The Canadian Field-Naturalist

VOL. XXXVIII OTTAWA, ONT., JANUARY, 1924 No. 1

FURTHER NOTES ON CANADIAN EUPHYLLOPODS

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THE following are my observations on this group of Crustaceans, made after the publication of my article in *The Canadian Field-Naturalist* for January, 1923.

The cold weather during the first eighteen or nineteen days of April, 1923, when the temperature was mostly below the freezing point, delayed the arrival of spring around Ottawa, and consequently also the hatching and development of Phyllopods. Thus on April 8th I went to the collecting locality on the fields at Billings' Bridge and found them all flooded by the overflow of the Rideau River, now breaking up, making them impossible of approach. The cold weather at this period would, however, prevent the hatching of any Phyllopod eggs; nor were there any pools formed yet by the water receding. On April 15th I went out to Fairy Lake and examined the pools on the fields north of it where fairy-shrimps generally occur. Though the land was practically free of snow, the ponds had new ice an inch thick, a result of the last cold days, although the winter ice had apparently melted during the mild weather around April 10th. I examined particularly the deep pond where the fairy-shrimps are so numerous later in the year, but there were no signs of hatched eggs or of larvæ. The water had a temperature of 36°F. (air 34°F.) under the ice, at 4 p.m. Overcast, slight wind.

On the 19th of April the weather was clear and the maximum temperature rose to 48°F., and the minimum was just above freezing, owing to southerly winds; and the next day clear, warm weather came on suddenly, the maximum temperature reaching 76°F., though the minimum was only 28°F. The result was the immediate hatching of the eggs of *Eubranchipus gelidus* in certain ice-free ponds on April 19-20th; but the eggs of *Limnetis gouldii* did not hatch until the last three days of the month, though the temperatures during the intervening week were between 30° and 70°F.

It will thus be seen that in 1923 the fairy-shrimps first appeared about 10 days later than in 1922, and the clam-shrimps almost a week later than in the preceding year. Furthermore, the last specimens of both species were found five to eight days later in 1923 than in 1922; viz., *E. gelidus* on May 27th, and *L. gouldii* on June 26, 1923. It is one of the puzzles of nature why *Limnetis gouldii*, around Ottawa, hatches a week or two later than *Eubranchipus gelidus*, even in the same pool, though its growth to maturity takes a longer time (about a month) than *E. gelidus*, which latter becomes ripe in a fortnight.

Eubranchipus gelidus.

As mentioned, this species hatched in 1923 around Ottawa on April 19th and 20th, and by an excursion to Fairy Lake on April 21st I secured definite proof of this. It was a lovely, clear day, about as warm as the preceding one, and with a fresh breeze. I examined the various pools on the pasture fields north of the lake, but, even though Copepods were numerous, I saw no Cladocera nor Ostracods, and fairy-shrimps in one pool only, the one nearest Wrightville, where I have never found them before. The fairy-shrimps (*E. gelidus*) were now all in the metanauplius stage and of a size from 1½ to 4 mm. long, and far fewer than the Copepods also occurring here. Owing to their transparency they were difficult to see, and they were found only in the deeper parts of the pond where the water was 1 foot to 1½ feet deep, and where there were many dead leaves on the grass-bottom. Standing in the pool in my rubber boots, I secured a number of them by the aid of a pipette. Temperature of air and water at 6.30 p.m. was 60°F.

We are again greatly indebted to Professor G. O. Sars of Christiania, Norway, for the two beautiful figures of the youngest and the middle-sized metanauplii from this pool and date, shown on the plate accompanying this article. These represent stages of *Eubranchipus gelidus* never before recorded or described; ones 3 mm. long being the earliest stage hitherto known. It will be seen that the youngest larvæ (1½ mm. long, Fig. 1), of which only a couple of specimens were found, are similar to the corresponding stages of its arctic relative, *Branchinecta paludosa*, so well described and figured already (see G.O. Sars: *Fauna Norvegiæ, I, Phyllocarida et Phyllopoda*, Kristiana, 1896, p. 53, Tab. VIII, figs. 15, 16, and F. Johansen: *Euphyllopod Crustacea of the American Arctic, Rep. Can. Arctic Exped.*

1913-18, Vol. VII, Part G., Ottawa, 1922, pp. 17-20). The main difference lies, as Prof. Sars points out in his letter of September 24, 1923, to me, in the first pair of antennæ (*A*), which in the *Eubranchipus* larva are much larger, heavier, and longer* than in the *Branchinecta* larva. It will, however, be seen that the *Eubranchipus* larva represents a stage between the two larvæ figured (1896) by Sars, having the same relative size of the two pairs of antennæ (*A* and *AA*); the same small number (6-7) of foliaceous legs (*P*), with the hindmost 4-5 ones hardly indicated on the tapering, clumsy abdomen (*T*), which ends in a pair of simple (not double or triple) spines (*N*), and the same general shape of the whole larva as the youngest stage figured in Sars' Fig. 15 (1896).

On the other hand, this youngest *Eubranchipus* larva known is similar to the larva figured in Sars' Fig. 16 (1896) in several particulars. Thus both paired eyes (*EE*) are similarly and well indicated; the labrum (*L*) is of a similar† shape (spoon-shaped), though comparatively larger than in Sars' Fig. 16, and the innermost pair of the two pairs of separate stylets or spike-bristles (*B*), originating on the base of the second pair of antennæ and parallelling the labrum on each side are cleft at the hairy end. Each of the half-a-dozen foliaceous legs developed is also similar to the foliaceous legs developed in Sars' older larva (Fig. 16), though the latter has about nine foliaceous legs out. The outermost pair of the two pairs of stylets mentioned, on the base of the second antennæ, are long, pointed and slender and end in about ten hairs on the inner side; there are also two pairs of similar, but shorter spike-bristles (*BB*), the innermost pair shortest, on the mandibular palp (*Mp*), besides its three terminal spines. The short branch of the second antenna has four terminal spines and its long branch 4-5 times as many, covering its whole length. The first pair of antennæ end in one short and two long hair-spines; and the upper (first) foliaceous legs have five short, terminal spines and four similar spines above the "gill" or respiratory lobe, the number of these spines decreasing on the succeeding, foliaceous legs.

