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ENTOMOSTRACA FROM THE PANAMA CANAL ZONE WITH DESCRIPTION OF ONE NEW SPECIES

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During the months of June and July, 1924, the writer spent six weeks in the Canal Zone making collections, mainly of Entomostraca, for the Museum of Zoology of the University of Michigan. The work was done with facilities provided by the Institute for Research in Tropical America, in connection with the newly established laboratory on Barro Colorado Island in Gatun Lake. It is a pleasure to acknowledge the cordial and helpful attitude of the people of the Canal Zone, officials and others, which contributed much to the success and enjoyableness of the work. Mr. James Zetek, resident custodian of the laboratory, and Mr. Ignacio Molino, his assistant, were untiring in their efforts to make the new laboratory of service to those working there. Mr. J. B. Shropshire, sanitary inspector for the U. S. Army of the Canal Zone, was a constant source of inspiration, and by his knowledge of the region and his enthusiastic interest was of great assistance.

General Notes on the Region

The Canal Zone is a strip of territory ten miles wide and about forty miles long, extending across the Isthmus of Panama at its narrowest part (Fig. 1). It lies between 8° 53′ and 9° 24′ north latitude, a strictly tropical location. The mean annual temperature is about 80 degrees F., with very little seasonal variation. There are two seasons, the rainy, including the months from May to December, and the dry from January to April. The annual rainfall is about 70 inches at the Pacific end of the Canal and twice that at the Atlantic end. The topography of the Zone is rough, with many steep hills and narrow valleys, though the region is hilly rather than mountainous. The greatest elevation on the center line of the Canal before excavation was 312 feet, though elevations of a little over a thousand feet are found in the Zone. The region is covered with jungle, except for many cleared areas devoted to cattle grazing, and more recent clearings, given mainly to banana culture.

The region proved to be an excellent field for collecting plankton Crustacea, on account of the abundance and variety of fresh-water habitats. It should be remembered, however, that this abundance of standing water is due to the construction of the Canal, and is of very recent origin. In January and February, 1912, Dr. Marsh,[1] who visited the Canal Zone for the purpose of collecting Copepods, found a very different situation. His visit was during the latter years of the construction work, when, as he says, "Gatun Lake was very small." He summarizes the situation by saying, "The general character of the country is not especially favorable to the growth of plankton organisms either in variety or number. There are no lakes in the Canal Zone and comparatively few permanent pools." There were six reservoirs built by throwing dams across valleys, which he describes as "plankton

[1] C. Dwight Marsh. Report on Fresh-water Copepoda from Panama, with Descriptions of New Species. Smithsonian Miscl. Coll., Vol. 61, No. 3, 1913.

poor'' on account of stagnation and lack of oxygen in the deeper strata.

In spite of this rather unpromising outlook, Marsh lists 14 species of Copepods from his collections in fresh and brackish water of the Canal Zone and adjacent areas. Among these are seven new species. He made no attempt to determine the species of Cladocera in the collections, but concerning them he says, ''The small number of Cladocera presents a striking contrast to similar collections made in the United States.''

Through the courtesy of Mr. Waldo Schmitt, of the Smithsonian Institution, where Marsh's collections were deposited, I have had recent opportunity to examine them for Cladocera. In 57 bottles I was able to find only six species, and these in very small numbers: *Pseudosida bidentata* Herrick, *Moina micrura* King, *Ilyocryptus spinifer* Herrick, *Macrothrix squamosa* Sars, *Alona costata* Sars, and *Alona rectangula* Sars, all of which are common species in my more recent collections. Though Cladocera were present in only small numbers, as observed by Dr. Marsh, it seems hardly probable that the group was at that time as poorly represented in the fauna as these records would indicate.

The contrast between the conditions existing in 1912 and 1924 is striking. In the interval the Canal has been completed and the water has stood for ten years at the present level in Gatun and Miraflores lakes. The present extensive freshwater area has become well populated with plankton Crustacea in this time, and it is more reasonable to believe that this population has arisen by the spread of species present in the few lakes and ponds existing before the Canal was built than that they have been transported from some remote region.

The object of the work in 1924 was to make a general survey of the Entomostraca of the Canal Zone, in order to learn what species were present and something of their distribution. It seems desirable that a record should be obtained of the Entomostraca that have become established in these new lakes after ten years at the present level. Accordingly collections were made from all sorts of available situations, scattered

widely over the Canal Zone. The collections included 157 vials of material from which there have been determined 45 species of Entomostraca.

