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THE LARGER FRESHWATER — CRUSTACEA FROM CANADA AND ALASKA.

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(Continued from Vol. XXXIV, p. 148.)

III. EUPHYLLOPODA (BRANCHIOPODA).

The crustacea belonging to this order comprise the three super-families of the "fairy shrimps" (Anostraca or Branchiopidae) the "tadpole-shrimps" (Notostraca or Apodidae), and the "clam-shrimps" (Conchostraca or Limnadidae (Estheriidae)). Most of the species are of a fair size and easily observed at the right time of the year by any one interested in freshwater life.

They derive their name from the fact that most of the appendages ("feet") behind the mouth parts are peculiarly formed so as to serve as respiratory or locomotory organs, being divided up into many hairy leaves or flagella. When present the tail has no appendages, with the exception of its last joint, and the body is composed of a great number of segments.

From olden time, these interesting crustacea have attracted both laymen and scientists, not only because of their peculiar biology (seasonal occurrence, etc.), but also because they have been considered as representing a very ancient type of crustacea, if not the origin of that numerous and widely distributed class. At any rate, fossil remains of these crustacea or similar forms have been found in deposits of great age; viz. Conchostraca from the Devonian, Notostraca from the Trias, and the Anostraca from the Oligocene (Tertiary) on.

The first important works on these crustacea were published by the Danish Zoologist O. F. Muller in the latter part of the 18th century; since then a great number of workers in different countries have studied them very carefully, of whom G. O. Sars

in Norway, W. Baird in England, C. C. Claus in Germany, E. Daday de Décs in France, and A. S. Packard in the United States, have probably contributed most (see bibliography).

A. FAIRY-SHRIMPS.

The first sub-order (super-family) Anostraca is easily distinguished from the two others by the lack of a shell (carapace) and by the elongated shape of the body, in which the head is distinctly marked off.

The general form of these "fairy-shrimps" has been often described and may be assumed to be fairly well known,¹ so that only the essential points need be referred to here. The head carries two pairs of feelers (antennæ) of which the first pair is short and slender, but the second pair much longer and stouter and is in the males extraordinarily developed as clasping organs (for use during copulation), and of greatly varied form often with accessory appendages, etc. On the front end of the head is situated a simple unpaired, median eye, remnant of the large nauplius-eye of the larval stage. More conspicuous, however, are the two large, composite eyes on short peduncles which are very movable and have brilliant, metallic colours. The mouth (on the under side) is supplied with various masticatory parts (maxillæ, mandibles, etc.), and behind them follows a greater (11 or 17-19) number of ambulatory trunk-limbs, the foliaceous, hairy legs, of which the first and last pairs are the shortest. They are admir-

¹ See Ottawa Naturalist, July, 1895 (A. H. H. Kett) and April, 1890 (E. E. Prince).

ably suited for propelling the animal, moving consecutively, as grain stalks before the wind, but they have also respiratory importance, being subdivided into inner and outer parts, and even those far from the mouth have "gnathobases" (chewing parts), and pass along by their movements any food that is secured. The last pair is modified for reproductive purposes. The conspicuous genital organs mark the boundary between the prae- and the post-genital regions, both mostly of about the same length. With the ripe males the copulatory organ presents a mostly bifid, smaller bag; while with the females it is an oblong or more rounded (elliptical) sack containing, at the right time of the year, the eggs. The tail is mostly long and slender and consists of 8-9 joints; it ends in two furcal rami (cercopods), only exceptionally united (*Thamnocephalus*).

Except when strongly colored the animals are so transparent that the internal parts are to be seen plainly with a magnifying glass; most conspicuous is the long slender "heart" extending through nearly all the trunk-segments (somites) dorsally and with a pair of openings (ostia) on each of these. The alimentary canal is also conspicuous, owing to the food filling it out; it is seen stretching as an almost uniform tube to the end of the last tail segment, where it opens. The maxillary gland (excretion organ) is also conspicuous on the underside of the head (it is especially large in the younger stages); and in the males the white testes and their auxiliary organs (vasa deferentia) are plainly seen in living individuals, though not so conspicuous as the female's unripe (ovarial) or ripe eggs. Less conspicuous are the ladder-like nervous system (though the brain is large and well defined) and the little differentiated blood vessels.