At the time of collecting these *Eubranchipus* larvæ I made a sketch of what I considered the youngest stage (1½ mm. long), which sketch differs from Prof. Sars' drawing reproduced here in a few minor details, which I venture to set forth. In my drawing of the larva the paired eyes are better developed and set off; the labrum more slender or narrow and decidedly spoon-shaped (as is the bill of *Ornithorhynchus* seen from above) and the abdomen-tail comparatively shorter and more rounded above than in Prof. Sars' drawing. I also find a tiny spine on the outside of each of the 2 long spines in which the abdomen-tail ends; and eight, instead of six or seven, foliaceous legs free of the abdomen-tail, with only one, instead of two or three, more foliaceous legs indicated. Nor was I able to discover the innermost pair of the two pairs of spike-bristles on the base of the second antennæ; but Prof. Sars' drawing is probably more correct than mine, which was made by magnifying about 100 times, ventral view. The larva figured by Sars is probably a little younger than the one I sketched.

When collecting these *Eubranchipus* metanauplii, I noticed that the youngest individuals, described above, had a paler, more whitish and transparent general colour than the older ones, apart from the paired eyes and the large, orange maxillary gland inside the labrum. These youngest individuals were very lively in their movements, jumping in the water by the aid of the large swimming antennæ (*AA*) and holding themselves in more of a vertical than a horizontal position during this, a characteristic of all Phyllopod-nauplii. They were also quite tenacious to life, being still alive in the corked vial when I reached my office several hours after collecting them.

The second drawing made by Prof. Sars (Fig. 2 on the plate) shows a little older stage, when the metanauplius is about 2 mm. long. It will be seen at a glance that the paired eyes (*EE*) are now much better developed and set off than in Fig. 1, also the second pair of antennæ (*AA*) and mandibular palps (*Mp*) are much smaller in proportion, while the foliaceous legs (*P*) are much better developed both as to number, hairs (spines) and branches, the total number (eleven) of the adults being present, though the two hindmost pairs are as yet rudimentary. Behind the last pair will be seen on each side of the abdomen-tail a similar swelling or rounded process, the beginning to the genital organs (*G*). The abdomen-tail (*T*) is thick and almost cylindrical, not cone-shaped as in the younger stage, and ends in two long, single spines, longer than in the younger stage, each one with a small, single spine on the outside (*N*). It will also be seen that the length of the head, including labrum, is only one-fourth of the total length, while in the younger stage (Fig. 1) it is one-third. This is, of course, due, not to any great decrease in the size of the head, but to a considerable lengthening of body and tail. The first pair of antennæ (*A*) are still large, almost as long as the head.

*In addition I would suggest that in the *Eubranchipus* larva (youngest stage) the abdomen-tail (T) behind the foliaceous legs (P) is thicker (more clumsy and cone-shaped), and the two spines (N) in which it ends, longer, than in the *Branchinecta* larva.

†The shape of the labrum seems to be more spoon-shaped in the *Eubranchipus* larva, and more oval in the *Branchinecta* larva.

These 2 mm. long metanauplii of *Eubranchipus* thus correspond almost exactly to the stage of *Branchinecta* mentioned and figured by Sars (1896, p. 55, Tab. VIII, Fig. 17); but the *Eubranchipus* larvæ are readily distinguished from the *Branchinecta* metanauplii by the much longer and thicker first pair of antennæ (*A*); by the more spatulate than oval-shaped labrum (*L*), and by the different number and shape of the spines (*N*) in which the tail (*T*) ends (see above). Although Sars (1896) does not include the body and tail in his Fig. 17, it is clear from the little younger stage (Fig. 16) of *Branchinecta*, that the cercopods (paired process) (*C*), in which the tail ends, develop much earlier in *Branchinecta* than in *Eubranchipus* (where they are first found at a length of 3 mm.), and carry at least 3 spines, as compared to the two spines (*N*) protruding directly from the tail-end of *Eubranchipus* larvæ 2 mm. long.

The colouration of these 2 mm. long metanauplii of *Eubranchipus*, when alive, was more vivid orange than in the 1½ mm. stage, but less so than in the ones 3-4 mm. long. It need bardly be added that the position, when swimming, is partly vertical, partly horizontal, and that the movements are effected both by the second pair of antennæ and by the foliaceous legs, the tail not yet being sufficiently long and movable to be of much assistance.