In making these collections most of the work was done from the shore rather than from boats, because, in most localities, boats were either not available or they could not be used to advantage. It was only in the open portions of Gatun Lake and three reservoirs that a boat was used. The collecting was done with a conical net of No. 10 bolting cloth, with an opening of about 5 inches and a length of 12 inches. The closed end was provided with a copper funnel weighted with lead. It is possible to throw such a net out to a distance of 75 feet or more from the shore, and to collect either from the surface or from the deeper layers by allowing the net to sink to the desired depth before drawing it in. By this method the shore zone, which is the most productive part of the lake, can be collected thoroughly. From the shore may be collected also the species of the open water and deeper strata, especially on shores which slope steeply, as clearly shown by comparison of shore collections with those made from boats. Collecting from the shore is, nevertheless, difficult in the waters of that region, because the luxurious growth of vegetation on the shore and in the shallow water makes it difficult either to reach the shore or to throw the net over into the clear water beyond. In making collections, the material from several casts of the net was commonly concentrated into one vial and the Entomostraca separated as well as possible from foreign matter.

Collections of Entomostraca from this region are of importance for several reasons. In the Isthmus of Panama mingle the faunas of the two great continents of the Western Hemisphere—one of which is mainly tropical, the other chiefly temperate. The tropical situation of the Canal Zone makes work there desirable, because, though there are records from tropical regions encircling the world, such records are few compared with those from temperate and sub-arctic regions.

The Canal Zone is a favorable place for biological work because it combines primitive tropical conditions with acces-

sibility, excellent living conditions, and good facilities for scientific work. The Barro Colorado Island Laboratory is most favorably situated for the study of problems dealing with fresh-water faunas in tropical lakes, located as it is in Gatun Lake with its 164 square miles of area and great diversity of conditions (Fig. 1).

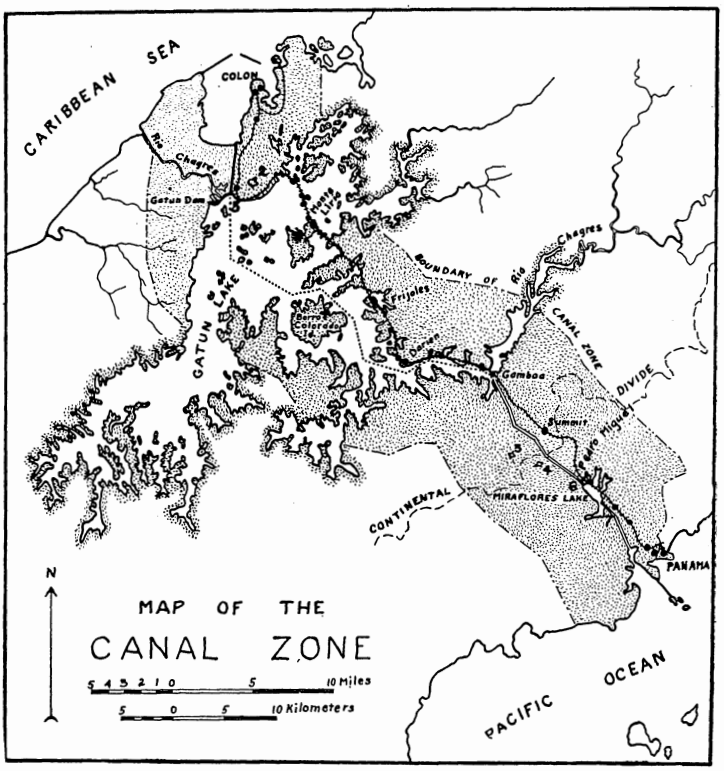

FIG. 1. Map of the Canal Zone showing the larger bodies of fresh water. 1, Brazos Brook Res.; 2, Agua Clara Res.; 3, Comacho Res.; 4, Rio Grande Res.; 5, Gatun Lock; 6, Pedro Miguel Lock; 7, Miraflores Lock. The Canal Zone Boundary follows the 100-foot contour around Gatun Lake. The cross on Barro Colorado Island marks the location of the laboratory.

Description of the Lakes and the Collections From Each

Gatun Lake

The greater part of the length of the canal, about 30 miles, has an elevation of 85 feet above sea level, maintained by Gatun Dam across the valley of the Chagres River. By the building of this dam Gatun Lake, with an area of 164 square miles, the largest artificial, fresh water lake in the world, was produced. This affords a vast and varied home for fresh water Entomostraca. The inundated valley of the Chagres River and its tributary streams was a region of rough topography—steep hills and narrow valleys—as a result of which the lake has a very irregular outline, with many islands and long, crooked arms, spread out like a giant amoeba (Fig. 1). It is not confined within the ten-mile strip of the Canal Zone, but extends far beyond its borders, the greatest extent about 30 miles. The Canal Zone boundary follows the 100-foot contour around Gatun Lake. During the ten years since the present shore line was established by the slowly rising water of the new lake, there has arisen a well developed band of littoral vegetation with varying width, according to the steepness of the shore. This provides many miles of highly productive area for littoral species of Entomostraca. In the open waters of the lake still stand, over most of its area, the trunks of the drowned jungle trees, some still reaching above the water, others decayed to the water level, though the submerged parts still stand as a menace to the unwary navigator.

