced whirling about in an extraordinary manner, ever and anon dipping their beaks into the water. Their behaviour first drew our attention, on wading out to the scene, to the dense streaks of *Diaptomus* which were clearly visible by the red colour of the fatty contents of their little bodies, and could be dipped up in unlimited quantity by a net held in the hand. After two years in formalin, the brick-red coloration is still retained in full strength.

The pirouetting of the Phalaropes has been observed and described at least once before, by F. M. Chapman. In May, 1903, there was witnessed an unusual demonstration of Phalaropes (Northern and Red) on the coast at Monterey, California. These "seafarers among the snipe" had been delayed by the violence of a northwest gale in the voyage to their Arctic summer homes: "All the quiet bodies of water contained Phalaropes, a large pond in the city of Monterey being fairly speckled with them. As I [Chapman] approached its margin, I was not a little astonished to observe that apparently one-half of the Phalaropes in it were spinning about in the most remarkable manner. It required only a few moments' watching to learn that the revolving birds were feeding. The lobed feet were moved alternately in such a manner that the birds spun around in the same spot, making a complete revolution in about two seconds, and from three to four to as many as forty turns without stopping. A rotary movement of the shallow water was thus created, bringing to the surface small forms of aquatic life which the Phalaropes eagerly devoured, their slender bills darting rapidly two or three times during each revolution" (Chapman, 1908).

Cyclops parvus Herrick is treated by G. O. Sars (1913) as a synonym of *C. lucidulus* Koch. It is one of a group of North American species, the others being *C. brevispinosus* and *C. americanus*, which C. D. Marsh (1910) puts as varieties of *C. viridis*, defining the latter as follows: Spinous armature of the third joints of the outer branches (Re 3) of the four pairs of swimming-feet (p 1 to p 4) having the formula 2, 3, 3, 3 or 3, 4, 4, 4; the third joint of the inner branch (Ri 3) of p 4 may have an ectal spine or an ectal bristle; the small ental spine of the second joint of p 5 may be separated by an articulation or not. The following is a tabulation of the three varieties according to the data supplied by Marsh:

	<i>americanus</i> Marsh	<i>brevispinosus</i> Herrick	<i>parvus</i> Herrick
Re 3 (spines).....	3, 4, 4, 4	3, 4, 4, 4	2, 3, 3, 3
p 4 Ri 3 se.....	seta	spine	seta
C st e.....	seta	spine	seta
p 5 si.....	articulated	not articulated	articulated

C st e refers to the outer terminal caudal seta.

The word *seta* is frequently used to signify a flexible, plumose bristle; a spine is a rigid *seta*, needle-like, sometimes sparsely ciliate, pectinate or denticulate. There is an intermediate form, half spine, half *seta*.

The *Cyclops parvus* (or "*viridis*") of Quill Lake exhibited at least nine kinds of fluctuation in the spinous armature of *Re 3*. The flexible setae on the inner margin of the ramus showed no variation; they are the natatory setae. The spines give increased strength with economy of surface to the natatory feet, and may be named supporting setae; they are the variable elements in the feet.

Spinous armature of *Re 3* in *Cyclops parvus* (female) from Little Quill Lake:

Right foot				Left foot				Number
p 1	p 2	p 3	p 4	p 1	p 2	p 3	p 4	
2	3	3	3	2	3	3	3	6
2	3	3	3	2	4	4	3	1
2	3	3	3	3	3	3	3	1
2	3	3	3	3	4	3	3	1
2	4	3	3	2	4	3	3	2
2	3	4	3	2	3	4	4	1
2	4	4	3	3	4	4	4	1
3	4	3	3	3	4	3	3	1
3	4	4	3	3	4	4	3	1
								—
								15

Miss Esther F. Byrnes independently suggested the close relationship between *C. americanus* and *C. parvus*, as indicated by their general points of agreement, and in addition by the occasional finding of an adult *Cyclops* in which most of the swimming-feet agree with *C. americanus* in having three outer spines on the terminal segments of the outer rami, while others are in the condition of *C. parvus*, having only two. In Quill Lake such variations are uncommonly frequent, as the table above demonstrates. For further discussion of the *C. viridis* complex, the article by E. B. Forbes (1897) may be consulted. (Fig. 1.)

Laophonte calamorum n. sp. may be diagnosed as follows: Length of female, 0.5 mm., ovisac not observed and no males found. The segments of the body

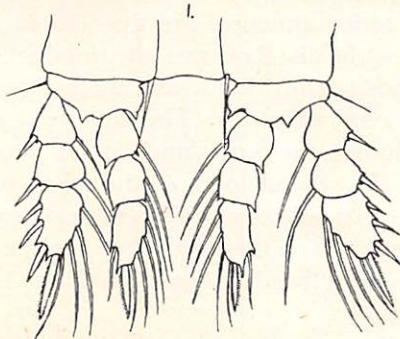


FIG. 1.—*Cyclops parvus* Herrick, second pair of swimming feet (*p 2*). Little Quill Lake.

are defined with thickened projecting rims characteristic of the family; the genital segment, above and at the sides, but not below, is as sharply divided as the rest. At the lateral posterior edges of the second and third abdominal segments, there is a little triangular lappet appearing, when seen from above, as two pairs of blunt, spur-shaped protuberances tipped with minute spinules. The anal operculum has a smooth margin, but a row of spinules extends across the middle of it above. The rostral projection is not conspicuous; in dorsal view it terminates the head with a straight edge from which it is angularly deflexed, ending in a bluntly rounded free border, finely ciliated. The caudal rami are smooth, twice as long as broad, without any setae on the proximal three-fourths of the outer border; the dorsal seta (not shown in the figure) arises nearly in the same plane with the more proximal of the two lateral setae; the distal lateral seta is inserted near to the apical margin; from the latter arise three setae, a middle one, long and strong, flanked on each side by a very small seta, the outer one being minutely serrulate and closely appressed to the middle

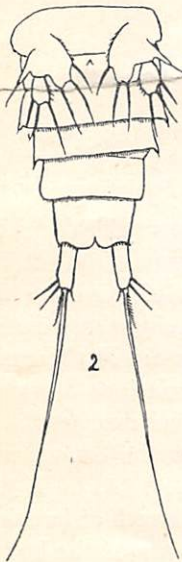
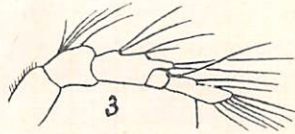
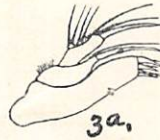


FIG. 2.—*Laophonte calamorum* n. sp. Fifth pair of feet and urosome from below. Little Quill Lake.



FIGS. 3, 3a and 4.—*Laophonte calamorum* n. sp.

3. Anterior antenna.
3a. Maxilla.
4. First foot.

seta (Fig. 2). The anterior antennae are five-jointed, the proximal part consisting of three segments, the distal of two; the terminal segment is seven-eighths the length of the composite third joint, and three times the length of the penultimate joint (fourth joint) (Fig. 3). The first feet conform to the *Laophonte* type, both rami two-jointed, the inner much larger than the outer, terminating in a prehensile claw; the second joint of the outer branch carries five setae (Fig. 4). The fifth feet carry three marginal setae on each lobe, and in addition a strongly exerted lateral seta on the basal lobe. In the second, third and fourth feet Ri 1 is achaetous; Re 1 has 1 se 0 si; Re 2 has 1 se 1 si. The remaining joints may be tabulated:

	P 2	P 3	P 4
Ri 2:	0 se 2 as 2 si	1 se 2 as 3 si	trisetose
Re 3:	3 se 1 st 2 si	3 se 1 st 2 si	2 se 1 st 2 si

The terminal setae on *Ri* are referred to as apical setae (*as*); the terminal seta of *Re* is indicated by the letters *st*.

Out of fifty-eight species of Diatoms identified from the Quill Lakes, Professor Bailey found that six of them belong to marine types. In discussing the question of regarding these marine forms as relict species or as bird-droppings, he points out the difficulties in the way of accepting the theory of bird-dispersion to account for their presence. He adds that the only other supposition is that they are survivals of a time when the sea covered that region, possibly in an interglacial period. This would seem to agree well with Sir William Dawson's views concerning the nature of the glacial period in Canada, where, as he thought, floating glaciers or icebergs existed in an interglacial sea (in a spatial sense) rather than a continuous ice-sheet at any one time.

II. SHUBENACADIE RIVER, NOVA SCOTIA.

The collections were made by Mr. A. H. Leim in 1919 and 1920. The Shubenacadie River opens into Cobequid Bay which in turn opens into the Basin of Minas at the head of the Bay of Fundy. At Shubenacadie, as I am informed by Mr. Leim, the water is brackish and tidal; at Milford Station, at Enfield and at Elmsdale it is fresh and above the tides. The summer plankton at the fresh water stations was very scanty and in 1919 only summer gatherings were made. The spring plankton, up to the middle of June, was fairly copious, the greatest quantity being obtained at Elmsdale on May 18, 1920, and the next on May 25.