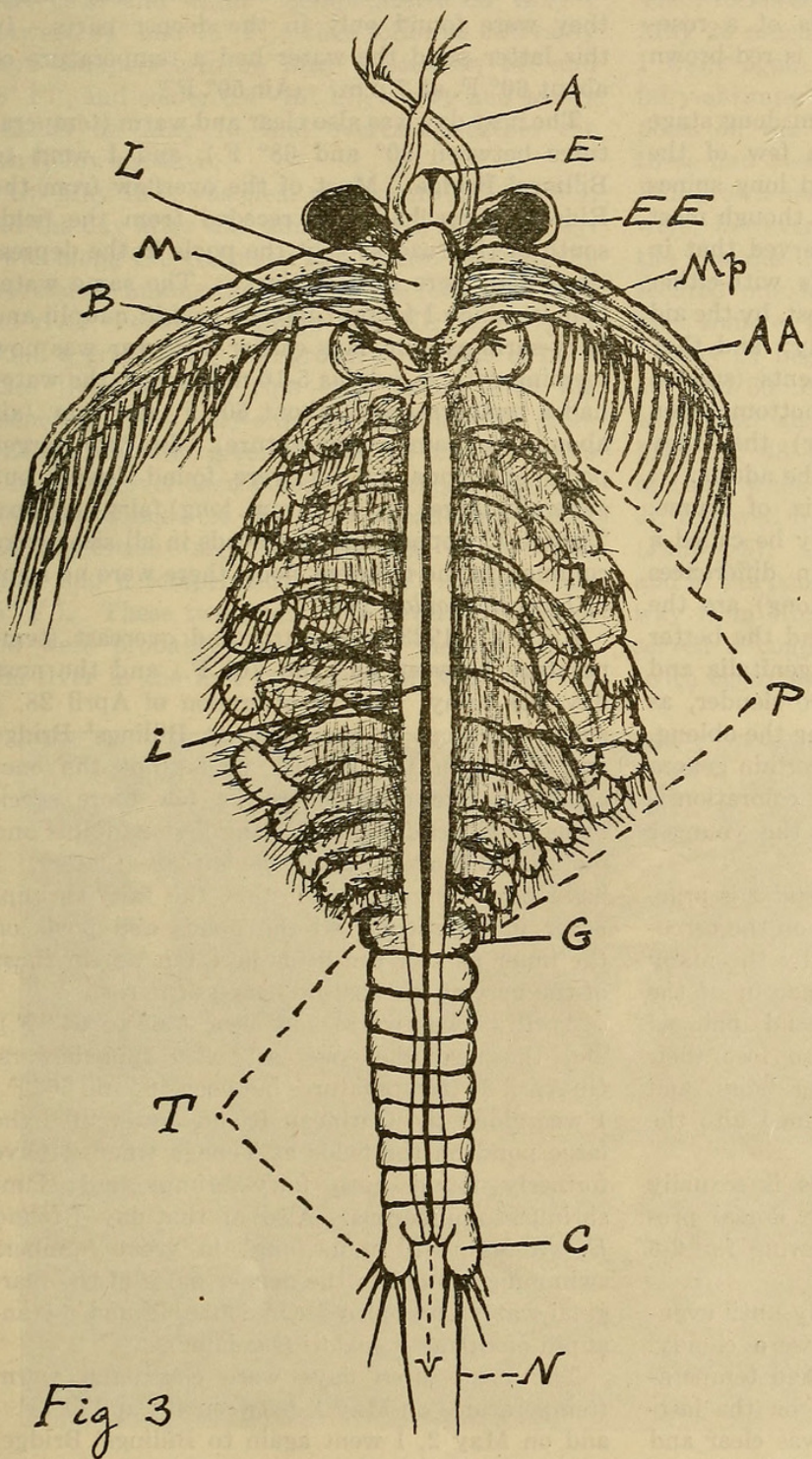


Fig 3

To illustrate the appearance of *Eubranchipus gelidus* at the stage where it is 3 mm. long, I reproduce a rough sketch of the youngest specimen collected by Dr. A. G. Huntsman in a pond near Bond Lake, at Toronto, Ontario, on April 10, 1920 (see *The Canadian Field-Naturalist* for February, 1921, p. 28). The same stage was collected by myself at Billings' Bridge, Ottawa, Ontario, on April 13, 1922 (see the same publication for January, 1923, p. 1), and, as mentioned, on April 21, 1923, near Wrightville (Hull), Quebec, (see below).

It will be seen from my sketch (Fig. 3), about 100x, that the two pairs of antennæ (*A* and *AA*) are still fairly large (1 mm. long), and the paired eyes (*EE*) still better set off on peduncles and developed; but that the mandibular palps (*Mp*) and labrum (*L*) are now much smaller, and the latter more oval in shape than formerly. On the other hand, the mouth-parts (maxillæ and mandibulæ) and particularly the foliaceous legs (*P*) are better developed, all eleven of the latter ones now being free of the abdomen-tail (*T*) and practically as in the adults, except the last 1-2 pairs. The head and body occupy exactly two-thirds of the total length, and the genital region is better indicated than in the younger stages. Apart from

the genital segment (*G*) the tail (*T*) consists of eight segments or rings, the last one of which runs out laterally into a pair of oval lobes or cercopods (*C*), supplied with five rather long spines, and the whole shape of the tail is oblong-cylindrical and square "cut" at both ends, as in the adults, though shorter.

As for coloration, when alive, the back, tail (including cercopods) and two pairs of antennæ are pale; the nauplius-eye (*E*) black, and the paired (composite) eyes (*EE*) red-purple; the intestine (*I*) shows green contents (algæ), and the foliaceous legs have their free ends of a rose-orange colour, while the labrum (*L*) is red-brown (maxillary gland).

It will thus be seen that this 3 mm. long stage of *Eubranchipus gelidus* has still a few of the larval characters (large antennæ and long spines on cercopods, paler coloration, etc.), though most of the adult characters. I also observed that in life they swim in the water *horizontally*, with either the dorsal or the ventral side uppermost, by the aid of the foliaceous legs almost entirely; and they showed also by their other movements (sudden jerks with the tail, seeking the bottom when disturbed, and circling in the water) that they had acquired most of the habits of the adults.

The stage which is 4 mm. long is, of course, still nearer the adult, and can hardly be called a metanauplius any more. The main differences from the preceding stage (3 mm. long) are the still smaller antennæ and labrum, and the better development of the foliaceous legs, genitalia and tail. The latter is longer and more slender, as are the cercopods; the latter assuming the oblong, lanceolate form so characteristic of certain genera of adult fairy-shrimps. The general coloration is of course also more vivid than in the younger stages.

At a size of half a centimeter *E. gelidus* is practically as the adults, the long spines on the cercopods falling off and being replaced by the many short, fine hairs which fringe the margin of the cercopods in the adult. The second pair of antennæ and mandibular palps also lose their appendages (spike-bristles) and long hairs, and the former are in the male transformed into the large claspers used for copulation.

At a length of $1\frac{1}{2}$ cm. *E. gelidus* is sexually mature and developed (female with dorsal processes, etc.), though they keep growing for 2-3 weeks longer.