From Gatun Lake there were collected 101 vials of material, in the main from a strip extending from Gatun Dam on the north to Pedro Miguel Lock on the south, through a distance of about 30 miles. Of these vials, 83 were collected from 64 different places along the line of the Panama Railroad between Gatun and the Chagres River bridge, just south of Gamboa. This 25 miles of railroad has proved to be an exceedingly productive collecting ground, not only on account of its accessibility, but also because of fortunate conditions pro-

duced by the railroad itself. Through this distance the railroad, for the most part, skirts the irregular shore of Gatun Lake in such a position that its embankment cuts off many small arms of the lake, thus producing numerous ponds connected with the main part of the lake only by concealed culverts. In the region north of Monte Lirio, the railroad fill has been built across wider parts of the lake, which thus become readily accessible to the collector. Other collections from this lake have been made in the region of Gatun Dam, at the spillway, the intake for the hydro-electric plant, and from Gatun Lock. Abundant material was also secured near the Barro Colorado Island Laboratory by collecting from the laboratory landing out to the ship canal, a distance of about half a mile; and by towing behind a boat between Frijoles and the laboratory. Collections were also made at both ends of the Culebra Cut through the Continental Divide, an eight-mile extension of the lake.

The collections from Gatun Lake and associated ponds have yielded 34 species. From the *open waters* of the lake, sufficiently far from the shore to be definitely removed from its influence, there were 13 species, found in collections at various stations from the Gatun Spillway to Pedro Miguel Lock. The most common Cladocera were *Diaphanosoma brachyurum, Ceriodaphnia cornuta,* and *Bosmina longirostris,* which were present in large numbers in nearly all collections from this part of the lake. The most prevalent Copepods were *Cyclops tenuis* and *Diaptomus leoninicollinus,* the latter of which was the most abundant Entomostracan of the open waters, though it did not appear in as many collections as some other species. The full list of species from this and other localities is given in Table I at the end of the paper. In collections made from the *shore* of the lake at various places, there were 21 species, including all of those from the open water, and in addition, 8 others, doubtless taken in drawing the net to shore through the plant-grown margin. This observation indicates that it is possible to get a pretty complete representation of the pelagic species by merely collecting at various places along the

shore, provided the net is thrown well beyond the marginal vegetation. From 24 *ponds* along the railroad, connected with Gatun Lake by concealed culverts, there were collected 34 species, including all of those taken from the open water of the lake and along the shore.

Brazos Brook and Agua Clara Reservoirs

These two reservoirs, part of the domestic water supply of the Canal Zone, are located near the Atlantic Portal, between Gatun and Colon, and have areas of 156 and 69 acres respectively. The two have many similarities and certain interesting differences. Both have been constructed by building a dam across a valley and have very irregular outlines and long shore lines. The shores of these lakes, unlike that of Gatun Lake, are kept free from vegetation, both in the marginal water and for about 25 feet back from the water's edge. The water is supplied by rainfall on a rather limited watershed, and there is an additional supply to Brazos Brook Reservoir through a tunnel from Gatun Lake. Brazos Brook Reservoir is the older, having been constructed in 1906, while Agua Clara was built in 1910.

From each of these lakes there were collected 5 vials of material by extensive towing from a boat. Entomostraca were abundant, more so in the deeper than in the superficial strata. In Brazos Brook Reservoir there were found 16 species, in Agua Clara 9. Whether the larger number from the former is due to its greater size and age, its supply of water from Gatun Lake, or to some other factor, is purely a matter of speculation. In Brazos Brook Reservoir the two species by far the most abundant were *Bosminopsis dietersi* and *Diaptomus leoninicollinus,* the latter of which was wanting, and the former very scarce, in collections from Agua Clara Reservoir. In Agua Clara the most abundant species were *Bosmina longirostris, B. longispina, Cyclops leuckarti,* and *C. tenuis*—species, which while not wholly lacking in collections from Brazos Brook, are much less abundant there. The men who have the care of the reservoirs say that the two present quite

different problems, because each has a different species of Chara as its dominant aquatic plant, conditions no doubt to some extent correlated with the differences in Entomostracan fauna.