At Elmsdale on May 18, at 7.22 p.m., the surface tow, with the fine net, registered 90 per cent. of *Diaptomus minutus* and 10 per cent. of *Cyclops*, with a few Cladocera (*Bosmina longirostris*). Twenty minutes later (at 7.43 p.m.) the gathering, consisting of several hundreds of small Copepods, contained about 76 per cent. of *Diaptomus minutus*, males and females; the remainder consisted mainly of a species of *Cyclops* which proved, according to my determination, to be *Cyclops scutifer*, males and females, but none with ovisacs. There were also a few Cladocera and Acarina.

At the same place on May 25, at 4.50 p.m., there was the same percentage (76) of *Diaptomus minutus*, together with many female and some male *Cyclops scutifer*, one ovigerous *Cyclops serrulatus*, and many immature *Cyclops* sp. This gathering also contained some *Daphnia* and *Bosmina longirostris*.

Cyclops scutifer has not previously been recorded from North America, hence the grounds of the determination must be mentioned briefly. To begin with, it belongs to the group of species of which *C. strenuus* is the type, distinguished by the spinous armature of the natatory legs. One member of this group is recorded from America, namely, *C. strenuus* itself, but, according to Marsh, from one spot only, a pond in the Adirondacks. The form collected by Mr. Leim agrees precisely with *C. scutifer* G. O. Sars in the following characters, so that no doubt is possible regarding the identification: Total length, 1.22 mm.; fifth feet practically indistinguishable from those of *C. strenuus*; the shield-like expansion of the lateral parts of the last two trunk-segments (*th4* and *th5*); the shape of the divergent spermatophores; the length of the caudal rami and

interrelative lengths of the caudal setae; the tumid form of the seta on the inner margin of the first basal joint of the fourth foot; the vestigial outer apical spine of the inner ramus of the fourth foot, not easy to find, from barely one-fifth to nearly one-third the length of the inner apical spine to which it is closely applied.

C. scutifer was again present, accompanied by *C. leuckarti*, in material from Lake Utopia, N.B., collected June 4, 1921, at 4.45 p.m., in a fifteen minute tow at 18-23 metres. The bulk of the gathering, which was sent to me by Dr. Huntsman, consisted of Cladocera (*Daphnia longispina*, *Leptodora hyalina*, *Holopedium gibberum* and one *Polyphemus pediculus*). Of thirteen *Cyclops*, three were *C. leuckarti*, one of which was ovigerous, and ten were *C. scutifer*, of which three were ovigerous and none carried spermatophores. In the same gathering there were nine *Epischura lacustris*, of which one was a male, and several of the others carried a spermatophore, all typical.

At Enfield, June 8, 1920, at 3.08 p.m., the vial contained a male *Epischura nordenskioldi* and a large Cladoceran, *Eurycercus lamellatus*. An hour later (4.09 p.m.) there was no *Epischura* in the tow, but a male *Diaptomus* and several *Cyclops*, including a female *C. scutifer* with the ends of the spermatophores projecting beyond the borders of the urosome in dorsal view.

At Elmsdale, June 11-12, 1920, in an all-night setting, only two female *Epischura nordenskioldi* were obtained. This species has been recorded from near St. Johns, Newfoundland. It is characterized in the female by a straight abdomen and five spines on the end-joint of the fifth foot. On June 14 there were several *Epischura*, male and female, two of the latter bearing an annular spermatophore, that is, a slender cylinder wrapped quite half-way round the genital segment from left to right, so that when viewed from the right side it appears to encircle the body. This disposition of the spermatophore is characteristic of *E. nordenskioldi* and is mentioned by De Guerne and Richard (1889, p. 148). On June 28, a female *Epischura* was present having a straight abdomen and six spines on the end-joint of the fifth foot; this should be *E. nevadensis*. Accompanying it was a male *E. nordenskioldi*. On July 5, at the same station, a male of *E. lacustris* was obtained, together with *Cyclops serrulatus*.

The synopsis of a night-gathering at Elmsdale, July 9-10, 1920 (8 p.m. to 9 a.m.), may be taken as a sample of the summer plankton at that spot:

<i>Cyclops ater</i>	6 (females)
<i>Cyclops albidus</i>	18 (females)
<i>Epischura lacustris</i>	2 (male and female)
<i>Epischura nordenskioldi</i>	2 (females)
<i>Eurycercus lamellatus</i>	1
<i>Ophryoxus gracilis</i>	1
	—
Total	30

An all-night setting at Elmsdale, July 15-16, yielded fifteen Entomostraca all told and all females:

<i>Cyclops albidus</i>	6
<i>C. viridis (brevispinosus)</i>	4
<i>C. ater</i>	5
	<hr/> 15

It should be noted that Sars treats *Cyclops brevispinosus* as a distinct species under the name *C. robustus*.

As the summer advances the gatherings become still more impoverished. On July 19, 10.17 a.m., the surface net yielded only two copepods, a *Cyclops albidus* and one *C. serrulatus* with ovisacs, the posterior end of each ovisac pointed and marked by an opercular ring. The latter species is named *Leptocyclops agilis* (Koch) by Sars. A few Ostracods, *Candona parallela*, were taken at Elmsdale on this date.

At Milford Station, August 4, 1919, towing in the current with the fine surface net at 9.55 p.m. yielded three *Cyclops serrulatus* only. At Elmsdale, August 9, 1919, there were two copepods only in the vial, *Cyclops serrulatus* and *Diaptomus minutus*.

Finally at Elmsdale, on August 27, 1919, 8.42 p.m., the tow in the current at a depth of ten feet yielded a single damaged specimen of *Cyclops fuscus*.

At Shubenacadie there is to be found a mixture of fresh, brackish and salt water species. The brackish water form discovered here is a species of a genus of Harpacticoid copepods new to North America, *Canuella canadensis* n. sp. On May 28, 1920, the gathering was wholly freshwater, comprising eleven individuals:

<i>Cyclops viridis (brevispinosus)</i>	2
<i>Cyclops serrulatus</i>	1
<i>Cyclops leuckarti</i>	3
<i>Diaptomus minutus</i>	5
	<hr/> 11

On July 3, 1920, 4.42 p.m., the Shubenacadie vial contained fifteen Entomostraca:

<i>Centropages hamatus</i>	1
<i>Eurytemora hirundooides</i>	5
<i>Cyclops viridis (brevispinosus)</i>	4
<i>Canuella canadensis</i>	1
<i>Cypria ophthalmica</i>	4
	<hr/> 15

Less than an hour later, at 5.34 p.m., there was a typical and relatively copious *Canuella* plankton. Many of the *Canuella* females carried the two ovisacs characteristic of the genus, but I have no record of the male:

<i>Canuella canadensis</i>	84 per cent.
<i>Cyclops viridis (brevispinosus)</i>	9 " "
<i>Eurytemora hirundooides</i>	1 " "
<i>Cypria ophthalmica</i>	6 " "
	<hr/> 100

On July 31, 1919, a similar swarm of *Canuella* was encountered at the surface in the ebbing tide at 9.30 p.m. In this gathering, which included several hundreds of Entomostraca, the approximate percentage was:

<i>Canuella canadensis</i>	75 per cent.
<i>Eurytemora hirundoides</i>	5 " "
<i>Cypria ophthalmica</i>	20 " "
	—
	100

On the same evening at 10.10 p.m. in the ebbing tide at a depth of 12 feet, using a coarser silk net, the complete catch comprised 130 *Eurytemora hirundoides*, 1 *Acartia tonsa*, 1 *Cyclops viridis (americanus)*, 12 *Canuella canadensis*.

Many of the *Eurytemora* females had spermatophores, many carried an ovisac, and nine were males.

On the following evening (August 1, 1919) at high tide (8.45 p.m.), there were 41 *Eurytemora hirundoides*, 1 *Canuella*, and 1 young *Cyclops*. At the turn of the tide (9.10 p.m.) there were 16 *Eurytemora*, 13 *Cyclops viridis (s.l.)* and 3 *Canuella*. These numbers illustrate the reciprocal relations between tidal and fluviatile species in the surface plankton at Shubenacadie. The absence of the Ostracods (*Cypria ophthalmica*) which are frequently taken with the *Canuella*, is noticeable.

Canuella canadensis n. sp. differs from *C. perplexa* Scott by unit characters touching especially the spinous armature in the fourth pair of swimming feet and in the caudal furca. It agrees with the European species in the short, five-jointed anterior antennae, densely setose, carrying about eight coarsely spicate spines in addition to a number of slender, flexible, plumose setae and a couple of sensory setae; and in the seven-jointed outer branch of the posterior antennae. The mouth-parts are essentially the same, differences being hard to detect. I have observed that the outer branch of the mandibular palp is three-jointed, being figured as unjointed in *C. perplexa*; and the outer branch of the maxillary palp carries eight setae (instead of ten).

TABLE OF DIFFERENCES IN P 4.