On April 22, 1923, it rained heavily until evening, and the two following days were cloudy. April 22-25, 1923, around Ottawa, had temperatures between 34° and 60° F., and on the last-mentioned day, when the weather was clear and warm, I went to the same collecting-locality (Wrightville) where I had gone ten and four days before. I now found the same pool that I examined on April 25 full of young *E. gelidus*, now measuring 4-12 mm. in length, though the great bulk of them were less than 10 mm. long. The large, shallow pond a little south of it, where *E. gelidus* generally occurs, contained on this occasion, only a few fairy-shrimps, measuring between 5 and 9 mm., but in the deep pond west of it (see April 15, 1923, etc.), where they seem to be so much more numerous every year, many more of the same lengths were collected, though they were found only in the deeper parts. In this latter pond the water had a temperature of about 60° F. at 7 p.m. (Air 50° F.)

The next day was also clear and warm (temperatures between 30° and 68° F.), and I went to Billings' Bridge. Most of the overflow from the Rideau River had now receded from the fields south of the road so that the pools in the depressions here were now distinct. The same water hole in which I found *Limnetis gouldii* nauplii and fairy-shrimps four days earlier last year was now teeming with *E. gelidus* 5-10 mm. long; the water had a temperature of about 60° F. at 7 p.m. (air about the same temperature). In two larger pools or ponds nearby were found fewer, but generally larger (up to 12 mm. long) fairy-shrimps. Though Copepods and Ostracods in all sizes were common in the different pools there were no signs of *Limnetis gouldii* yet.

April 27, 1923, was warm and overcast (temperature between 36° and 70° F.) and the next day was rainy. In the afternoon of April 28, I again went out to the fields at Billings' Bridge and found in the smaller pools (not the ones examined two days before), a few more specimens of *E. gelidus*, besides the first nauplius and metanauplii of *Limnetis gouldii* (see later). I have now assured myself that the fairy-shrimps occur in practically all the ponds and pools on the inner part of the fields here but not in those of the part of the pasture nearest the road.

April 29 was warm and clear (36° to 64° F.), and the next day overcast with rain-showers. On April 30 (temperatures between 36° and 56° F.) I was along the Gatineau River, and visited the large pond on the fields at Tenaga where I have formerly found both fairy-shrimps and clam-shrimps so numerous. Also, on that day, I found *E. gelidus* (5-13 mm. long) in great numbers swimming around in the deeper parts of the marginal water; and also secured nauplii and metanauplii of *Limnetis gouldii* (see later).

The next three days were clear and warm (temperatures on May 1, between 40° and 58° F.); and on May 2, I went again to Billings' Bridge. All the pools on the inner part of the pasture

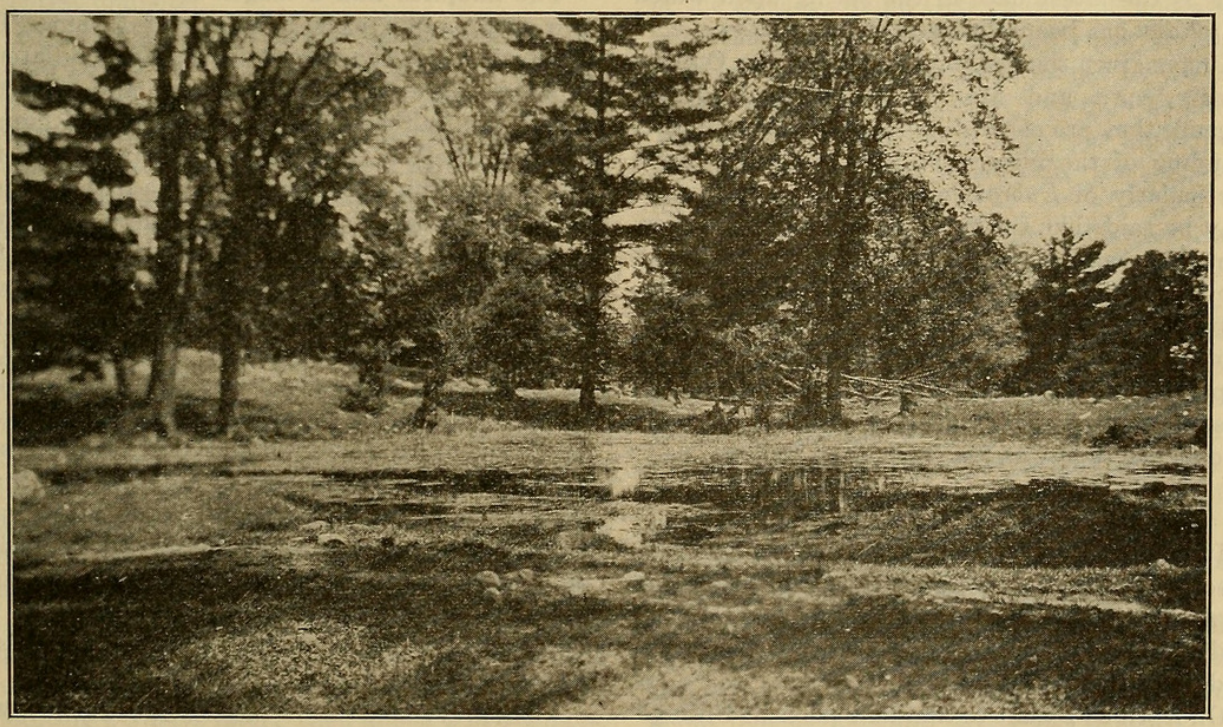
were now teeming with *E. gelidus*, even the ones almost dried up. Some of the pools were already dried up completely; and it thus seems as if a great many fairy-shrimps are killed before their time is up, when they occur in very small pools. In size, they were between 10 and 15 mm. long, and mostly sexually mature (females with ripe eggs, males with big claspers, etc.). I kept some of the specimens collected alive until 16 days after, the females living the longest.

May 4 began rainy, but the next three days were clear and warm (temperatures on May 7 between 44° and 76° F.); then followed two rainy days (temperatures on May 8 between 44° and 78° F.), and colder (24°-46° F.), snowy and windy weather on May 10, and overcast weather the two following days.