Comacho and Rio Grande Reservoirs

These two reservoirs are located near together, but somewhat remote from the two just described, on the western side of the Canal in the higher region of the Continental Divide, near Culebra. They have areas of 38 and 62 acres respectively, and in all respects are quite comparable to the former ones, receiving every care to keep them clean and to protect their watersheds from contamination. Comacho Reservoir was built in 1907, and Rio Grande, though originally constructed by the French during their operations in the Isthmus, was rebuilt in 1906. From Comacho Reservoir were collected two vials of material, one from the shore and one by towing behind a boat, and from Rio Grande one vial from the shore.

These collections include 7 and 4 species respectively from the lakes, in each of them *Cyclops tenuis* being by far the most abundant. This species is also abundant in Agua Clara Reservoir, but in other respects the fauna of these two is very different from that of the other two reservoirs. The Rio Grande Reservoir, though larger than the Comacho, shows fewer species, possibly due to less extensive collecting, but more probably because it has steeper and cleaner sides.

Miscellaneous Ponds, Marshes and Streams

Under this heading are included 12 ponds, pools, marshes, and small streams, mostly in the higher regions of the Continental Divide between Gamboa and Pedro Miguel, and all without connection or close proximity to Gatun Lake or other good sized bodies of water. They are not of sufficient importance for individual treatment, nor sharply enough differentiated for satisfactory classification. The number of species from these ponds was 23 and the greatest number from one pond was 9. There is no significant difference between the fauna of these ponds and those connected with Gatun Lake. The

species from these collectively and the number of records for each species are given in Table I. Of interest is a brick-lined reservoir about 10 x 30 feet and 15 feet deep among the ruins of Fort Lorenzo at the mouth of the Chagres River, constructed by the Spanish about three hundred years ago. In this there was a rich fauna of *Cyclops tenuis* only.

Miraflores Lake

This body of water lies between Pedro Miguel and Miraflores Locks, at an elevation 31 feet below the level of Gatun Lake (54 feet above sea level). It has an area of 1.6 square miles and was made by impounding the waters of the Rio Grande, a rather small stream, at Miraflores Lock (Fig. 1). Like all other lakes of the Canal Zone, this one has a very irregular outline and in addition is further subdivided by the railroad and highway embankments, so that it has five divisions connected only by culverts. Littoral vegetation is well developed and at places the shore zone is oiled to prevent mosquito breeding. The lake receives water from several small streams. It also receives water through two sets of locks, wherein lies its special peculiarity. During the operation of the Pedro Miguel Lock, it receives a good volume from Gatun Lake through the Culebra Cut, making it virtually a part of the Gatun Lake System. At the other side of the lake, about a mile away, the Miraflores Lock communicates with the sea level division of the Canal with an average level 54 feet below that of the lake. In the operation of the locks, though there is a downward flow of water from the lake into the lower level of the canal, there is also a mixing of the waters in the lock basins, with the result that some of the sea water finds its way upward through the two steps of the lock in sufficient amount to give to the waters of the lake a degree of salinity—small, but sufficient to necessitate its abandonment as a source of domestic and steam-producing water. The amount of salinity[2] varies greatly from time to time, depending upon

[2] For the records of salinity of Miraflores Lake and also for the information concerning the four reservoirs, I am indebted to Mr. A. G. Nolte, Acting Director of Water Purification.

the amount of run-off and the number of lockages. It is higher in the dry and lower in the rainy season. It also varies from place to place in the lake. Analyses are made monthly from three stations. During the eighteen months ending with December, 1924, the extremes of salinity were 40 and 2,057 parts of chlorides per million parts of water, though the great majority of readings are between 100 and 1,000. During the months when my collecting was done (June and July, 1924) the average chloride content in the main lake was 476 parts per million, while at the old pump station in the part cut off by the railroad embankment it was 315, which is about a fair figure for the average difference between these two parts. Though analyses are not made in other parts of the lake, which are still farther removed from the source of salinity, in them the chloride content is doubtless still less.

From this lake there were collected 27 vials of material, nine from the main part of the lake through which ships pass, eight from the smaller part between the railroad and highway embankments, and four and six respectively from the two larger of the three parts extending toward the north beyond the highway. The fauna of the lake, as seen in these collections, shows decided contrast to that of the bodies of water so far treated. The collections from Miraflores Lake included 24 species of Entomostraca, many of which are common to all the lakes and ponds of the Canal Zone, but there were wanting 4 species, which have appeared abundantly in collections from other localities, viz. *Ceriodaphnia cornuta, Bosmina longirostris, B. longispina,* and *Diaptomus leoninicollinus.* Three of these were collected in the waters of the Culebra Cut just above the Pedro Miguel Lock, and hence are constantly carried into this lake during the operation of the locks. On the other hand there are present in abundance *Cyclops panamensis* and *Pseudodiaptomus culebrensis,* which have not appeared in collections from any other locality, the latter of which, and probably the former also, was described from material collected in brackish water. Thus it seems that this lake, though in a very definite sense a part of Gatun Lake and

constantly receiving water and Entomostraca from it, is also definitely influenced, and receives a distinctive character, from the smaller volume of sea water which finds its way into it through the Miraflores Lock.