The fairy-shrimps have this in common with most of the crustacea, that their young stages are quite unlike the full-grown animals. The egg hatches into a larva, the so-called nauplius or metanauplius. It is often only the size of a pin-head, but usually of a vivid, red color, and of an oval or pear-shape. The first pair of antennae is longer than in the full-grown individuals and pointed directly ahead; they are probably used as balancing

more than as locomotory organs. Between them is the large median eye. There follows the second pair of antennae greatly developed as the principal swimming organs and divided up into several long, spined branches. Of the mouth parts the mandibular-palps are the most developed and leg-like; they also help in swimming, having long hairs. The somites carrying the foliaceous legs are little differentiated, and the more posterior ones as yet only represented by hairy serrations on the under side of the "abdomen". No tail is yet present, the hind-end of the larva being rounded-tapering. These nauplii make up for their inconspicuous size by their violent movements; they probably subsist right after hatching for a time on the yolk they contain.

The nauplius grows rapidly both in length and in the development of the appendages and soon reaches the metanauplius stage, which is so-termed owing to the presence of larval and adult characters. Thus the second pair of antennae and the mandibular palps are still large and the principal swimming organs, and of the foliaceous legs and abdominal segments only the foremost are developed to any extent and well marked off from the succeeding ones. The tail is short and clumsy and little differentiated from the abdomen, merely tapering from the latter. On the other hand there are now besides the median nauplius eye two large composite eyes, though their peduncles are less pronounced than in the fullgrown individuals; and the maxillary gland seems to reach its highest development (size) in the metanauplius stage. The more oblong shape of the whole body, the beginning differentiation and development of somites and foliaceous legs and tail, and the proportions of the various appendages compared with the length of the whole animal, also make this stage very distinct from that of the nauplius.

Gradually the metanauplii grow in length and take on the appearance of the adults. The foliaceous legs all become fully developed and assume their locomotory duties, and simultaneously the second pair of antennae becomes more rudimentary (females) or transformed into the claspers (plus accessories) of the males.

The mouth-parts lose their former locomotory functions and become limited to masticatory processes. The genital organs begin to appear and the tail grows rapidly in length, so that soon the shape of the adult is reached, and only the particular development of the claspers and the genital organs remain. The eggs of the fairy shrimps apparently do not all hatch at the same time (day). I have observed how nauplii and metanauplii or young and full-grown individuals are present together in the same pond, though the great majority of the individuals are either in one stage or the other.

The fairy-shrimps are of a transparent reddish, yellowish, blueish or greenish color, more pronounced on some parts of the animal than on others. Besides, certain species, especially the females, have additional strong purple, violet, brownish or black colors in patterns characteristic for each species, though there is great variety in the intensity in the various individuals. In the males the most strongly colored parts of the body are generally the claspers (second pair of antennæ) and in the females the parts near the ovarium; also the underside of the head, the foliaceous legs and the tip of the tail in both sexes. The ripe eggs have a strongly yellow, orange or light brown color.

The fairy-shrimps swim in the water with equal facility upon the belly or upon the back, according to whether their food is above or below them in the water. Locomotion is accomplished by means of the foliaceous legs and by the long tail serving as a rudder; when disturbed they will make a sudden jerk with the tail and dart in one or the other direction. Where there is a strong current in the pond (lake) in which they live they will go with it though moving their foliaceous legs all the time; in quieter pools, the younger individuals especially (metanauplii and slightly older ones) will float in the water belly downwards with little apparent movement from place to place, if left undisturbed. Their food consists of smaller, aquatic invertebrates (Cladocera, etc.), and I have often observed them "browsing" in the mud-bottom of the pond or among the green algae there. In return they form an important item in the diet of certain aquatic

insect larvæ (beetles, caddis-flies, etc.) or young fishes, against which they have little other protection than their transparency. Just prior to and during the time the eggs are becoming ripe the females generally carry the males around; the latter seize their mates around the genital somites dorsally with their claspers and retain their hold until the time of copulation is over. Then the males leave their "victim" for another female and repeat the process, which is perhaps a necessary procedure as there are generally far more females than males of a certain species in the same pond. When the eggs have been laid they, so far as has been observed, rise to the surface of the water and float there until hatched, or if the pond dries up or freezes to the bottom they remain (hibernate) in the mud until hatching is possible, when the pond is again filled with water or its ice melts. As a matter of fact this desiccation or freezing (hibernation) of the eggs seems to be necessary for their development (see *Ottawa Naturalist*, April, 1896, Prince).