On May 13 it was clear and warm (34°-62° F.); and the day after was similar, a real summer day. I was along the Gatineau and in two pools in the depressions among the trees on the rocky hill near the river, between Tenaga and Kirk's Ferry, I found a great many full-grown *E. gelidus* of both sexes (females with ripe eggs, males with big claspers). The fairy-shrimps had almost more brilliant, metallic, greenish and red-brown colours than I had ever seen before, probably a result of the deep colours of the many dead leaves and the vegetation (algæ, etc.) in the water. The latter had a temperature of 43° F. at noon (air 55° F.). These two pools were several feet deep and were probably the result of melting snow. The river in the first two weeks of May rose far beyond its normal level, inundating all the lower land on both sides, but the pools were found beyond its reach. Fairy-shrimps have not before been observed in these pools. In the pond examined two weeks earlier, many adult *E. gelidus* were also found on this date (females with ripe eggs); both in this pond and in the 2 pools nearer Kirk's Ferry a few immature individuals were collected.

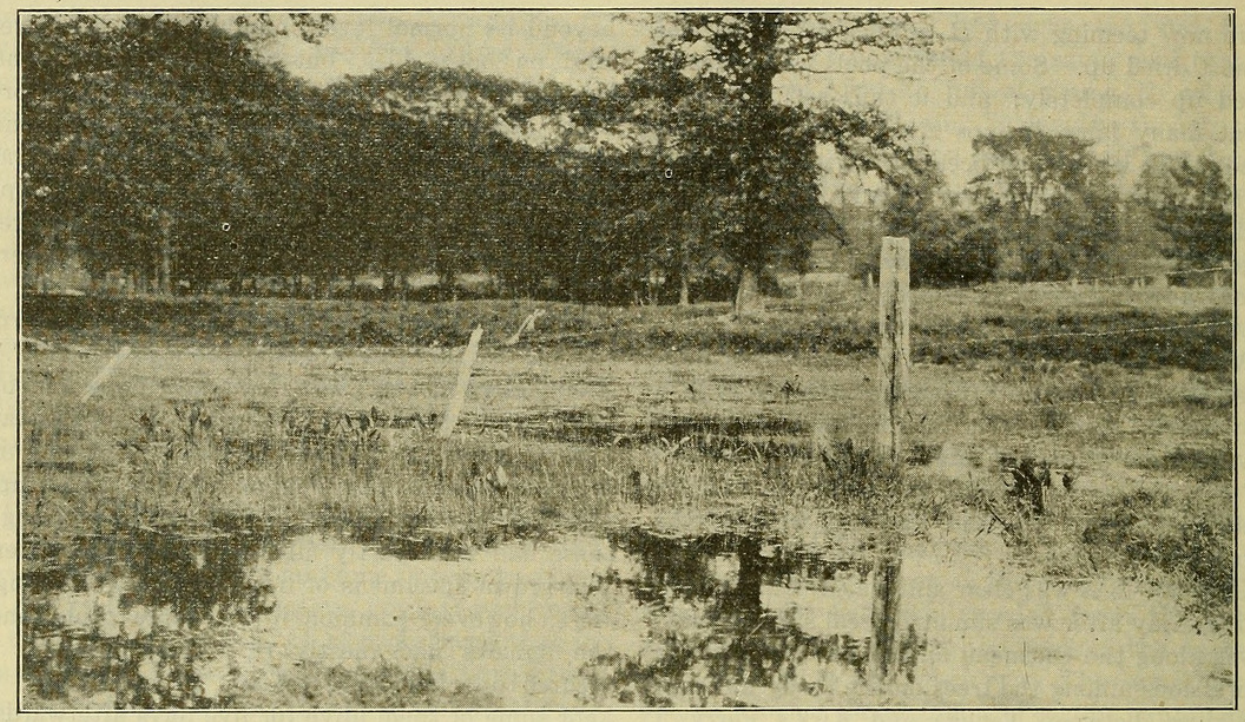
The next 3 days were rainy, May 16 being warm (50°-72° F.), the two other days cooler (40°-56° F.). Then followed two clear and warm days and on May 20 much rain fell from noon on. That day I went again to Billings' Bridge but found no fairy-shrimps in the smaller (almost dried up) pools on the inner part of the pasture, though these had been partly filled again by rain-water. Full-grown specimens of both sexes, 1½ cm. long, were, however, common in the large pools, and the females had mostly ripe eggs, although I secured one immature female, 10 mm. long. I kept some of them alive for five days afterwards.

May 21 began overcast (temperatures between 48° and 56° F.); but then came a longer period with clear and warm weather, (temperatures on May 28: 48°-68° F.), lasting until the beginning of June, when it changed to hot and sultry (June 3), followed by a thunderstorm and rain-showers (June 4-5). On May 27 I was at Westborough and in the pool in the woods along the new Driveway from Richmond Road to the Rapids I observed a couple of full-grown female *E. gelidus* (with eggs), swimming around in the deeper part



Photograph by D. Jenness

Pond at Tenaga, Quebec, May, 1921



Photograph by F. Johansen *Ponds at Billings' Bridge, Ontario, May, 1921*

of the pool, and quickly hiding themselves among the dead leaves at the bottom when I tried to catch them. These must have been the very last fairy-shrimps still alive this year, because in spite of careful looking only 2-3 specimens were seen in this pool. They had not formerly been observed there; and the pool is apparently formed by melting water from the surrounding drier swamp, dammed up by the building of the new driveway. This is the latest date in the spring upon which *E. gelidus* has been observed around Ottawa.

I have given the meteorological data for Ottawa during April and May, 1923, in such detail, because they are of vital importance for an understanding of the biology of *Limnetis gouldii*, and particularly of *Eubranchipus gelidus*. Indeed, it may be said that the fairy-shrimps are as important a presage of spring as are certain birds and the frogs, and in addition, by their complete disappearance in the middle or the end of May, signify the advent of summer weather. It is my hope that in the future they may be included in phenological observations, and studied in detail also at places in Canada other than Ottawa.