General Notes on the Species

The species determined from the collections number 45, including Phyllopoda 1; Cladocera 30; Copepoda 14. In this list there is only one new species. This is not surprising because the Entomostraca are a group which, as a whole, have a ready dispersal, and most of the species have a wide range. In this connection it should be remembered that Dr. Marsh collected seven new species of Copepods from the Canal Zone in 1912.

In comparing the Entomostraca of this region with those from a corresponding area in the temperate or northern latitudes, one has the impression while making collections that the Panama fauna is scant. This is because the amount of material gathered by the net is small. On study of the material it is learned, however, that both species and individuals are quite numerous, and that the seeming scantiness of the collections is due to the small size of the individuals. There are wholly lacking from these collections such forms as the large daphnids and the big species of Diaptomus which make so large a bulk of collections from most waters in the United States. In collecting and studying this material, I was constantly struck with the difference between it and that from the Colorado Rockies, which abounds in large species. To one who expects luxuriant life in the tropics, this may be somewhat of a surprise, and possibly a disappointment as well, for it is by no means true that all groups of animals decrease in size and numbers toward the poles: sometimes the reverse is the case.

While no determinations of species of Ostracoda were made, they were present in collections from some types of habitat, but never in very large numbers. They do not seem to be an important part of the Entomostracan fauna of the region. It

is also worthy of note that Amphipods were never taken or observed, though much collecting was done in situations where one would expect them in abundance in our northern waters.

It is of interest to summarize the known facts of distribution of the several species in this fauna, remembering that more complete explorations may, to a certain extent, change some of the conclusions. Nearly half of the species in the list are world wide in their distribution and might be expected in collections from almost anywhere. These species show no preference for either warmer or colder waters, and are equally at home in tropical waters of perennial warmth or in those of temperate or sub-arctic regions, which are icebound for weeks or months each year. A smaller group includes other species with a very wide distribution, but only in tropical and sub-tropical regions, including such places as Palestine, Congo, East Africa, Algiers, Celebes, New Guinea, Sumatra, Australia, South America, and the southern edge of the United States.

A yet more restricted group includes those species which are not known outside the American continent, among which are a few common all over North America but unknown in South America, and a few others found in South America but extending into North America not farther than the southern edge of the United States. Yet a few other species (7 in number) are known only by the records from the Canal Zone.

Of the 30 species of Cladocera, 28 are listed by Birge in Ward and Whipple's Fresh Water Biology as living in the United States. That is, all but two of the species collected in the Canal Zone range northward at least as far as the southern part of the United States. On the other hand, 16 of the 30 species are known to occur also in South America. This indicates clearly the intermediate nature of the fauna of the Canal Zone between that of the two continents, with the influence of the northern continent seemingly the stronger. More extensive explorations in South America, will, in all probability, show a much closer relationship with the Canal Zone than at present appears.

Of the 18 species of Copepods[3] recorded from the Canal Zone, only 10 are known to occur in the United States. None of the remaining 8 are known outside of Central America, and 7 of them only in Panama. In the Cladocera there is no group corresponding to these 8 species of Copepods with restricted distribution. It is not surprising that none of the 3 species of Diaptomus found in the Canal Zone is known also in the United States, because this genus is composed of many species, each with rather restricted distribution. Cyclops, on the other hand, is a genus which includes species of very wide range, and it is somewhat surprising that 3 of the 12 species listed from the Canal Zone should be new. Explorations in South America may be expected to extend the range of these species.

Notes on the Individual Species

The following list of species includes notes on the occurrence of each in the Canal Zone, as indicated in the present collections; and also notes on the general distribution of each, so that the significance of its presence in the Canal Zone may be seen.

PHYLLOPODA

Gatuna, new genus

The specimens resemble most closely Estheria, having the head and body enclosed within a bivalved shell showing distinct lines of growth, while the general form of the body also suggests that genus (Fig. 2). Certain differences, however, exist. The shell has 7 lines of growth and there are 15 pairs of post cephalic appendages. The head, while resembling that of Estheria more than that of Limnadia, is shorter than in the former genus, being more like that of the Cladoceran Simocephalus—very full in front of the eye, with a short beak

[3] In addition to the 14 species listed in this paper, Dr. Marsh lists *Pseudodiaptomus cristobalensis* Marsh, *Cyclops aequoreus* Fischer, *C. quinquepartitus* Marsh, and *C. varicans* Sars.