The sudden appearance of the fairy-shrimps is truly wonderful and has long puzzled students. Outside of the arctic they are generally found only in temporary pools or ponds, being hatched there in thousands as soon as the ice in the latter melts or when they are again filled with water. In the arctic and probably in mountain-lakes (ponds) at high elevation, say about 10,000 feet, where the conditions are similar, nauplii appear (hatch) immediately after the ponds melt (June), and the animals have thus a period of 3-4 months in which to grow to maturity and deposit their eggs in case the pond they are found in does not dry up before the water freezes and all, except the hibernating eggs, are killed off by being frozen into the ice, or die a natural death. At more southern latitudes, however, and at lower elevations, the ponds in which they occur are far more likely to dry up; thus near Ottawa, Ontario, I have found the first ones in the middle of April², when they (*Eubbranchipus gelidus*) were about 1 cm. long, thus young individuals probably hatched a couple of weeks before; the full-

² See also Halkett's observation, *Ottawa Naturalist*, July, 1895, p. 89.

grown ripe individuals collected by A. G. Huntsman near Toronto, Ontario, in June 1908, probably represent their last appearance in the summer. Young ones (3-10 mm.) were collected on April 10, 1920, near Toronto, Ontario; they therefore probably hatch earlier near Toronto than at Ottawa. Near Ottawa I have not observed them later than the month of May, and in all cases they were found only in temporary pools or canals caused by snow melting and the overflow of the Ottawa, Gatineau or Rideau Rivers in the spring. As to their occurrence in the United States I refer the reader to Packard's and Verrill's articles about them; it is sufficient here to state, that while certain species occur only in the winter and early spring, others are present both in the spring and in the fall, but not in the summer; while again others (*Artemia*) are found when the water is very warm.

According to my own field observations during a period of three years along the arctic coast of north-western America I may safely state that there is only one "brood" (generation) per year in the arctic; the same is probably true of the sub-arctic zone of this continent; while in southern Canada and the United States two or more broods (generations) per year may occur; though the long time during which the ponds are dried up during the summer here probably restricts the number of generations considerably.

Apart from the enemies in (insects, fishes) and outside (birds) the water a great number of fairy-shrimps (and Notostraca as well) are killed off prematurely in the summer or autumn by the drying up of (at least in the arctic) the particular small pond in which they live or by being thrown up along the margin of the particular lake by waves in windy weather, as I have repeatedly observed in the arctic parts of America and Greenland. I have also observed how a great number of phyllopods in the fall freeze into the ice as the latter begins to form and grows in thickness, though a number of individuals were living in the water right under the ice, even if there were only a few inches of free water. It will, therefore, be realized how important it is for the propagation of these animals, that they occur in such vast num-

bers and that the hatching of the eggs takes place almost immediately after the melting of the pond or lake-ice in the spring, or after the autumn rains (absent in the arctic) have filled the dried up reservoirs in which the eggs are lying.

The fairy shrimps on this continent are divided into two groups (super-families) according to the number of their pre-genital, foliaceous body-legs. The one group (*Polyartemiidae*) has 17 to 19 pairs of these while the other group (comprising the great majority of fairy-shrimps species) has only 11 pairs.

To the first group belong two genera, of which one (*Polyartemia*, 19 pairs of foliaceous legs) is not found in America, but a species (*P. forcipata* Fisch.), occurs in the arctic parts of Europe and Asia, both in Scandinavia and Siberia and probably also in the intervening arctic part of Russia³. Its biology, structure and development have been given in detail by G. O. Sars, in *Fauna Norwegiae*, 1896, pp. 59-65.

The genus found in America is *Polyartemiella*, so-called owing to its similarity to *Polyartemia*, from which it, however, is distinguished by having two pairs less of foliaceous legs. Curiously enough the genus *Polyartemiella* seems to be limited to the arctic and subarctic parts of Alaska and Yukon Territory, and thus resembles somewhat the freshwater Amphipod *Synurella*. In the same way as *S. johanseni* has its nearest relatives in Europe and Asia, so have also the two known species of *Polyartemiella* their nearest relative in the Eurasian form *Polyartemia* mentioned above. Considering their respective distribution we may perhaps assume, that both *Synurella* and *Polyartemia* have their original home in Eurasia, and have spread from there to the northwest corner of America, where then the latter genus became transformed in the course of time to the only slightly different genus *Polyartemiella*. This invasion of America took place perhaps via a former land-connection between Siberia and Alaska, a view which is supported by the fact, that one of the *Polyartemiella* species (*P. judayi*) has been found upon at least some of the islands in the Bering Sea (De Dées).

3. Recorded from Novaja Semlja (Hansen).

The males of the two *Polyartemiella* species are easily distinguished by their claspers. In one (*P. hazeni* Murdoch) the claspers are big, antler-like processes with four branches: in the other (*P. judayi*, De Déés), they are more like fish-hooks (or sickles) and three branched, thus more like those of *Polyartemia*.