Limnetis gouldii (*L. brachyurus.*)

It has been mentioned above that in 1923 this species did not occur around Ottawa until the end of April, though careful search was made for it, and *Eubranchipus gelidus* occurred from the middle of the month on.

On April 28 I went to the same pools at Billings' Bridge, Ontario, where I secured *L. gouldii* last year (see *The Canadian Field-Naturalist* for January, 1923, p. 2), and in a small pool similar to the one in which I had secured *E. geidus* two days before, I now found one nauplius and 2 metanauplii of *L. gouldii*. I used the same method as last year; but though I kept at it for an hour I did not get any more larvæ, which indicated that the eggs had only just begun to hatch. The water in this pool had a temperature of 50° F. at 7 p.m. (Air 57° F.; misty rain.)

The nauplius had a length of ½ mm. and the two metanauplii each a length of ¾ mm. The former had the characteristic appearance (lateral, cephalic "horns", nauplius-eye ,and "turtle-shell", etc.) already described by me and figured by Sars (*C. F.-N.* for January, 1923), though the one secured this year seemed to be a little younger than the nauplii found last year here, while the metanauplii already had the paired eyes, the double carapace ("clam-shell"), several foliaceous legs, etc. These 3 specimens have been presented to the U.S. National Museum. I kept them alive for awhile in a vial and noticed that the nauplius, when swimming in the water, holds itself mostly vertically, with the hind-end downwards; uses during this the second pair of antennæ and mandibular palps simultaneously; and after each forward movement (stroke) the larva falls back a little, as is the case with the corresponding stages of fairy- and tadpole-shrimps (see *Meddel. om Grönland*, Vol. XLV, p. 336, and *Rep. Can. Arct. Exped.*, 1913-18, Vol. VII, Part G., p. 18.)

The pond on the fields at Tenaga, Quebec, was visited on April 30, and *L. gouldii* was also common this year in the shallow, marginal water of it,

together with *E. gelidus*. The water had a temperature of 52° F. at 4.30 p.m. (Air 46° F.; rainy.). Only one of the larvæ found on this date was in the nauplius stage ("turtle-shell", etc.) and measured ½ mm.; the others, though not much larger (up to ¾ mm.), all had the double carapace ("clam-shell", etc.), and were thus in the metanauplius stage. They occurred particularly at places where dead leaves covered the bottom of the pond, and quite a few were secured.

On May 20 I again went to Billings' Bridge and examined the pools here carefully, but though Copepods, Ostracods and *Eubranchipus gelidus* occurred in thousands, I secured only four larvæ of *L. gouldii* (all metanauplii), three of which measured ¾ mm., and one 1 mm. in length. The water in the pool where they occurred had a temperature of 60° F. at 7.45 p.m. (Air 50°F.; clear).

It will thus be seen that in 1923 *L. gouldii* hatched around Ottawa in the last days of April and the first days of May. Apparently, however, some of the eggs hatch before the others in the same pool, and they hatch better in some ponds, as in those at Tenaga, than in others, such as those at Billings' Bridge.

I was surprised not to find any *L. gouldii* in the two pools between Tenaga and Kirk's Ferry where *E. gelidus* and other Entomostraca were so common on May 14, as it seemed an ideal place for them. They were, however, common enough in the pond at Tenaga where I secured them two weeks before; they now measured 1-1½ mm. in greatest diameter.

By visiting Billings' Bridge again on May 20, I found *L. gouldii* to be very common in the large pools or ponds on the pasture. The specimens secured measured from 1½ to 2 mm. in longest diameter, and (particularly the smallest ones) had a vivid, orange colour, the foliaceous legs and head being strongest colored. The water in these pools had a temperature of about 60° F. at 6 p.m. (Air 58° F.; rainy). The other smaller pools on the pasture had dried up completely or nearly so, and though they had been partly filled again by the heavy rainfall of last week, no Euphyllopoda were found in them now. The young *Limnetis* observed today were moulting frequently; but, although I kept a number of them alive and isolated two of the size-extremes, I was not able to get definite data about this, as they died before the shell was moulted. From my observations I would, however, suggest that the moulting of the shell, involving the change from a nauplius into a metanauplius, takes place in 1-2 days; the next moulting 2-3 days later; then another in 3-4 days, and so on fairly regularly, with longer and longer intervals between two successive moultings.

On June 5 I again visited Tenaga, and the *L. gouldii* were still numerous in the pond where they were collected three weeks before. The animals were keeping to the vegetation along the margin of the pond, but there were no *Eubranchipus gelidus* at all to be seen. The twenty specimens of clam-shrimps collected measured from 2¼ to 3 mm., and had a brilliant orange colour, paler when seen in the water. Both sexes were represented; and the females had dorsally, on each side inside the shell, about fifteen olive-green eggs, which fell out when the mother animal died. The two sexes were frequently seen in copulation, the male being by far the most energetic during this (see below).

On June 16 I again visited the fields at Billings' Bridge, and found *L. gouldii* common enough in several of the pools on the inner part of the pasture. Both sexes were present and frequently found in copulation, the females carrying eggs. Their size was now 2-3 mm., the females being the larger. Some of them were bright orange, others were brownish, and this difference in colour was not according to size or sex, but accidental.

On June 26, I was along the Gatineau and found a few living, full-grown *L. gouldii* in the usual pond at Tenaga. The eight specimens secured all had a bright orange-red-brown colour, with a growth of white Infusoria and green Alga-mould on the shell, foliaceous legs, etc. Four of them were females with eggs, which copulated freely with the four males, which latter had the same size as the females. This is the last occurrence of the species around Ottawa in 1923, and a week later than in the two preceding years; probably their late occurrence can be explained by the delay in the hatching of the eggs two months earlier. The weather during June, 1923, was mostly clear and warm with half a dozen rainy days scattered through the month.

A number of clam-shrimps collected during June, 1923, were kept alive for study, and I made the following additional observations of them.