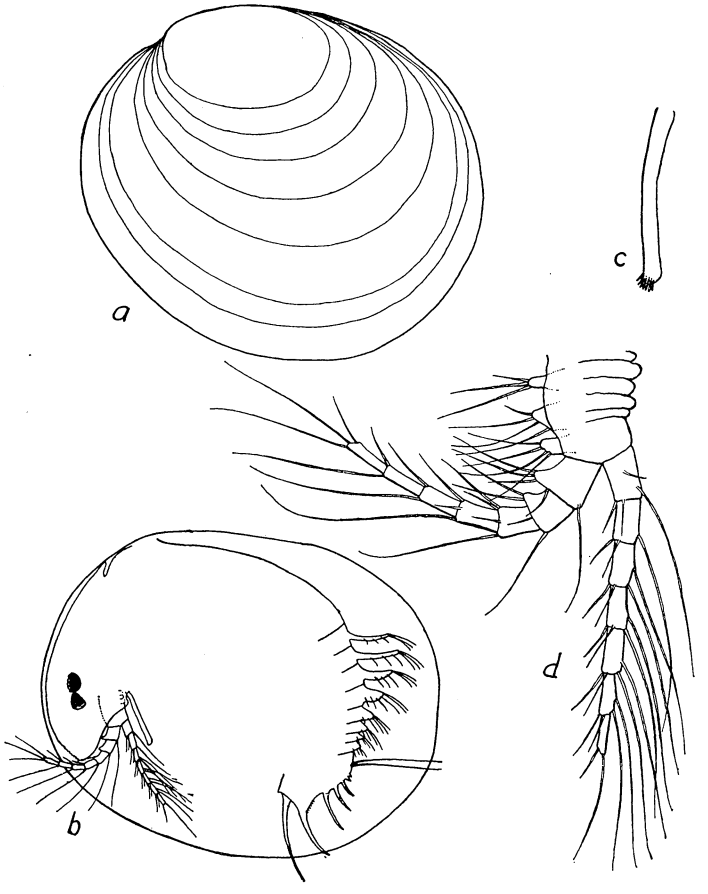

FIG. 2. *Gatuna spinifera.* a, Left valve of shell. b, With left valve removed, showing certain features. c, First antenna. d, Second antenna.

at the base of the first antennae. Immediately below the compound eye there is an ocellus as large as the eye. The first antennae are unsegmented, of about uniform thickness and even contour throughout, except for a slight enlargement just short of the tip. The flagellae of the second antenna have 7 segments.

Gatuna spinifera, new species

Head and body covered with a bivalve shell with 7 lines of growth, well developed umbones at about first one-fourth of its length. Its length does not greatly exceed its height.

The shape of the head suggests that of the Cladoceran, Simocephalus, but fuller at the frons, with a short beak near the base of the first antennae. The front margin of the head, below the eye, just dorsal to the most prominent part of the frons, bears a series of about 10 small serrations decreasing in size upward. The eye is well developed, with many lenses and deep black pigmentation, while immediately below it is the ocellus, as large as the eye, but less deeply pigmented and somewhat angular in shape.

The first antenna is unsegmented, reaches to about the second joint of the flagellum of the second antenna and has about uniform thickness and even contour throughout, except for a slight enlargement just short of the tip. The second antenna is short, not extending much beyond the edge of the shell. The basal joint is stout, its thickness about two-thirds its length. This joint bears 3 setiferous processes, extending forward from its mesial surface to a little beyond the front margin of the joint. The flagellae have 7 segments, bearing long setae on the posterior surface and shorter ones on the anterior. There are 15 pairs of post cephalic appendages, all similar. The telson bears at the end a pair of long, curved, articulated furcal rami, and on its dorsal surface, between the caudal stylets and the furcal rami, 6 pairs of fixed spines in a series, increasing in length from the first, which is a small conical stump, to the last, which is of the same form as the furcal rami and nearly as long. The 6 spines and furcal rami bear small spines on their concave surfaces, and the 6th spine bears on its dorsal surface near the base, 6–10 larger spinules.

Each of the 8 segments just anterior to the telson bears on its dorsal surface a process bearing setae directed posteriorly. These processes decrease in length posteriorly, the anterior ones being tall, digitiform processes, and the posterior ones short, conical elevations. On the segments anterior to these,

the dorsal process is represented by very small eminences with minute spines.

Size: Length 2.1 mm.; height 1.5 mm. or more, there being considerable variation in proportions.