The first named species, about 1 cm. long, was originally discovered by Murdoch of the International Polar Expedition in tundra pools at Point Barrow, Alaska, in the middle of July, 1882, and described and figured by him in the reports of the said expedition p. 150. A better description and figure of it has later been given by De Déés, p. 106-07, (1910); according to Pearse⁴ it also occurs at other places along the arctic coasts of Alaska and Yukon Territory. It has hitherto not been found east of the Mackenzie River. During the Canadian Arctic Expedition I secured in tundra ponds at Teller (Port Clarence), Alaska, a couple of males and half a dozen females of apparently the same species in the beginning of August, 1913. They differ in various points from Murdoch's description, but a full account and figures of them will be given in the reports of the Canadian Arctic Expedition (Vol. VII, Part G.) to which I refer.

Polyartemiella judayi (about 12 mm.) was originally described by De Déés in *Annales des Sciences Naturelles*, Paris, 9th series, Vol. XI, 1910, p. 108-11, from specimens collected by Dr. Juday on the Pribilof Islands in Bering Sea. I did not myself find this species in Alaska, and as is the case with the other species (*P. hazeni*) little is known about the life history, the young stages not having been secured as yet, though both sexes are known.⁵

The genus *Polyartemiella* thus seems to be limited to the arctic and subarctic parts of northwest America, west of Mackenzie River.

To the second group of fairy-shrimps (those with 11 pairs of foliaceous legs)

⁴ *Polyartemiella hanseni* (Murdoch) coll. by J. M. Jessup at Muskeg Lake, lat. 69° 40' N., long. 141° W., July 25, 1912, and at Muskeg pools on flood plain of Firth River, lat. 69° 20' N., long. 141° W., June 23, 1912 (Pearse, 1913).

⁵ The females are a few millimeters longer than the males.

belong three or four families, of which only two have been recorded from Canada and one of these latter also from Alaska. The characters separating the families are not very good, because they are mainly the appendages (claspers and accessories) on the head of the ripe males, and even two species belonging to the same genus are extremely different in this respect. I, therefore, do not find it necessary to give the distinctions between the families here, beyond mentioning, that the genus *Thamnocephalus*, which occurs in the middle parts of the United States (Kansas, Colorado, etc.), is very distinct from all the other fairy-shrimps belonging to this group, by reason of the fusion of the post-genital segments and the cereopods.

Probably the most widely distributed of all fairy-shrimps is the circumpolar form *Branchinecta paludosa* O. F. Müller. It reaches a length of 2 cm., and the male claspers are fairly simple (though when the animals are ripe, well developed), consisting of a stout and long, cylindrical basal part with a row of short spines on their inner margin, and when fully developed, a little longer, more slender, triangular and falciform, apical part (joint). The protruding parts of the male genitalia are thick, arcuated and paired (bifid), while the ovisac of the female is very long, slender and thickest near its free rounded end.

This species was first described by Otto Fabricius from West Greenland as *Cancer stagnalis* (Fauna Groenlandica, p. 247, 1780), and much confusion was caused by his thinking it was the same as Linnaeus' species of the same name from Europe, and by O. F. Müller in his *Zoologia Danica* II, calling it *Cancer paludosus*, in the belief that it was the same genus as the species (*Branchipus stagnalis*), occurring upon the continent of Europe and first recorded by Linnaeus as *Cancer stagnalis*. It was finally established as being the circumpolar, arctic form *Branchinecta paludosa* by Verrill. It is distributed from Alaska to Greenland in the new world, and in Eurasia it has been recorded from northern Scandinavia, Spitsbergen, Novaja Semlja and Siberia. Curiously enough it has not yet been found in East Greenland. Another species (*B. gainii*) of the same genus was found by Charcot in the Antarctic.