	<i>C. perplexa.</i>	<i>C. canadensis</i>
Re 1.	1 se 0 si	1 se 0 si
Re 2.	1 se 1 si	1 se 0 si
Re 3.	3 se 1 st 1 si	2 se 1 st 1 si
Ri 1.	0 se 1 si	0 se 1 si
Ri 2.	0 se 1 si (vestigial)	0 se 0 si
Ri 3.	2 se 1 st 1 si	2 se 1 st 1 si (Fig. 5) [or 1 se 2 as 1 si]

The feature of these differences, trivial as they may appear, lies in their constancy; and the same remark holds good for the caudal furca, the branches of which are ciliated on their outer and inner margins, without any lateral seta outside, this seta being situated at the apex alongside the terminal setae. On

the inner margin of each furcal ramus, a group of two slender setae occurs at three-fourths of the distance from base to apex (Fig. 6). The fifth feet are vestigial, a generic character. Total length, 1.21 mm.

Of the two species of *Canuella* found off the coast of Norway, *C. perplexa* was taken at the depth of a few fathoms on a sandy bottom partly overgrown by algae at a spot outside the Christiania Fjord; while *C. furcigera* occurred in



FIG. 5.—*Canuella canadensis* n. sp. Fourth pair of swimming feet (\bar{p} 4). Shubenacadie.

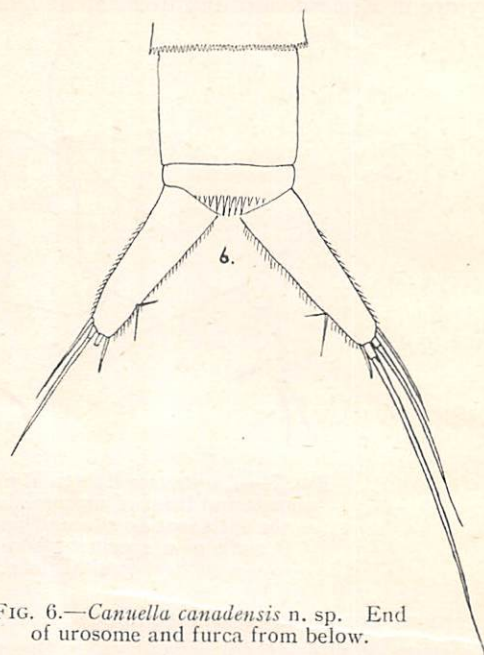


FIG. 6.—*Canuella canadensis* n. sp. End of urosome and furca from below.

the upper part of the Christiania Fjord, not far from the town, at the depth of a few fathoms on a muddy bottom. The former would therefore belong to the Laminarian zone, the latter to the sublittoral zone. *Canuella canadensis* clearly belongs to the estuarine zone, occurring as it does in association with fresh-water as well as marine species of Entomostraca.

III. SHAD STOMACH CONTENTS.

The contents were taken by Mr. A. H. Leim from the stomachs of shad (*Alosa sapidissima*) in 1920. The shad were caught in a weir near the low tide level at Scotsman Bay, N.S. This is separated from Minas Basin by Cape Split. Owing to the heavy tides (38 feet), there is much mixing of the water, the salinity being estimated at 30 pro mille, and the temperature 14.4°C. The first sample I received was from a shad 26 centimetres long, July 28, 1920, aged two years. The material was a copious chyme composed almost entirely of *Acartia clausi*. In addition there were present in subequal numbers, two species of *Eurytemora*, namely, *E. herdmani* Thompson and Scott, and *E. thompsoni* n. sp. Many *Harpacticoids* (*Leimia vaga* n. gen. et sp.) were sprinkled throughout the mass, and some Mysid shrimps (*Neomysis*).

Eurytemora thompsoni is near to *E. affinis* Poppe, differing in the following points. The ental spur or unguiform process of the penultimate joint of the fifth legs of the female is ciliate on both edges, especially on the inner edge. The apical setae of these legs are long, flexible, not very unequal. The penultimate joint itself presents a constriction about the middle, often quite marked. The thoracic pleurae of the fifth segment are obtusely pointed, not wing-like as they are in *E. herdmani* and in *E. hirundoides* (Fig. 7). The furcal rami and

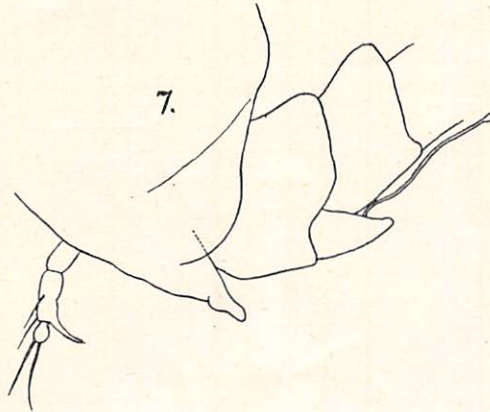


FIG. 7.—*Eurytemora thompsoni* n. sp., showing end of thorax and front of urosome in side view, with the fifth foot *in situ* and part of the long stalk of a spermatophore behind the genital lobe.

anal segment are finely spinulose above; inner margins of the rami longiciliate; the insertion of the lateral seta divides the ramus into unequal proximal and distal portions in the proportion of 10:5; the terminal setae are as long as, or longer than, the ramus; the latter is six to seven times as long as broad. In the male there are spines on joints 8 to 12 of the right anterior antennae; taking the length of the spine on joint 9 as unity, the following are the approximate interrelative lengths:

Joint	<i>Herdmani</i>	<i>Hirundoides</i>	<i>Thompsoni</i>
8	$\frac{3}{4}$	very small	$\frac{1}{2}$
9	1	1	1
10	0	1	$\frac{1}{2}$
11	0	1	$\frac{3}{4}$
12	2	$2\frac{1}{2}$	$1\frac{1}{3}$

By this character the males of *E. herdmani* and *E. thompsoni* are readily separable, without further dissection.

Leimia vaga n.g. et sp. is a small Harpacticoid which strays, sometimes in no inconsiderable numbers, into the food of the shad. It is not easily placed in its proper family, since it exhibits a commingling of characters, with a balance in favour of the Canthocamptidæ. It seems to effect a link between the fresh-water types and the marine types of adjoining families, but not especially between

fresh-water and marine Canthocamptidæ. It has the caudal furca, antennary exopodite, natatory feet and even the fifth feet of species of the fresh-water genus *Attheyella* (Canthocamptidæ); the first foot (p 1) is almost that of a *Danielssenia* (Tachidiidæ); the reduced antennae of *Cletodes*; and the sharply marked segmentation of *Laophonte*.

The *anterior antennae* are short and thick, six-jointed, the terminal joint large and blunt; the *posterior antennae* are two-jointed, and the outer branch, though unarticulate, is large and conspicuous, standing out sideways in a dorsal view of the head (prepared out), exceeding half the length of the terminal joint, and carrying four large setae, as in *Attheyella crassa* G. O. Sars. On the inner (convex) border of the proximal joint of the posterior antennae, that is, on the side opposite to the insertion of the outer branch, there are two setae of which the distal one is much the larger, rather more than twice the length of the outer branch. In *Attheyella crassa* these setae are subequal and about half the length of the outer branch. The distal joint of the posterior antennae has four spines

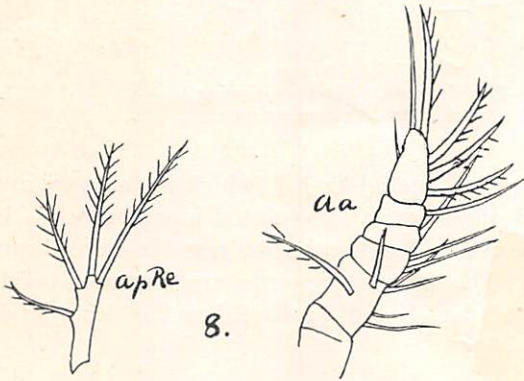


FIG. 8.—*Leimia vaga* n. g. et sp. Anterior antenna (Aa) and outer branch of posterior antenna (Ap Re).
Shad stomach, Scotsman Bay, N.S.

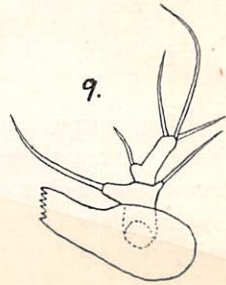


FIG. 9.—*Leimia vaga*.
Mandible.

and two geniculate setae interspersed; the terminal spine has a flexible distal portion, giving it an intermediate character, so that it might be described as subgeniculate. The *mandibular palp* is simple and bipartite, the distal portion narrower than the proximal and set at a slight angle. When seen slantwise the shoulder of the wider basal portion causes a deceptive appearance of an obvious articulation, as in the figure. When mounted perfectly flat the articulation is not so obvious and it appears that the two parts are imperfectly divided. The basal portion carries a seta inside and outside, the former very strong and exerted (Figs. 8 and 9).

The *maxilla* is of the *Canthocamptus* type; its basal portion is occupied by the lobe carrying the manducatory setae; the distal portion is the palp which is devoid of branches, the obsolete outer branch being represented by a couple of setae arising close together from the front of the base of the palp; opposite to these setae, that is, from the inner side of the base of the palp, there arises a small internal lobe carrying two setae; the larger, main or distal lobe of the

palp may be called the unguiferous lobe, since two of the setae are fairly strong and claw-like. The appendage, as a whole, is closely similar to the figure by Sars in *Canthocamptus staphylinus*.