The foregoing description is based upon 6 females, one of them bearing eggs and another young. These were collected in the Canal Zone from ponds between Monte Lirio and Gamboa. No males were collected.

Type Specimens: Cat. No. 52035, Museum of Zoology, University of Michigan.

Among the specimens there was one female carrying four young which had shed the egg membrane. These were carried within the valves of the shell, attached by slender byssus threads to filamentous processes of certain trunk appendages. The attachments are long enough to allow the young to oc-

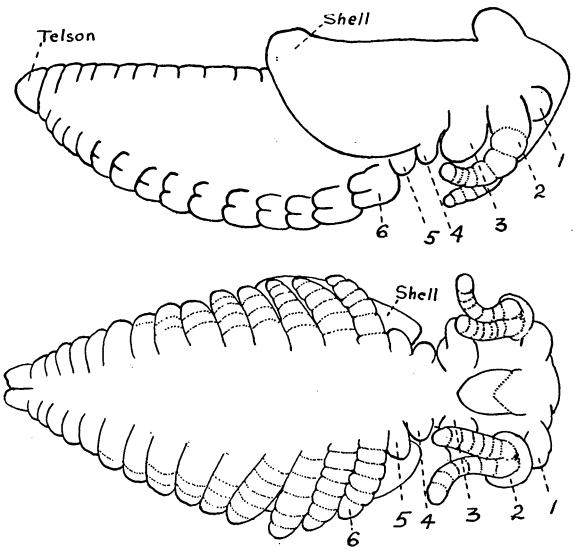

FIG. 3. *Gatuna spinifera*: young individual taken from brood chamber of female. Side and ventral views. 1, First antenna. 2, Second antenna. 3, Mandible. 4, First maxilla. 5, Second maxilla. 6, First post cephalic appendage.

cupy a position just anterior to the tall dorsal processes. The four young observed had a length of 0.5 mm., and instead of being in the nauplius or metanauplius form, at which stage Conchostraca are commonly liberated, were well advanced (Fig. 3). The second antennae were already biramous, and the four other appendages of the head appeared as rounded swellings, of which the mandibles were much the largest. Nearly all of the 15 pairs of trunk appendages were clearly visible and showed segmentation and biramous form. The beginning of the valves were represented by a pair of dorsolateral swellings in the anterior trunk region. The byssus thread was attached to the anterior surface of the head. It cannot be known at what stage the young are liberated, but these are already beyond the metanauplius stage and strongly suggest the young seen in the brood chambers of Cladocera, which attain the form of miniature adults before liberation.

CLADOCERA

Pseudosida bidentata Herrick

This species was found in 24 collections from ponds and along the shore of Gatun Lake, but always in small numbers. It has previously been collected in certain of our southern states and in Guatemala.

Diaphanosoma brachyurum (Lievin)

Found in 79 vials. One of the most common species of the Canal Zone, being found everywhere in ponds and lakes, usually only in small numbers, except in the open waters of Gatun Lake, where it attains great abundance, in some instances making the greater part of the collection. Common in Europe and United States. Collected by Juday in Mexico and Guatemala.

Simocephalus exspinosus (Koch)

Scanty material in poor condition was doubtfully referred to this species. Found in small numbers along the shores of

Miraflores Lake and in a neighboring marsh. Widespread but not abundant.

Simocephalus serrulatus (Koch)

Collected in small numbers in Miraflores Lake and two ponds connected with Gatun Lake. This species has a wide distribution, but has not been reported from South America, though Sars finds there *S. semiserratus* Sars, which differs from it only slightly.

Ceriodaphnia cornuta Sars

Found in 52 collections from various situations, but attaining great abundance only in some of the collections from the open water of Gatun Lake. It was not found in Miraflores Lake. The material included in this species is variable, including on the one hand individuals typical for *C. rigaudi* Richard, and on the other those with the full development of the spinous armature, which places them definitely in *C. cornuta*. Most species are of this latter type. A study of this material supports the view of Dr. Birge, that all these forms should be included under one species. The species has been reported from our southern states, South America and various widespread stations, nearly all tropical and sub-tropical.

Moinodaphnia macleayii (King)

This species was found in 10 collections from ponds having much vegetation, being most abundant in a dirty slough near Frijoles. South America, southern United States and other tropical and sub-tropical regions.

Moina micrura Kurz

Found in 53 collections from all sorts of situations, but most abundant in open water. It made up by far the greater part of collections from the bridge across the Chagres River at Gamboa. Common in North America and elsewhere, but not reported from South America.