As to the southern boundary of the distribution of *B. paludosa* on this continent little is known; but the records of it from Commander Islands, Siberia (Lilljeborg, and the Pribilofs (U.S.N.M.) indicate that it is found at least upon some (western?) of the Aleutian Islands. Also, some young ones were collected by J. M. Jessup in a puddle at Whitehorse, Yukon Territory, June 7, 1912 (Pearse, 1918). I did not observe it at Nome or Teller, Alaska, but it was found by Murdoch at Point Barrow in the same pools as *Polyartemiella hazeni*. I found it very common along the coast from Camden Bay to Demarcation Point, Alaska, and also on Herschel Island, Yukon Territory, in the summer (June-August) of 1914. It was also collected by J. M. Jessup in Muskeg Lake (lat. $69^{\circ}40'N$. long. $141^{\circ}W$) on July 25, 1912 (Pearse, 1913). We may, therefore, perhaps assume that it occurs over the whole of Alaska and the Yukon Territory, except the southern part of the former, at a certain time of the year, and where suitable ponds or lakes are present. Dr. J. Rae brought back from Cape Krusenstern, Dolphin and Union Strait, Northwest Territory, some fragments of both sexes collected in August, 1849; they were referred by W. Baird to this species. According to the great number of observations and collections of this species by me in 1914-16 in this locality (Bernard Harbour) there can hardly be any doubt about it, an opinion also expressed by Verrill and Packard. It was further secured (Sars) by the "Gjoea" Expedition (Amundsen) on the south side of King William Land, in 1904 and 1905; by the "Neptune" Expedition at Fullerton on the west side of Hudson Bay in 1903-04; by Turner in pools on rocks at Fort Chimo, Ungava; by Packard in August, 1864, and by Bryant in 1908, at Hamilton Inlet in Labrador; by the Second Norwegian Arctic Expedition on Johan Peninsula, Ellesmere Land, in 1898-99; by Hart at Discovery Bay (lat. $81^{\circ}41'N$.) and by the Princeton Expedition, 1899, at Cape Sabine, on the west side of Grinnell Land. In west Greenland it has furthermore been recorded from a number of places up to Polaris Bay (about lat. $82^{\circ}N$.), where it was taken by Bessels in August 1872, (Packard), and on Northumberland Island, (Ortman). There can therefore be little doubt that it occurs

upon all the islands composing the Canadian Arctic Archipelago.

The structure and biology of this species has been so well treated and figured by G. O. Sars in his monumental work (1896) that I need only refer briefly to the life-history. The additional observations I was fortunate to make during my stay along the arctic coast of northwest America with the southern party of the Canadian Arctic Expedition 1913-16, will be found in the reports of the said expedition (Volume VII, Part G). Suffice it to say that its whole life-history is now known, because I secured in the north still earlier stages than Sars' metanauplii (see his Tab. VIII) and actually succeeded in rearing in the spring the nauplii from hibernating eggs kept all through the winter. Its life-history is, therefore, the following, at least in the arctic part of northwest America. The hibernating eggs frozen in the ice, hatch out a little after the latter melts in the spring or early summer (June), and the nauplii and metanauplii continue to grow until at the end of July or beginning of August they are sexually ripe. The copulation and laying of the eggs then takes place during August and part of September, until the water freezes and kills them all except the eggs. Apparently, however, a great number of the adults die a natural death from the middle of August on, presumably when copulation and egg-laying is over. That they are also killed off by other causes (enemies, waves, drying up of the ponds) has already been referred to. The earliest records in the year I have from this coast is Chantry Island, June 17, 1916, (a couple of nauplii and many metanauplii), and the latest record is adults of both sexes from Bernard Harbour, August 23, 1915 (specimens kept).

Mr. A. Halkett writes in his field-notes from the "Neptune" Expedition, that female phyllopods of this species (identified by Prof. G. O. Sars of Christiania, and by me) were collected in ponds at Fullerton on the west side of Hudson Bay as late as the end of October and the beginning of November, 1903. The water-depth of one of the ponds was about seven feet, and they were then all covered by ice, which in the last days of October was of a thickness of about one foot. The temperature of the air was about zero, and that

of the water around freezing-point. The water on testing showed to be slightly saline, though used for drinking-purposes.

Since my return from the expedition I received from Professor A. Willey, of McGill University, Montreal, P.Q., six adult branchipods (4 females, 2 males) which so far as I can see belong to this species. They were collected in a pond cut off from the river at Point St. Charles, near Montreal in May-June about 20 years ago. Professor Willey informs me that they have not been observed in that locality since. They were about 2 cm. long, and the females had ripe eggs in the brood-pouch. This is certainly a most extraordinary record, and quite at variance with what one should expect—to find this circumpolar form at Montreal. The species has been recorded from the Carpathians (De Dées), so it would be far more natural to expect to find it in the Rocky Mountains than in the lowlands of the St. Lawrence River. However, the shape of the male claspers, their rows of spines, the oblong ovisac of the females, etc., makes me feel confident the specimens belong to *B. paludosa*. The eggs were perhaps brought with a ship returning from Labrador or other part of the eastern arctic and then developed when the snow melted in the spring. My identification of these specimens from Montreal has been verified by Professor A. S. Pearse, of Wisconsin University (letter to me of March 29, 1920).