The first maxilliped also agrees with *Canthocamptus* in having "only two digitiform lobules inside the unguiferous joint" (Sars); the first of these inner lobes is trisetose. The second *maxillipede* has a simple hand ciliated on the inner border, at least in its wider proximal portion, bearing a very delicate claw drawn out into an extremely fine though rigid point.

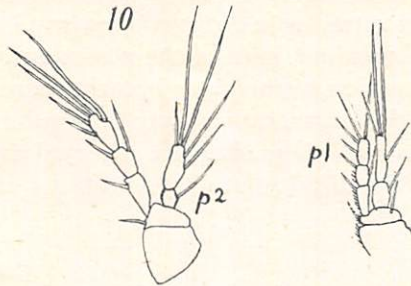


FIG. 10.—*Leimia vaga*. First swimming foot (*p 1*) and second swimming foot (*p 2*).

The four pairs of swimming feet, including *p 1*, which is natatory and not prehensile, have a three-jointed outer and a two-jointed inner branch. In the first feet the branches are subequal in length; in the rest the inner branch is much shorter than the outer. The following points are common to all the swimming feet (*p 1* to *p 4*): *Re 1* has 1 *se* 0 *si*; *Re 2* has 1 *se* 1 *si*; *Ri 1* has 0 *se* 1 *si* (Fig. 10).

SYNOPSIS OF THE SETAE ON THE TERMINAL JOINTS.

	<i>p 1</i>	<i>p 2</i>	<i>p 3</i>	<i>p 4</i>
<i>Re 3</i> .	2 <i>se</i> 1 <i>st</i> 1 <i>si</i>	2 <i>se</i> 1 <i>st</i> 2 <i>si</i>	2 <i>se</i> 1 <i>st</i> 2 <i>si</i>	2 <i>se</i> 1 <i>st</i> 3 <i>si</i>
<i>Ri 2</i> .	1 <i>se</i> 2 <i>as</i> 1 <i>si</i>	1 <i>se</i> 2 <i>as</i> 2 <i>si</i>	1 <i>se</i> 2 <i>as</i> 2 <i>si</i>	1 <i>se</i> 1 <i>as</i> 1 <i>si</i>

Not only the number but also the insertion and size of the setae have to be noted. To do this thoroughly would require more figures than can be afforded and more text than can be allotted. In the first foot there are no geniculate setae; the *st* and *si* of *Re 3* are side by side, apical in position and subequal in length; *Ri 2* carries three setae side by side at its apex, namely, an *se* and two long equal apical setae; and one *si* with central insertion. The second and third feet are alike; the proximal inner seta (*si 1*) of *Re 3* occupies a distal position and is the longest and stoutest of all the setae on the joint, this relation being accentuated in the third foot. The six setae of *p 4 Re 3* are all inserted distad of the middle of the joint, and in fact are crowded around the broad stunted apex (Fig. 11).

The segments of the urosome are fringed with short spinules above and long filaments below. The basal lobe of the fifth foot is produced outside to

carry the long exerted seta; its inner expansion is low, with five marginal setae; distal lobe with four setae. The caudal furca is longer than the anal segment, attenuating from base to apex in side view, with two lateral setae outside, one proximal and one distal; the dorsal seta is inserted remote from the apex, nearly at the level of the proximal lateral seta, arising from a small pedicle. The two longer caudal setae are coarsely ciliated and the outer margin of each furcal ramus is coarsely spinulose (Fig. 12).

The total length is 0.80 mm.; the ovisac is single; no male has been observed.

The presence of *Leimia vaga* in the same stomach contents with *Acartia clausi*, *Eurytemora herdmanni* and *Eurytemora thompsoni* completes an ecological assemblage of distinct individuality sufficient to give character to that region. The generic name is suggested in compliment to Mr. A. H. Leim, whose intensive studies of the Nova Scotian shad fishery have already yielded substantial results.

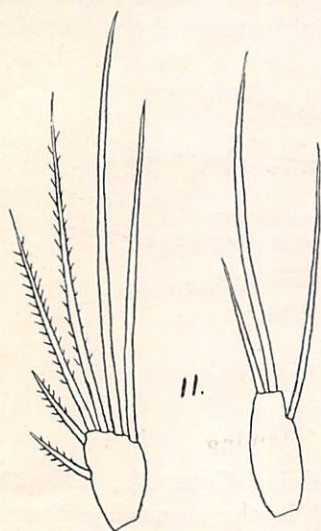


FIG. 11.—*Leimia vaga*. Third joint of outer branch of fourth foot ($p_4 Re 3$) and second joint of inner branch of same foot ($p_4 Ri 2$). The latter is trisetose.

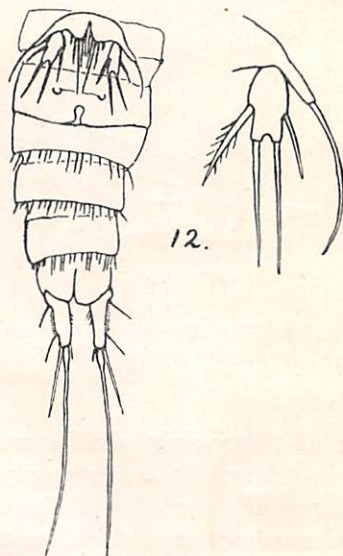


FIG. 12.—*Leimia vaga*. Urosome and fifth pair of feet, from below.

The family of the Peltidiidae, with flattened, shield-shaped bodies, like miniature woodlice which, as noted by Claus, they further resemble in their ability to roll the body into a ball, is represented by *Alteutha purpurocincta* Norman. According to G. P. Farran this is the name by which the species entered by Sars as *Alteutha depressa* Baird is henceforth to be known. Under the latter name it is listed at Woods Hole, Mass. There are some features of importance in the fourth pair of feet: in the third joint of the inner branch (Ri 3) the external seta and the two apical setae are spini-form as in the type figured by Sars (1904, Pl. XXXVIII); the corresponding setae are also spini-form in the third foot in both sexes in our material. In the second joint of the

inner branch (*p 4 Ri 2*) the first seta on the inner border (*si 1*) is only spiniform in the female, as in Sars's figure, not in the male. Lastly, the *si 2* of *p 4 Re 3* is a powerful serrate spine in both sexes. This feature has not been mentioned anywhere to my knowledge. The *si 1* of the same joint is a normal seta in close juxtaposition with the modified *si 2*, arising seemingly from the same acetabulum (Fig. 13).

There is the purple band across the middle of the body and my preparations further agree with the type in the absence of an inner seta on *p 1 Ri 2* and in the absence of an inner seta on the *Re 1* of the three middle legs (*p 2* to *p 4*). On the other hand the inner setae of *p 2 Re 3* are inserted more as in Sars's figure of *Alteutha interrupta* than as in his figure of *A. purpurocincla (depressa)*; thus the *si 1* arises near the proximal end of the joint opposite to the proximal interspace; *si 2* arises nearly midway between *si 1* and the apex of the joint, opposite to the interval between *se 1* and *se 2* (middle interspace). These slight differences are worth noting in conjunction with the special features of the fourth pair of feet.

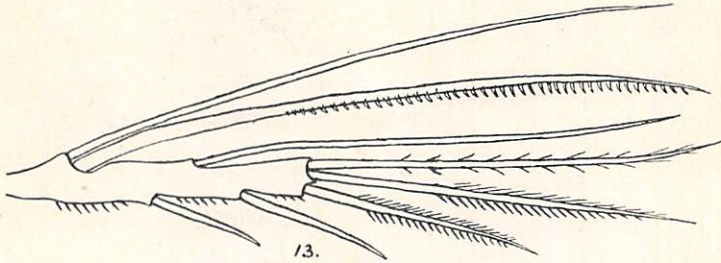


FIG. 13.—*Alteutha purpurocincla* (male). Third joint of outer branch of fourth foot (*p 4 Re 3*).
Shad stomach, Scotsman Bay, N.S.

Out of thirty-eight shad stomachs containing Copepods, *Alteutha* was present in thirty. It is commonly associated in the stomach contents with Cypris-larvae of barnacles (*Balanus*). The numbers are indicative of a considerable consumption of this class of food.

Thalestris longimana Claus is another large, highly distinctive Harpacticoid and the type of its genus. The segments of the body are excessively hard and brittle, and the back of the female is strongly arched. It occurred sparingly in four of the stomach contents always accompanied by *Alteutha*; one female carried an ovisac (August 5). It was not previously known from the Western Atlantic, the only species of *Thalestris* named from Woods Hole being *Thalestris gibba*.

A single female of another species occurred in one of the vials (No. 355, August 5), and is tentatively referred to *Thalestris brunnea*, with which it agrees in its short caudal furca. The structure of the fifth feet agrees with the type, except that the inner border of the inner expansion of the basal joint is coarsely spinulose, being rendered smooth by Sars.

An interesting record for the shad is that of *Halithalestris cronii*, a pelagic Harpacticoid first obtained in the Western Atlantic at two stations of the U.S.