During the copulation the male grasps, by the aid of the "hand" (modified, first pair of foliaceous legs) the female's shell, attaching themselves on the middle part of the free margin of one of the valves (carapace-shell); thus assuming a position vertical to that of the female, and with the beak of the head pressed against the "umbo" of this valve. It then moves its foliaceous legs continuously, and keeps the two valves of its own shell open, and when the female opens its two valves, the male bends the hindpart of its body in between the valves of the female shell, keeps it there for about five seconds and withdraws it again. This takes place a couple of times each minute, unless the female keeps its shell closed, swims vigorously

around alone, or the pair is disturbed by a third, visiting clam-shrimp. During the act of copulating the tail-end or abdomen of the male is bent back and protrudes from the female shell, and thus forces the valve of her shell opposite to the one to which his "hand" is attached to remain open as long as the copulation lasts. The genital organs have their aperture ventrally, between the thorax (foliaceous legs) and the last body-segments (abdomen); and it is therefore this part of the male's body which is inserted between the last pairs of foliaceous legs of the female, during the copulation. The latter takes place almost as soon as a male meets a female, even if the latter one carries eggs in the form of an olive-green colored mass on each side of the body, dorsally.

When these clam-shrimps were kept alive in water, many of the eggs would fall out from the females, thus showing that they were ripe; and both Prof. Sars and I have gone to much trouble to try to hatch them artificially, but without any success so far, though both dead mother-animals, deposited eggs, and mud from the ponds in which they were found were kept for years. These remarks hold good for *Eubranchipus gelidus* too; and the only way to get hold of the nauplii of these two Euphyllopoda thus seems to be to examine particular ponds carefully on the day the eggs hatch in nature.

EXPLANATIONS TO THE FIGURES

Ventral views of *Eubranchipus gelidus* metanauplii (*Originals*). Fig. 1, a larva 1.41 mm. long (youngest stage observed); fig. 2, a larva 2.15 mm. long.

Both figures drawn by Prof. G. O. Sars, from specimens collected at Ottawa on April 21, 1923, by F. Johansen. Fig. 3, sketch by the author of a larva 3 mm. long, collected by Dr. A. G. Huntsman, near Toronto, on April 10, 1920.

Legend: *A*, first pair of antennæ; *AA*, second pair of antennæ; *E*, the single nauplius-eye; *EE*, the paired, composite eyes; *L*, labrum; *B*, spike-bristles on base of second pair of antennæ, with *X*, the cheliform process; *Mp*, mandibular palps, with *BB*, spike-bristles on their base; *P*, foliaceous legs; *I*, intestine; *G*, genitalia-segment; *T*, abdomen-tail, ending in spines, *N*, and (later) a paired process, the cercopods, C; V, vent (anus); *M*, maxilla.

NESTING HABITS OF THE AMERICAN GOSHAWK

By A. D. HENDERSON

IN THE vicinity of Belvedere, Alberta, the American Goshawk is a regular resident, but is not numerous and is yearly becoming scarcer, as it is a bold hunter and is often shot when it comes around the farms in pursuit of pigeons and poultry. Its main food, however, is Ruffed Grouse and hares. The usual breeding place is in heavy poplar woods containing a scattered growth of spruce.

I have seen these birds in mid-winter in the Clear Hills, in the Peace River country, and also observed a nest with bird sitting near White Mud Prairies on April 28th, 1916. At Belvedere it is the earliest breeding Hawk and eggs can be taken throughout April and into May.

The first nest I ever examined was about twenty miles south of Belvedere on April 14th, 1903. It was in the crotch of a tall poplar and contained one egg and the bird was sitting. On April 18th, 1906, I observed a Goshawk sitting on a nest in the forks of a large poplar. On climbing to the nest I found it contained one egg. This nest was the usual structure built by a large Hawk, and was made of dead sticks with a lining of strips of dry poplar bark and a few green spruce twigs. It was about thirty feet from the ground. All the nests of the Goshawk I have examined were of similar construction, except that in most cases the green spruce twigs were omitted. The height of the nests varied from about twenty-five to seventy-five feet.

When a nest is being taken both birds usually remain in the vicinity uttering cries of *Kek, Kek,* and *Quee, Quee, Quee*. Sometimes only one bird is seen at the nest. Often a bird will swoop fiercely at the climber's head and has to be warded off or it would surely strike. On one occasion one hit my hat a hard blow. After the eggs are taken the bird will often return and sit on the edge of the nest or resume sitting.

The Goshawk usually uses the old nest of another Hawk, building it up on top and relining it, but often builds a complete nest of its own. It seems to be attached to the locality in which it breeds and will sometimes occupy the same nest for a number of years. If the same nest is not occupied, the bird will probably be found breeding in the same belt of timber not far away. I have never found a nest in an evergreen tree. When I first started looking for Hawks' and Owls' nests I examined every spruce with care, but as a matter of fact few nests are found in them in this locality.

Nesting dates of the Goshawk at Belvedere are as follows: April 11th, 1913, three eggs, fresh. April 24th, 1913, two eggs, fresh. May 1st, 1913, two eggs, fresh. May 27th, 1913, two eggs, fresh. April 5th, 1914, three eggs, fresh. April 6th, 1914, two eggs, fresh. May 9th, 1914, six eggs, incubation advanced. April 21st, 1915, four eggs, incubation advanced. April 24th, 1915, three eggs, incubation slight. May 1st, 1922, four eggs, incubation slight. April 19th, 1923, three eggs, incubation slight.