In Europe this species has been recorded from high altitudes in the Carpathians, but the above record from Montreal, Que., is the only instance known of its occurrence on this continent outside the arctic or sub-arctic regions.

A couple of other *Branchinecta* species are found in the middle United States, but have so far not been recorded from Canada or Alaska, and are not likely to occur here, though one of them (*B. coloradensis*) is perhaps an arctic relict form, being found only in ponds and pools on the highest mountains (above 10,000 feet) in Colorado.⁶

Nor has the interesting fairy-shrimp *Artemia salina* (*A. fertilis*, *A. gracilis*, *A. monica*), known from many parts of Europe,

West Greenland and some of the States, (Connecticut, Utah, California), and in lower California, been found in Canada so far.⁷ Much has been written about this species as to its sudden occurrence in salt lakes, and in railway tubs filled with brine, where it can withstand more than 270 grains of salt per litre, and where its red color increases in intensity with that of the salinity of the water. This is also the species to which the common European form *Branchipus stagnalis* (*B. ferox*) transformed by degrees when the salinity of the water in which it occurred was increased, as also the reverse occurred when the water was diluted, according to Schmankevitch's investigations. On this continent, however, *Branchipus stagnalis* does not occur (the species mentioned in *Ottawa Naturalist*, July, 1895, and April, 1896, is almost certainly *Eubranchipus gelidus* Hay), and so far as I know the experiments referred to above have not been successful over here, though there are apparently no generally accepted characters separating the genus *Artemia* from that of *Branchinecta* or *Branchipus*.

Of the genus *Eubranchipus* half a dozen species are known on this continent, the majority of them only from the United States, though all from the northern and middle States, and none from the west. Only one species (*E. gelidus* Hay) has so far been found in Canada and Alaska, but at least some of the others may well be found to occur in the Dominion, as they are known from New England to Wisconsin south of the boundary line, and one species (*E. vernalis* Verr.) has a very wide distribution. Perhaps the most widely distributed species is *E. gelidus*, which has so far been recorded from Massachusetts, New York and Indiana in the States and from Ontario and Yukon Territory in Canada; it also occurs in Alaska. For records in Yukon Territory and Alaska see Pearse, 1913. It is extremely common around Ottawa in the spring, and occurs on the Quebec as well as on the Ontario side of the Ottawa River. There can be little doubt but that this is the species A. Halkett observed in 1893 and 1894 at New Edinburgh, Ontario, (*Ottawa Naturalist*, July,

⁶ The eggs of this species are unusually large.

⁷ It may occur in Southern Ontario or Quebec, judging from its presence in Connecticut.

1895). Apparently he did not preserve the specimens, but it is the only fairy-shrimp I have found occurring around here. The female especially is easily distinguished from the other species belonging to this genus, having the ninth and tenth body segments produced into lateral, triangular processes dorsally, probably serving for copulatory purposes. The ovisac is broad and elliptical and contains about a dozen ripe, yellow-brown eggs. When the animal is swimming it is continually moving from side to side, so the eggs roll around inside. The clasping antennæ of the male are somewhat claw-shaped with a short swollen basal part supplied with two medio-ventral, short spines, and a more slender and longer terminal part with bifid tip. Twice as long, however, are a pair of accessory organs at the base of these antennæ (claspers) dorsally, in the shape of broad, lobated appendages which we may suppose are used for "tickling", or twisted around the female's body during copulation. The protruding male genitalia is a bifid sack ending in two pointed appendages.

These fairy shrimps attain a size of $1\frac{3}{4}$ cm. in May-June, when they are ripe, and vary greatly in color, the females especially having much rose-orange, blue and black-brown pigmentation; but my observations regarding the colors of the many individuals I have examined are too detailed to be included here. The paired eyes are dark purple and the tips of the cercopods white; the latter color shows up very conspicuously when the animals swim in the water. Of this species I have examined specimens from the following Canadian localities.

Montreal West, P. Que., May 5, 1920, A. Willey, coll., adult male and female, the latter with eggs.

De Grassi Point, Lake Simcoe, Ont., May 10, 1915 and May 6, 1917, E. M. Walker, coll., 27 adults, 12 males, 15 females, $1-1\frac{3}{4}$ cm. long.

Scarborough Junction (Toronto), Ont., June, 1908, A. G. Huntsman, coll., 11 adults (5 males, 6 females), $1\frac{1}{2}$, $1\frac{3}{4}$ cm. long (see *Natural History of Toronto Region* 1913, p. 275).