Fisheries Schooner *Grampus* in 1894 and recorded by R. W. Sharpe (1910). Since then it has been observed in plankton from Passamaquoddy Bay (J. P. McMurrich) and from several stations in the Gulf of St. Lawrence (A. Willey). A single example was present in shad stomach contents (No. 353, August 5). It bears a superficial resemblance, in shape of body and diverging caudal rami, to *Canuella*, but is double the size.

As mere stragglers into the diet of the shad must be mentioned the male of *Tachidius littoralis* Poppe and the male of *Nannopus littoralis* n. sp. According to Sars, the female of *Nannopus palustris* has no power of swimming. Each of these males was observed once only, in one sample, the bulk of which consisted of *Eurytemora thompsoni*. There is a certain amount of vagueness in the characterization of *Nannopus palustris* Brady. Sars states that Brady's figures of the first and fourth feet do not differ essentially from the Norwegian form. In Brady's figure of *p 1*, *Re 3* has six full-sized setae instead of the four setae in the Norwegian and Nova Scotian representatives. On the other hand the three setae on *p 1 Ri 2* in Brady's figure, namely, 1 se 1 as 1 si, are more like the variety which I have called *littoralis*. In the latter the formula for *p 4 Re 3*

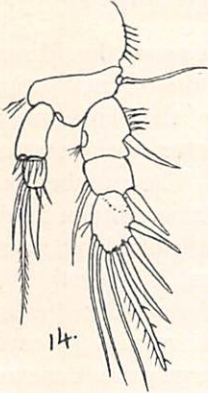


FIG. 14.—*Nannopus littoralis* n. sp. (male).
Third foot (*p 3*).
Shad stomach, Scotsman
Bay, N.S.



FIG. 15.—*Nannopus littoralis* n. sp. (male).
Left furcal ramus
from above.

is 3 se 1 st 3 si, a total of seven setae, while according to Sars, the formula for his type is 3 se 1 st 2 si, six in all. This is a clear difference. In *N. littoralis*, *p 3 Re 3* also carries seven setae (3 se 1 st 3 si) and the inner setae are not reduced; *p 2 Re 3* has six setae (3 se 1 st 2 si); the caudal setae are plain, the middle one not spurred, and there is an extra dorsal one; in *p 5* the distal lobe is not articulated, very slightly elevated, with four setae, the inner expansion is obsolete, but there is a row of four widely spaced setae in its place; lastly, in the second maxilliped the middle joint is much longer than the basal joint, at least as long as the claw. Although these are features of the male (length of 0.60 mm.), hitherto undescribed, they seem to warrant the creation of a new species. The inner branches of the first three pairs of feet are biarticulate, those of the fourth pair are vestigial, unarticulate, bisetose, the inner of the two setae being much the smaller. In the first two feet the distal segment of *Ri* carries three setae, namely, an outer apical spine, an inner apical bristle and an inner distal bristle. In the third foot, the apical spine of *Ri 2* is transformed into a powerful claw (Figs. 14 and 15).

The century count of the shad stomach contents in which the single examples of *Nannopus* and *Tachidius* were found gave the following result:

<i>Eurytemora thompsoni</i>	86 per cent.
<i>Eurytemora herdmani</i>	3 " "
<i>Acartia clausi</i>	10 " "
<i>Leimia vaga</i>	1 " "

The length of the shad was 19 cm. and its age two years (No. 320, July 31, 1920).

In the distribution of *Nannopus* a zonal arrangement can be made out somewhat analogous to that of *Canuella*. *N. palustris* was taken by Sars in a single locality near Christiania, in a shallow creek of the Fjord, on a muddy bottom close to the shore. *N. perplexa* G. O. Sars, is from Lake Tanganyika in Central Africa. The former, as indicated by the specific name, belongs to the paludine zone; the latter to the lacustrine zone. There was thus room for a littoral species, now occupied by *N. littoralis*.

IV. MIRAMICHI PLANKTON, 1918.

An expedition to investigate the fishery problems of the Miramichi river, estuary and bay was undertaken by the Atlantic Biological Station, N.B., in the *Prince* during the summer of 1918. A portion of the plankton material was entrusted to me by Dr. A. G. Huntsman, the director of the station, together with information regarding the localities visited. The numbers of the river "stations" are those established by the *Prince*. Station 82 lies in the centre of the brackish portion of the estuary. It is in the middle of a long, narrow channel between the confluence of the two main tributaries (the North West and the South West Miramichi rivers) and the inner bay formed by the broad mouth of the river. At this station on June 7, 1918, the maximum catch of smelt larvae was registered. The surface tow with the large pelagic metre net (mesh No. 0) consisted of 200 cc. of smelt larvae almost pure; in the deep tow at eight metres with the same net there was a solid phalanx of smelt larvae to the quantity of 400 cc. It was also the date of the minimum bottom salinity for this station and of the maximum uniformity of salinity and temperature from the surface to the bottom (depth 10 metres): the salinity standing between 7 and 8 promille, and the temperature between 14° and 15°C. The rise of the tide here has a maximum range of 8 feet.

On this date (June 7, sta. 82, 10.25 a.m.) the deep tow at 7 metres with the plankton net (mesh No. 5) amounted to 40 cc. and included very numerous smelt larvae and the following percentage Copepod content:

<i>Acartia tonsa</i>	52 per cent.
<i>Eurytemora hirundooides</i>	43 " "
<i>Eurytemora herdmani</i>	3 " "
<i>Tortanus discaudatus</i>	2 " "

In addition there was one example of a species, *Pseudodiaptomus coronatus*, to which further reference will be made later.

On July 4 (1 p.m.), the deep tow at station 82 contained several young fish larvae, together with 88 per cent. of *Acartia tonsa* and 12 per cent. of *Eurytemora hirundoides*. In addition there were present in individual numbers 98 *Ergasilus chautauquaënsis*, 8 *Laophonte huntsmani* n. sp., 109 *Bosmina longirostris* var. *cornuta*, one *Argulus* and five "Cypris" larvae of *Balanus*.

Ergasilus chautauquaënsis was originally found swimming freely, adults of both sexes, at Lake Chautauqua, N.Y., in 1886. The fresh-water fish upon whose gills the female would be a facultative parasite has not been discovered. In the Miramichi material I have seen only males which are distinguished from the females by the possession of a very large pair of blunt, claw-like posterior maxillipedes. Like *Bosmina*, they probably drifted down with the current into the lower reaches of the river-system without reproducing there. When seen from the ventral aspect, after preservation, they exhibit flecks of blue pigmentation (Fig. 16).

On August 9 (10 a.m.) the surface tow at station 82 with the finest plankton net (No. 20) amounted to 26 cc., comprising abundant phytoplankton and nearly

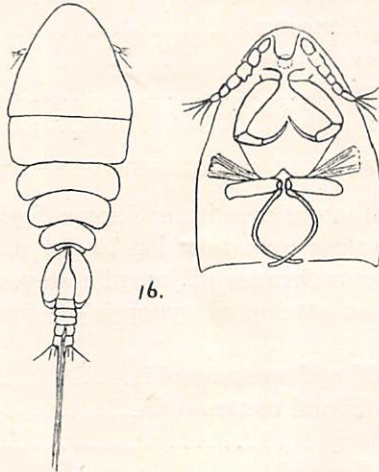


FIG. 16.—*Ergasilus chautauquaënsis* Fells. Male from above and forebody from below. Miramichi river.

100 per cent. of *Acartia tonsa*, all females. In addition there were very few *Eurytemora hirundoides*, numerous Calanoid and Balanid nauplii, 28 crab larvae, 46 *Laophonte huntsmani*, 160 *Ergasilus*, two *Evadne* and no *Polydora* larvae. At the same time in the deep tow at 7 metres with the medium net (No. 5) the total quantity of plankton was 30 cc. This consisted largely of Copepods with some Mysids. The percentage count gave the following results:

<i>Acartia tonsa</i> (female).....	58 per cent.
<i>Acartia tonsa</i> (male).....	22 " "
<i>Eurytemora hirundoides</i>	8 " "
<i>Temora longicornis</i>	5 " "
<i>Pseudodiaptomus coronatus</i>	4 " "
<i>Tortanus discaudatus</i>	3 " "

Two or three *Oithona similis* were found; *Centropages hamatus* was very rare and *Labidocera aestiva* still rarer.

No diatoms of the genus *Coscinodiscus* were seen.

On September 7, the deep tow at station 82 yielded 20 cc. of a nearly pure *Acartia tonsa* plankton, with scanty intermixture of *Eurytemora hirundoides*, *Pseudodiaptomus coronatus*, an Ergasilid copepod (*E. chautauquaënsis*) and a couple of *Laophonte huntsmani*.