The Goshawk does not like intruders near its nest and I have seen a pair of Goshawks noisily drive a Great Horned Owl out of a grove, two hundred yards from their nest. On another

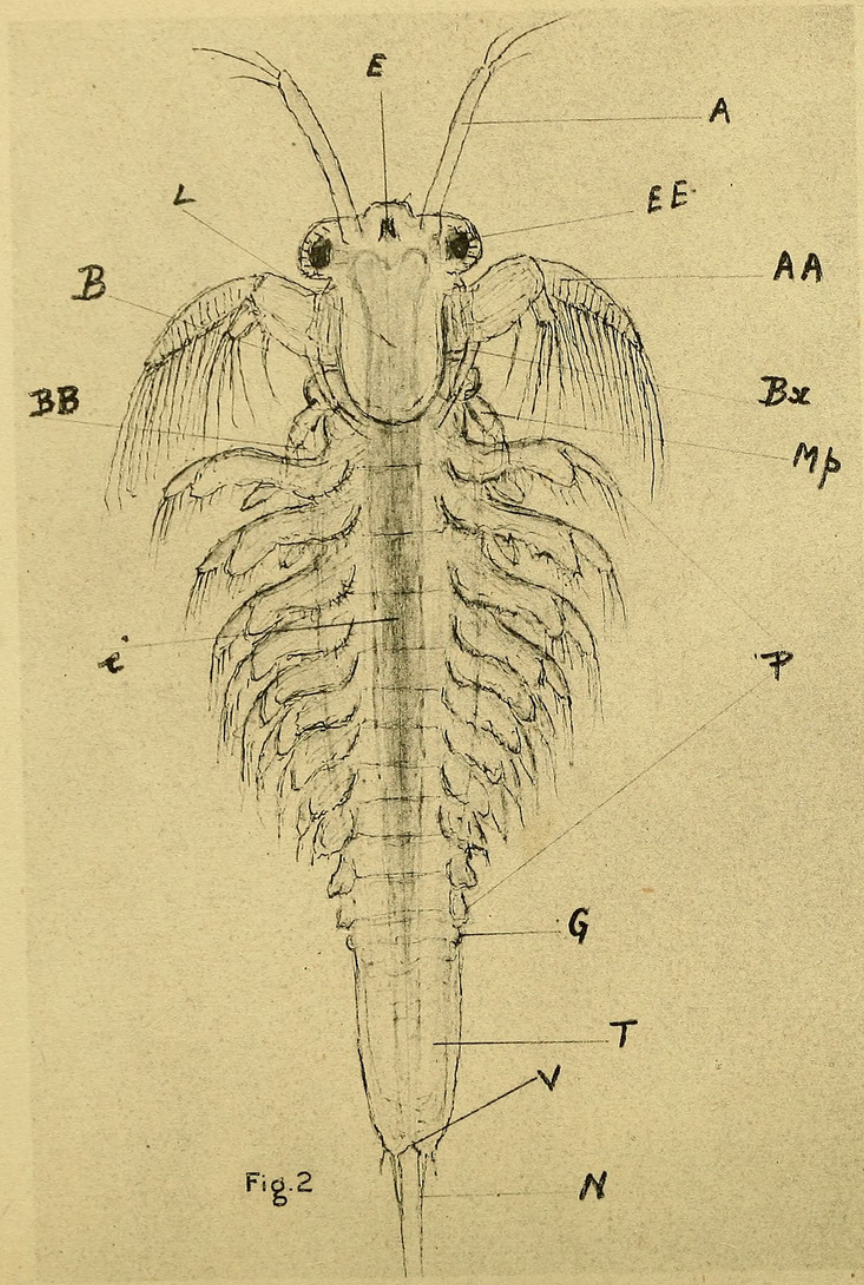


Fig.2

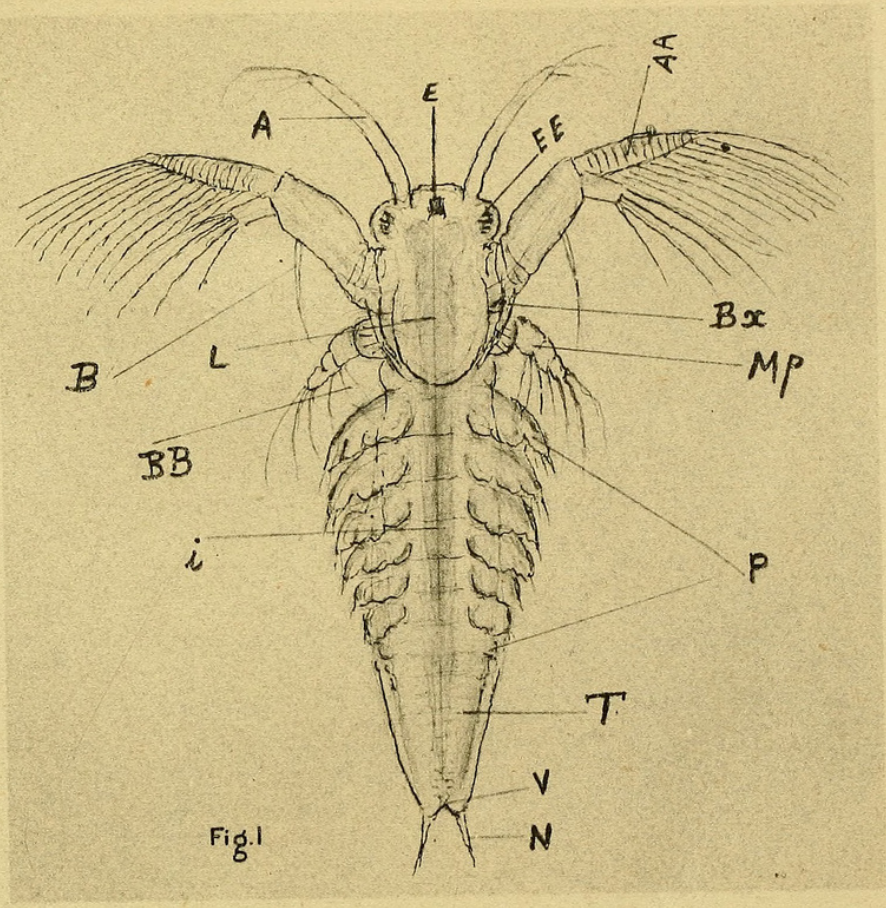


Fig.1

G. O. SARS, delin.

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