Ponds near Bond Lake, Toronto, Ont., (York County), April 10, 1920, A. G.

Huntsman, coll., (young stages, 3-10 mm. long, immature).

Around Ottawa I have collected them in temporary pools or canals at various places, at Hull Park, near Fairy Lake, Deschenes and Tenaga (Gatineau River), on the Quebec side, and at various points (Billings Bridge and Hartwell Locks) along the Rideau River on the Ontario side. Around Ottawa the nauplii hatch soon after the melting of the snow and the breaking up of the rivers, and the pools they occur in are literally teeming with them. They are found in pools on open fields or pastures as well as in the woods; already at the end of April they are $\frac{1}{2}$ cm. long and the females carry their light brown eggs in the sack. The smallest number I have seen in one pool is $\frac{1}{2}$ dozen, which were collected on April 20, 1919. I tried to keep a dozen of them, (4 males, 9 females) alive in a jar. The next day, however, two of the females and three of the males died; before the first of May the last male and a couple of the females died, during the beginning of May the rest of the females died except one which lived until May 7th. It will thus be seen, that these animals are more hardy than is generally supposed, especially the females; no food was given them while they were kept in confinement. I observed, that one second elapsed between two succeeding turnings-over of the egg-sack from right to left, or the reverse, when the female is swimming; the movement is apparently for the purpose of bathing the enclosed eggs in the water passing in and out of the egg-sack. May or June is probably the last month in which they are present in southern Ontario and Quebec; from July on all the pools in which I have observed them earlier in the summer are dried up and the deposited eggs remain in the bottom, probably hatching the following spring.

Prof. O'Donoghue, of the University of Manitoba, tells me in a letter (June, 1920) that "a species of *Branchipus*, or more probably an *Eubbranchipus*^s) is fairly common all around Winnipeg, on both sides of the Red and Assiniboine Rivers, as a rule

^s Probably *E. Gelidus*. (F. J.)

in the pools formed where the snow melts..."

On June 1, 1920 Dr. A. G. Huntsman, of Toronto, collected twelve specimens of *Eubbranchipus gelidus* in shallow sloughs near Wetaskiwin, Alberta (near Edmonton). One of these is an adult male, the others are females, mostly adults, and with ripe eggs.

Together with the *Streptocephalus coloradensis* (see below) these are the first records of fairy-shrimps from western Canada.

On the Canadian Arctic Expedition I found in a large shallow pond on top of a ridge at Bernard Harbour, N.W.T., a number of fairy shrimps (both sexes) of a peculiar species, (*Artemiopsis Stefanssonii*) not known before. Another species (*A. bungei* Sars) is known from Siberia and the New Siberian Islands. The new species will be described and figured in detail in the reports from the said expedition (Vol. VII, Part G), so I need only give a summary of my observations on it here. I first observed it on October 6, 1915, in a one foot deep pond which then had seven inches of ice covering it, but in spite of this the fairy shrimps were very active. In size they were from seven to eleven mm. long, the females being generally a little longer than the males, but all were apparently adult and ripe. They belong to the group of fairy shrimps with eleven pairs of progenital limbs, and the male had its claspers in the form of powerful, sickle-shaped, terminal parts (with two spines projecting some distances from their tips), projecting from a swollen basal part, besides somewhat spiral shaped protruding genital organs, while the female had a very large elliptical egg-sack with olive-brown eggs and a couple of curved processes projecting laterally from the dorsal side of the genital segments. Especially do these female characters remind one decidedly of *Embranchipus gelidus*, but the shape of the male claspers and genitalia, together with the absence of accessory copulatory organs (frontal processes, etc.), distinguish them at a glance. In color the males were paler than the females, the latter were orange-red-brown and transparent posteriorly. When found these fairy shrimps were mostly *in coitu*, the males holding the fe-

males by their claspers dorsally just above the egg-sack and aiding them in locomotion.⁹ Males not in copula would soon attack one of the females, which were present in larger numbers than the males, and remain with her as long as copulation lasted. I kept these fairy shrimps alive for some days in a jar, but finally they all died, nor did I have any success in trying to rear the eggs during the winter and next spring. What is apparently the *metanauplii* (2-3mm.) of this species I found next summer (July 3, 1916) in the same pond; at that date the *Branchinecta paludosa metanauplii* were considerably larger, so apparently the new species is somewhat later (a couple of weeks) in its development (hatching). On the other hand it lasts longer in the fall, no *Branchinecta* being met with after the freshwater freezes in September on this coast, while the other fairy shrimp, as mentioned, was secured as late as the end of the first week of October. Owing to the shallowness of the pond, however, they probably would not live many days longer, but be killed off when the water froze to the bottom before the middle of the month. I only found the new species in the pond mentioned, and the locality (Bernard Harbour) is the only one in which it has been met with so far. In this connection it is interesting to note that De Dées (1910) says in his account of the Siberian species (*A. bungei*) of the same genus, that it apparently can withstand a very cold water (about 1° Réamur), and at least some of the specimens were secured on October 10 (1886). This conforms remarkably well with my observations on the new Canadian arctic species (*A. Stefanssonii*.)