Station 75 is the typical station for the centre of the inner bay, which is separated by islands from the outer bay. At this station on August 8 (11.10 a.m.), in the five-minute deep tow at five metres (net No. 5), the quantity was 12 cc., with the following approximate percentage:

<i>Acartia clausi</i>	16 per cent.
<i>Acartia tonsa</i>	38 " "
<i>Centropages hamatus</i>	4 " "
<i>Eurytemora herdmani</i>	3 " "
<i>Labidocera aestiva</i>	1 " "
<i>Pseudocalanus elongatus</i>	5 " "
<i>Pseudodiaptomus coronatus</i>	2 " "
<i>Temora longicornis</i>	20 " "
<i>Tortanus discaudatus</i>	8 " "
<i>Oithona similis</i>	3 " "

The Cladoceran *Evadne* was present, and some *Sagitta*.

On August 14, the surface tow at station 75 (0.2 m. with finest net No. 20, 11.45 a.m.) yielded a preponderance of juvenile stages in a total quantity of 9 cc. The following is an attempted synopsis of the entire Entomostracan content:

<i>Balanus</i> nauplii and metanauplii.....	25 per cent.
<i>Calanoid</i> nauplii and metanauplii.....	25 " "
<i>Acartia</i> (juniores).....	30 " "
<i>Acartia tonsa</i> (female).....	4 " "
<i>Acartia clausi</i> (female).....	4 " "
<i>Acartia</i> spp. (males).....	4 " "
<i>Temora longicornis</i> (female juv.).....	1 " "
<i>Labidocera aestiva</i> (juv.).....	1 " "
<i>Tortanus discaudatus</i> (juv.).....	1 " "
<i>Centropages hamatus</i>	1 " "
Cladocera (<i>Evadne</i> and <i>Podon</i>).....	4 " "

The diatom *Coscinodiscus* was superabundant; *Oithona similis* was very rare in the sample, and but one male *Eurytemora herdmani* was found. In addition there were numbers of the larvae of the Annelid *Polydora*; molluscan veligers and crab larvae.

Laophonte huntsmani n. sp., is fairly close to *L. nana* G. O. Sars, having like it a six-jointed antennule in the female. The rostrum is so meagre and

depressed that the animal looks in side view as if it were decapitated. The outer branch of the first foot is 3-jointed in both sexes, instead of being 2-jointed as it is in *L. nana*. The exopodite of the posterior antennae (*Ap Re*) is not so reduced as in the latter species; it bears four setae and is practically indistinguishable from that in *L. parvula* and *L. nordgaardii* for example. The uniarticulate mandibular palp bears five setae, namely, one at the end and four on the outer margin. The fourth foot is the same as in *L. nana*; so is the fifth foot of the female, though the formula 5:4, is apt to differ on the two sides of the body, e.g., 5:3 on the right to 4:4 on the left. When the setae on the distal lobe are normal, the second (counted from the inside) is the longest, the third the thinnest, as in *L. nana*, but their insertion is distinctive, the second, third and fourth lying side by side at the apex, a gap separating the fourth from the fifth (i.e., the two outermost setae of the distal lobe), while in *L. nana* the fourth and fifth setae are contiguous. Thus the interrelative lengths of these setae are essentially the same in *L. huntsmani* and in *L. nana*, but their insertions are slightly different.

The caudal setae are nearly alike in the two species under comparison, all the marginal setae with terminal insertion, but the cylindrical caudal rami of *L. huntsmani* are sharply marked off from the anal segment and nearly twice the length of it, and each ramus is nearly three times as long as wide. The abdominal segments are fringed behind with fine combs below and at the sides, less conspicuously so in dorsal view.

In the fifth feet of the male, the inner expansion of the basal joint is suppressed, and the distal lobe carries 4 marginal setae, as against 3 in *L. nana*. The genital segment bears a rudimentary sixth pair of feet, each armed with a strong spine (broken in the one figured). The *anterior antennae* of the male are armed with a powerful, blunt, refringent spur projecting distad from the swelling, followed by a short, slender, tapering, terminal portion bearing setae. The modified inner branch of the third foot in the male resembles *L. nordgaardii* in the aspect of the sigmoid, spiniform process of the middle joint, and *L. nana* in the number of setae in the terminal joint. The length of the female is 0.59 mm., and of the male 0.48 mm. (Figs. 17 and 18).

Although *Pseudodiaptomus coronatus* Williams 1906 is reported to be very common in surface net tows among algae in Eel Pond and other suitable spots at Woods Hole, Mass. (R. W. Sharpe, 1910), yet its capture in considerable numbers (up to four per cent. of the copepod gathering) at the Miramichi Station 82 seems to be worth noticing. The genus *Pseudodiaptomus* was created by C. L. Herrick in 1884 for *P. pelagicus* from the estuary of the Mississippi, and was regarded by him as a "missing link" between the fresh-water genus *Diaptomus* and its "fellows of the sea." Other species have been described from the estuaries of the Amazon and the Congo. It is clearly bound up with a certain limited range of density, and illustrates the principle that intermediate form-complexes occupy intermediate locality-complexes.

Next to the rotundity of the head, a striking superficial feature, mentioned by L. W. Williams, is due to the fact that the long natatory setae of feet and furca are jointed at some distance from their bases. A unique characteristic is the disparity of the ovisacs, one of which is only large enough to accommodate

a couple of eggs. Many females, but only one male, came under my observation, although I searched very carefully for more males. The single male occurred in the deep tow at Station 82 on September 7th. In the same gathering there were some six females, none of which carried ovisacs. Females with ovisacs were taken from June to August inclusive.

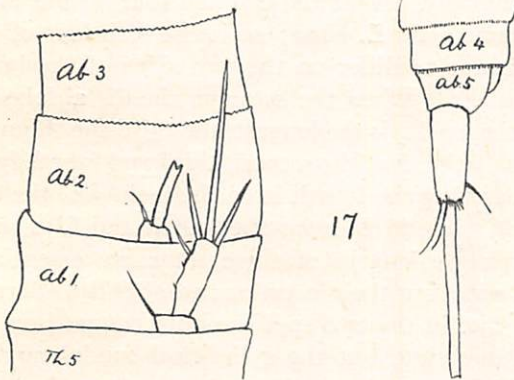


FIG. 17.—*Laophonte huntsmani* n. sp. (male). Portion of urosome with fifth foot from the left side, and end of urosome with furcal ramus from the left side. Miramichi river.

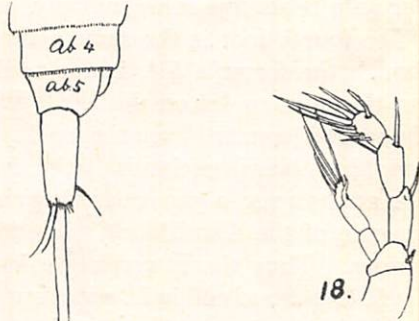


FIG. 18.—*Laophonte huntsmani* n. sp. Third foot of male.

This species is the most remarkable Calanoid in the Miramichi plankton, and when I saw it for the first time I was unable to place it in any genus known to me.

In Giesbrecht's and Schmeil's system (1898), *Pseudodiaptomus* is the seventh genus of Centropagidae; *Diaptomus* is the eighth and *Temora* the fourteenth genus in the same family. Sars (1902), in a footnote, created the family Pseudodiaptomidae to include the two genera *Pseudodiaptomus* Herrick and *Poppella* Richard, which he thinks form a natural group between the Diaptomidae and the Temoridae.

V. HUDSON BAY EXPEDITION, 1920.

In the course of a biological excursion to the Hudson Bay region in 1920, Mr. Frits Johansen succeeded in bringing back with him a valuable collection of plankton from James Bay. As the locality is a new one, the results were likely to be of special interest, and this expectation has been fully realized. The gathering that I have examined was obtained in an all-night setting of the plankton net below the surface off the east coast of James Bay, about latitude $53\frac{1}{2}^{\circ}$ N., September 9th, 1920. It consisted of a great quantity of one of the commonest and most widely distributed of all marine Calanoid copepods, *Acartia clausi*, together with other and rarer forms scattered throughout the mass.

Acartia clausi is equally abundant in Passamaquoddy Bay and is not a high Arctic species, James Bay lying far to the south of the Arctic circle, while for comparison it may be mentioned that Christiania lies on the 60th parallel of

north latitude. Sars describes and figures the last segment of the cephalothorax (Th 5) as having the edge armed with from four to six extremely small and closely set denticles. These cannot be found in the North American individuals, in which the fifth thoracic segment is edentulous. Some of the James Bay examples show a refringent spirally twisted *receptaculum seminis* which I have not observed elsewhere.

Other leading species common to Passamaquoddy and James Bays are *Pseudocalanus elongatus*, *Eurytemora herdmani* and *Tortanus discaudatus*. All of these species have discovered the northwest passage, and are found on the north Pacific coast, as well as on the north Atlantic coast of America. Of *Pseudocalanus* very few adult females were found; of *Tortanus* and *Eurytemora* some of both sexes. To these representative northwest species is to be added the name of one of the most abundant of northern Harpacticoids, from James Bay to Woods Hole, *Idyaea furcata*. An interesting confirmation of the identity of this form with the original type from the Mediterranean and coasts of northern Europe is afforded by its commensal Acinetarian, *Ophryodendron trinacrium* Grube, which I have observed on several occasions in Passamaquoddy Bay at the Biological Station. According to Bernard Collin it attaches itself exclusively to this host.