Dr. A. G. Huntsman of Toronto has recently sent me four adult (about 2½ cm. long) fairy-shrimps, one female, the rest males, which he collected on June 11, 1920, in shallow sloughs, three miles northeast of Medicine Hat, Alta. I have identified them as *Streptocephalus coloradensis* Dodds, and Prof. A. S. Pearse of the University of Wisconsin has verified my determination of this as of other uncommon Canadian Phyllopods. These *Streptocephalus* occurred together with *Lepidurus couesii*,

⁹ Though the principal swimming was done by the female.

and the two "clam-shrimps", *Estheria mexicana* and *Limnetis gouldii*. The female had ripe eggs in its long, tapering ¹⁰ ovisac, and the three males had the copulatory organs well developed. This is the first record of this family in Canada; it is known in the United States only from Colorado, from which state it was originally described and figured by Dodds in 1916. The family (and genus) is characterized by the male having very long, tortuous and three-jointed claspers (second antennæ), with particularly the terminal joint subdivided into branches and

¹⁰ Thus distinguished from the female *B. paludosa*.

appendages (see figure by Cockerell, 1912). The male has the protruding genitalia rather small and slender; while with the female the second pair of antennæ hardly exceeds the first pair in length.

This new Canadian record makes it very probable that the species also occurs in Wyoming and Montana. In Colorado it occurs, according to Dodds (Proc. U. S. N. M. Vol. 49), on the eastern slope of the Rocky Mountains (Eldorado and Fort Collins), up to an elevation of almost 9,000 feet. The new record at Medicine Hat (which lies at an elevation of about 2,135 feet) apparently gives the lowest known altitude of the occurrence of the species.

(To be concluded.)

SOME NOTES ON THE BELTED KINGFISHER.

BY PROF. WILLIAM ROWAN, UNIVERSITY OF ALBERTA, EDMONTON.

The following notes were obtained at the new Biological Station of the Manitoba University on the shores of Indian Bay, Shoal Lake, Lake of the Woods, Man., between the 15th of June and the 4th of August 1920. The Biological Station is placed in the wildest scenery right on the shores of the bay, 100 miles east of Winnipeg. Most of the intervening country is muskeg and little of it is settled. The University buildings consist of two bungalows, and there are half a dozen other buildings inhabited by employees of the Greater Winnipeg Water District and hands connected with the little private railway which supplies them with food and weekly mail bag. The birds were therefore studied in a comparatively undisturbed and natural environment.

The shores of the lake are entirely rocky and thickly clothed with trees, mainly poplars. The scores of islands in Shoal Lake are similarly of solid rock, covered with extremely dense vegetation. On our arrival the nesting sites of the Kingfisher, one of the most abundant birds, was a problem, for even his colossal beak is useless when it comes to working in rock. No amount of searching or watching from the canoe along the banks revealed a single nesting hole. The continual passage, however, of Kingfishers from the shores of the lake to the banks of a large gravel pit—a relic of the water works operations—

put us on the right track and on the third day we had found the first nest. The holes are so characteristic that, having found one, others were easy, and a half hour's search revealed nearly a dozen nests in the two banks. The pit is about a quarter of a mile in length and some hundred yards across and the banks are mainly of soft sand. The only other birds nesting in holes here are Rough-Winged Swallows, and of these there is but one small colony with their little holes characteristically close to one another. The Kingfisher's holes are much larger, being six or seven inches across, and all are at the tops of the banks. Some are old, others in use. The latter can immediately be detected by the curious double track of the two feet of the parents worn into the soft sand and running from the entrance inwards. There is no offensive smell however, and no filth oozing out, two characteristics of some other species of Kingfisher. The burrow is as a rule between two and three feet in length, horizontal and straight. The terminal chamber is very roomy, as indeed it must be to hold the seven or eight large young. It is invariably sunk beneath the level of the run, and if dug out is found to have the wall dripping and reeking with filth. The young, when ready to fly, have an extremely offensive smell, their breast and belly feathers being plastered together with caked sand.



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