The *Centropages* of James Bay is not the common North Atlantic species, *C. hamatus*, which occurs in the Gulf of St. Lawrence and in the Bay of Fundy, but it is the representative North Pacific species, *C. mcmurrichi*. A female of this species from James Bay measured 1.30 mm. in length, a male 1.40 mm. The female has the ental spur with the specific marks and proportions on the second joint of the outer branch of the fifth foot (*p 5 Re 2*), right and left. This spur is denticulated on its outer side with two rows of small teeth; and its length somewhat exceeds two-thirds of the length of the end-joint (*p 5 Re 3*). In the male the spur occurs only on the right foot, where it is called the "thumb," while the right *p 5 Re 3* is prolonged into a slender curved "dactylus" which is opposed to the thumb, the two processes together constituting a "chela." In the male *C. mcmurrichi*, the thumb or ental spur of the right *p 5 Re 2* is strongly curved towards the dactylus (*Re 3*) and, measured from its distal angle of origin to the tip, is exactly two-thirds the length of the dactylus, measured from base to apex. The latter (*Re 3*) carries a vestigial spine (*se*) about the middle of its outer curvature, and a small *si* set upon an oblique process (as in *C. hamatus*) on the inner curvature; a short way distad of the *si* there is a strong recurved hamulus, duly figured by McMurrich, but not present in *C. hamatus*. It is clear therefore that *C. mcmurrichi* fulfils the conditions of an elementary species, deviating from the standard at all points.

Stephos sinuatus n. sp. An undescribed species of the Calanoid genus *Stephos* T. Scott 1892 appears in the James Bay plankton. The species of this genus are characterized by an extraordinary complication of the fifth legs in the male. They are bottom-forms (benthonic) and cannot as a rule be captured in the ordinary tow-net. Their presence in the plankton is therefore exceptional and to be attributed to nocturnal excursions. The anterior antennae of *Stephos* are 24-jointed, about as long as the cephalothorax, and the same in both sexes.

In the female of *Stephos sinuatus* n. sp. the last segment of the thorax (*Th* 5) is symmetrical and evenly rounded behind; in the male it is rounded on the left side, bluntly produced on the right. The genital segment of the female is symmetrical, convexly protuberant below; in the male the second abdominal segment is produced below into a blunt process. The fifth legs of the female are three-jointed, counting the basal pieces which are confluent across the middle line; the terminal joint, less than twice the length of the middle joint, consists of a tumid proximal portion, with convex inner border, separated on the outside by a distinct shoulder from the curved, sharp-pointed distal portion with concave inner border; the points of the feet meet like finger-tips in the middle line *in situ*; on the outer side of the distal portion, about the end of the first third of it, there is a delicate spinule beyond which the nearly even outer border appears to be obscurely and minutely ciliate.

In the description of the fifth feet of the male in this genus, writers are compelled to rely largely upon faithful representations in order to spare their text. The right and left feet are nearly equally long but the left foot is more evenly hinged, its segments consisting of two basal pieces and a three-jointed ramus, the inner branch being suppressed. The end-joint of the left foot commonly terminates in a cluster of spines (e.g., *S. gyrans*, *S. fultoni*, *S. lamellatus* and *S. sinuatus*); but in *S. scotti* the terminal joint carries a row of four small, leaf-like appendages outside and two short claw-like lamellae at the tip; in *S. minor* the end-joint has a group of delicate setae (about two in number) outside, a doubly toothed border inside and two blunt digitiform processes at the tip; while in *S. longipes* the end-joint is rectangular terminating at its distal angles in two short processes, one acuminate and straight, the other curved and blunt.

The right fifth foot of the male has one of its proximal segments (the third, corresponding to Re 1) greatly elongated, while the end-joint is variously modified: in *S. gyrans* it appears as a complex clutch; in *S. fultoni*, *S. minor* and *S. scotti* it is a strong, curved claw, shaped like a reaping hook, i.e., falcate; in *S. longipes* it is an acutely geniculate claw; in *S. lamellatus* it is shaped like an irregular hand with several obtuse, digitiform processes; finally in *S. sinuatus* it has a deep, bay-like emargination which possibly serves for threading the spermatophore as it is being sewn on to the body of the female. (Fig. 19.)

CYCLOPOIDA: Of the marine Cyclopoida two species are represented in Mr. Johansen's collection. One of these is a very striking form, *Euryte longicauda* Philippi (= *Thorellia brunnea* Boeck), first described from the Mediterranean. Sars has found it along the whole Norwegian coast from Christiania in the south to Vadso in the north. Its extreme range is from the Polar Islands north of Grinnel Land to the Black Sea. It has not been recorded from the western Atlantic before. In the female, the anterior antenna, although shorter than the cephalic segment, is 21-jointed; the furcal ramus is about nine times as long as its minimum breadth in the middle. In the male the anterior antenna is about 17-jointed, from the fifth to the tenth inclusive the joints are very short and crowded: I have noted the caudal furca as being only four times as long as broad;

as there is no mention of a sexual difference in the length of the caudal rami it seems not impossible that the short-tailed male may belong to another species. A female measured 1.32 mm. in length; a male 0.99 mm. and another male 0.82 mm. The maxillae and the posterior maxillipeds showed the generic characteristics of *Euryte*, the former having a lamelliform palp terminating in a broad serrated edge, and the latter being prehensile and geniculate, the distal portion bent at an acute angle upon the proximal portion.

The other cyclopid Copepod was identified as belonging to a species having the same range of distribution (from the Polar Islands to the Black Sea) as *Euryte longicauda*, namely *Cyclopina gracilis*. The anterior antenna of the male is the same as in the type figured by Sars; in the 4-jointed posterior antenna the last joint is as long as the antepenultimate; the caudal furca of the male is as long as the anal segment, each ramus $1\frac{1}{3}$ times as long as the greatest breadth. It seems likely that it is a brevifurcate form of *Cyclopina gracilis*. The length of the male is 0.50 mm.; a mature female was not found. But an adult female



FIG. 19.—*Stephos sinuatus* n. sp. Fifth pair of feet of male. James Bay.

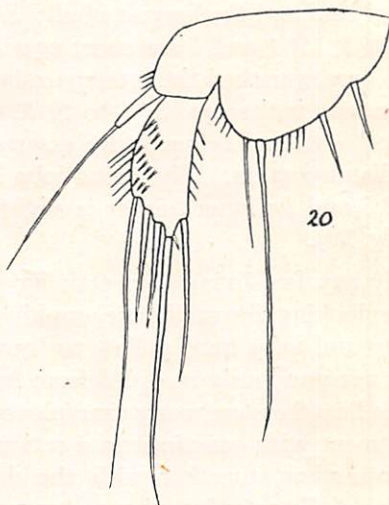


FIG. 20.—*Zaus aurelii* Poppe. Fifth foot of female. James Bay.

was found, in which the furcal ramus is no longer than it is broad and in other respects it agrees closely with *C. brevifurca* Sars, but unfortunately the distal portion of the anterior antennae was broken off on both sides so that this piece of confirmation is lacking. It is not uncommon to find the male of one species and the female of another species of the same genus in one small plankton gathering.

HARPACTICOIDA: In addition to *Idyaea furcata*, already mentioned, there were present a number of other interesting Harpacticoids. The Family Ectinosomidae is represented by *Ectinosoma melaniceps* Boeck; the length of the female measured about 0.55 mm., which is the size of a closely related species, *E. normani*, both having 7-jointed antennules (anterior antennae), but the particular

mark of *E. melaniceps*, apart from colour, is the unusual breadth and lanceolate form of the short outer apical spine on the inner expansion of the proximal joint of the fifth foot, and this feature is exactly reproduced in the specimen which I dissected. Other minor characters confirm the identification.

The family Harpacticidae is represented by *Harpacticus uniremis*, which is frequently associated ecologically with *Idyaea furcata*, and by *Zaus aurelii* Poppe. The latter was first obtained in the North Pacific on floating kelp in Lat. 55° 56' N., Long. 154° 7' W. It occurs also in Passamaquoddy Bay. Its critical mark is to be found in the fifth feet of the female. These are constructed on the same plan as in *Zaus spinatus* and the following differences are based on a comparison between my preparation of *Z. aurelii* from James Bay, and Sars's figure of *Z. spinatus*. The inner expansion of the proximal joint joins the main stem at an acute angle (obtuse in *Z. spinatus*) and the summit nearly reaches the end of the first quarter of the distal joint. The setae of the inner expansion are four in number, *St 1* to *St 4*, counted from within outwards; of these, *St 3* is the apical seta and the longest of all; *St 4* is the slenderest, less than half the length of *St 3*; *St 1* and *2* are short equal spines; the interspace between *St 1* and *St 2* is narrower than the interspace between *St 2* and *St 3*. The distal lobe carries five marginal setae, *St 1* to *St 5*, counted from within outwards; *St 2* is the apical seta and is markedly exerted; *St 5* is slender, with a very fine capillary distal portion. The distal lobe itself is longer than broad in the proportion 12:5 and its inner border is slightly concave, while in *Z. spinatus* it is convex (Fig. 20).

Hardly any free-living Copepods have such an extraordinary shape as the Tegastidae, looking like miniature amphipods, with highly compressed, ventrally flexed body and very hard yellow to brown-coloured integument. The genus *Tegastes* is not previously recorded from America. In Mr. Johansen's collection from James Bay there are many examples of *Tegastes nanus* and fewer *T. falcatus*. After treatment with caustic soda a reticulate sculpturing of the integument is brought into view, together with the dark brown intersegmental junctions. Five species of *Tegastes* have been observed by Sars off the western Norwegian coast, and four of these were taken at one locality, Eggesbonaes, at a depth of three fathoms on muddy sand. *Tegastes falcatus* has been recorded by A. Scott from Ceylon; hence its range is from James Bay to the Gulf of Mannar.

In the family Thalestridae there is a form which I take to be the hitherto unknown male of *Thalestris brunnea* Sars. The intersegmental junctions appeared dark red under the microscope and the integument was so hard that the needle glanced off it; this in itself is given as a characteristic of *Th. brunnea*. The rostrum appears as a short cone, not defined behind; and the furcal rami are shorter than the anal segment. The characters of the second maxilliped and of the mandibular palp confirm the identification. In the first foot the inner spine of the second basal joint is a straight rod abruptly hooked at the tip; the distal joint of the two-jointed inner branch of the second foot carries two sigmoidally curved outer spines, a similar but smaller spine at the apex, three plumose setae and one capillary seta. The length is 0.50 mm. (Figs. 21 and 22).

Another leading member of the family new to the western Atlantic, is *Rhynchothalestris helgolandica*, of which male and female individuals were secured. This is a crimson-banded harpacticoid with long mobile rostrum and very short caudal furca, the rami broader than long. Its specific marks are very distinct and there is no possibility of mistaking it. The length of the female, measured from the base of the elongated rostrum to the end of the abbreviated furca, is 0.75 mm.; that of the male 0.51 mm. The crimson coloration extends to the bases of the thoracic legs and to the basal joint of the 9-jointed anterior antenna.

A third Thalestrid of the same size (0.75 mm.) having a rostrum of medium length defined behind and furca again shorter than the anal segment which in its turn is much shorter than the penultimate segment, and 9-jointed anterior antennae, proved to be *Dactylopusia vulgaris* Sars.

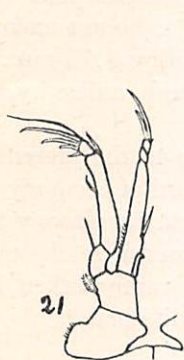


FIG. 21.—*Thalestris brunnea* G. O. Sars. First foot of male. James Bay.



FIG. 22.—*Thalestris brunnea*. Second or distal joint of second foot of male ($p \geq Ri \ 2$).



FIG. 23.—*Stenhelvia gibba*. Distal joint of fifth foot of female. James Bay.

The next family in the Sarsian system is the Diosaccidae, represented by a species which I have identified as *Stenhelvia gibba* with which it agrees in size, 0.63 mm. long. There are however slight deviations which approximate it to *S. proxima*. In the first foot the third joint of the outer branch ($p \ 1 \ Re \ 3$) is shorter than the second joint ($Re \ 2$) as in *S. gibba*, but the whole outer branch (Re) is almost as long as the first joint of the inner branch ($Ri \ 1$) and this joint is very slightly more than twice as long as the two distal joints ($Ri \ 2$ and $Ri \ 3$) combined. In the fifth foot it may be said in general that the shape is like that of *S. proxima*, but the disposition of the setae is more like that of *S. gibba*, without being identical with the latter. On the inner expansion, the two outermost setae ($St \ 4$ and $St \ 5$) are inserted upon a common eminence, $St \ 5$ being very short as in *S. gibba*. Near the inner side of the line of insertion of the distal lobe, the basal lobe presents a slight acuminate spur. The distal lobe is evenly rounded

at the margin; of its six setae, *St 2* and *St 3* (counted from the inside) are extremely slender and equal. In *S. gibba*, as figured by Sars, there is no excessively slender seta, *St 1* being the most exiguous. Ovisacs were not observed (Fig. 23).

In the Canthocamptidae, *Ameira longipes*, characterized by its slender and pellucid body, and a single somewhat aberrant example of *Parameira parva* were picked out.

The last family with which we have to deal is that of the Laophontidae, represented by one of the most extraordinary of all the species which have been mentioned here, namely, the phasma-like *Laophonte horrida*, 1.15 mm. in length. Norwegian examples reach the length of 1.30 mm. It is distinguished by the strong spinous armature of the body. Sars found it rather abundantly in the upper part of the Christiania Fjord at 10-20 fathoms on a muddy bottom; also occasionally off the west coast of Norway up to the Trondhjem Fjord; and T. Scott records it from the Finmark coast. Other extra-Norwegian polar records are mentioned by Sars, and it is stated by A. Brian (1921) to be not uncommon in the Gulf of Genoa, where it is much smaller, not exceeding 0.75 mm. The body is apt to be densely coated with mud when captured fresh, unless by chance it is taken pelagically by night as at James Bay.

In conclusion, the finds recorded from James Bay up to the present may be summarized in the subjoined tables, in which the standard of accuracy aimed at ranges between one and two per cent. Only one *Laophonte horrida* was found, but other *Laophonte* instars were present, and I have named it in the table as the representative of a number of harpacticoid species, rarely taken in the plankton net, which occurred in the material as solitary individuals.

PERCENTAGE COUNT EXCLUSIVE OF ACARTIA.

<i>Pseudocalanus elongatus</i>	2 per cent.
<i>Stephos sinuatus</i>	2 " "
<i>Centropages mcmurrichi</i>	5 " "
<i>Eurytemora herdmani</i>	52 " "
<i>Tortanus discaudatus</i>	8 " "
<i>Cyclopina gracilis</i>	2 " "
<i>Tegastes nanus</i>	8 " "
<i>Idyaea furcata</i>	20 " "
<i>Rhynchothalestris helgolandica</i>	1 " "

PERCENTAGE COUNT EXCLUSIVE OF CALANOIDS.

<i>Idyaea furcata</i>	68 per cent.
<i>Tegastes nanus</i>	16 " "
<i>Tegastes falcatus</i>	4 " "
<i>Rhynchothalestris helgolandica</i>	1 " "
<i>Ameira longipes</i>	2 " "
<i>Dactylopusia vulgaris</i>	1 " "
<i>Laophonte horrida</i> , etc.....	1 " "
<i>Cyclopina gracilis</i>	3 " "
<i>Cyclopina brevifurca</i>	1 " "
<i>Euryte longicauda</i>	3 " "

It cannot be without some significance that the plankton of James Bay, so far as observed, has yielded such a high proportion of well-known species not hitherto recorded from the American coast. Free-living Copepods are not only active in themselves, but they are carried long distances by currents. Every species that we know has doubtless had several thousand years to spread over the seven seas, and some of them have almost achieved an ocean-wide distribution. It is too soon to attempt any far-reaching generalization on the available data, but it seems certain that the Arctic Ocean has been a great centre of dispersal, a fact which may be connected with the extremes of climate of which that region has been the seat during geological time.

Montreal, July 1, 1922.

APPENDIX.

Since the above was written I have ascertained the occurrence of *Laophonte calamorum* in Lake St. John, which lies 120 miles north of Quebec, and am now able to add the description of the male of that species. The length is barely 0.4 mm.; the antepenultimate segment of the anterior antennae is expanded and the terminal segment is bluntly pointed. By these appendages the male holds on to the young female, the two moving about in linear procession as in *Canthocamptus* and some other genera. The second feet are unmodified; the third, fourth and fifth feet are transformed in the male, and there is a pair of setae on each side of the first abdominal segment representing a sixth pair of appendages. Of the six setae of p 3 Re 3, all, except the proximal *si*, are spines, and the same five spines recur on p 4 Re 3, where they are closer together, radiating out somewhat like the spokes of a wheel. The inner branch of the third foot is 3-jointed, and the middle joint has a straight mucroniform process not exceeding the length of the last joint which carries two apical setae and two inner setae. The basal joint of the fifth foot has no trace of an inner expansion; the short distal joint bears two long terminal setae only.

Associated with the *Laophonte* in the littoral zone of a swampy shore on the south side of Roberval, amongst dwarf reeds, was *Eurytemora affinis* Poppe. The history of this Copepod in Canadian waters is as follows: In Sir William Herdman's traverses of the North Atlantic in 1897 it was taken in two gatherings, on the outward and homeward journey, in company with *Eurytemora herdmani*, within a few miles of the mouth of the Saguenay river on both occasions. It is listed, without comment, by the authors of the report, Messrs. I. C. Thompson and A. Scott (Trans. Liverpool Biol. Soc., vol. XII, 1898). Giesbrecht and Schmeil admit the record of *E. affinis* in the Gulf of St. Lawrence with reserve. There is no reason to doubt the identification of so well-marked a species, and in this paper I have established the presence of *E. herdmani* in the Hudson Bay region (Johansen collection) and that of *E. affinis* in the Lake St. John region.

Montreal, September 16, 1922.

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