Bosmina longirostris (O. F. Mueller)

This is one of the most abundant species, being found in 71 collections, sometimes in great abundance, especially in Agua Clara Reservoir and the open waters of Gatun Lake. This species was not found in Miraflores Lake. Very widely distributed but not reported from South America.

Bosmina longispina Leydig

Found in 30 collections, in almost every case associated with *B. longirostris,* sometimes in large numbers. On account of the almost constant association of these two species, I at first suspected that they might be only forms of one species. Careful study, however, showed that there were two distinct types and that these fit the description of the two species. This species is wanting from Miraflores Lake. Widespread, but not reported from South America.

Bosminopsis dietersi Richard

This species was found in 29 collections from all kinds of situations, but is much more common in open waters. It is by far the most abundant species from Brazos Brook Reservoir. Reported from Louisiana and Buenos Ayres.

Grimaldina brazzai Richard

Very small numbers of this species were found in two localities, Miraflores Lake and a ditch by the roadside near Gold Hill. Known to occur in Louisiana, Brazil, Congo, and New Guinea.

Ilyocryptus spinifer Herrick

Found in 25 collections from weedy shores, where it was taken in very small numbers, except in three collections where it was fairly abundant and made the greater part of the collection. The material from the Canal Zone corresponds to the figure of *I. longiremis* Sars, described from South American material, which (together with *I. hayli* Brady) Dr. Birge considers to be the same species as *I. spinifer* Herrick. Com-

mon throughout North and South America, with a wide distribution in the eastern continents and islands.

Macrothrix squamosa Sars

Small numbers were found in 6 ponds, which agree well with the material described by Sars from South America and differ slightly from *M. laticornis*.

Macrothrix rosea (Jurine)

This species is quite common, being found in 37 collections from shores and ponds. It was usually collected only in small numbers, but in collections from 3 ponds near Gold Hill and a marsh west of Miraflores Lock, it was fairly abundant and formed the greater part of the material. It is upon characteristics of the male that Sars bases his *M. elegans*, found in South America. Males were not observed in the Canal Zone material but Dr. Birge states that all males found in America agree with that species, and these are no doubt of the same type. *M. rosea* has a wide distribution throughout the world.

Kurzia latissima (Kurz)

A few specimens were found in a small stream flowing from a marsh into Miraflores Lake on the west side. Widespread in United States and Europe.

Euryalona occidentalis Sars

Found in one of the arms of Miraflores Lake. United States and Brazil.

Oxyurella tenuicaudatus (Sars)

A very few specimens were found in a pond between Darien and Gamboa. Widespread but not reported from South America.

Leydigea acanthocercoides (Fischer)

Found in one collection from the part of Miraflores Lake between the railroad and highway. Louisiana, Argentine.

Alona affinis (Leydig)

Found in small numbers in 4 ponds cut off from Gatun Lake by the railroad embankment. Cosmopolitan.

Alona costata (Sars)

Small numbers were found in material from 2 marshes near Gold Hill and one west of Miraflores Lock. This species also has a wide distribution.

Alona intermedia Sars

Found in 2 small streams, one near Gold Hill, the other draining the marsh west of Miraflores Lake. This species also has a wide distribution in United States and Europe and has been found in Brazil.

Alona rectangula Sars

This species was found in 56 collections from various kinds of situations, but always in very small numbers. The species has a wide distribution in America and Europe and is reported by Sars from South America, though he states that there is a small possibility that the specimens may have come from elsewhere.

Dunhevedia setigera (Birge)

This species was found in 3 ponds separated from Gatun Lake by the railroad, between Monte Lirio and Frijoles. Found in various parts of United States and near Mexico City. If this species is the same as *D. crassa* King, it is found in Australia and Europe.

Dunhevedia odontophlax Sars

Found in collections from a narrow arm of Gatun Lake near Frijoles. These specimens clearly differ from those assigned to the former species, by the presence of a single dentiform process on the keel of the labum, a feature which marks *D. odontophlax* as described by Sars in material from Brazil and Chili.

Chydorus barroisi (Richard)

In 5 collections from ponds between Frijoles and Gamboa there were small numbers of this species. Southern United States, Brazil and other tropical and sub-tropical regions.

Chydorus hybridis Daday

A few specimens were found in 6 ponds between Frijoles and Summit. Reported in United States from north to south.

Chydorus sphaericus (O. F. Mueller)

Found in 14 collections from shores. Cosmopolitan.

Alonella dadayi Birge

Found in one pond near Monte Lirio. Birge states that this species is found in Louisiana and Texas, and in South America.

Alonella dentifera Sars

Found in a dirty pond near Frijoles. Louisiana, Texas, Brazil.

Dadaya macrops (Daday)

Found in small numbers in 3 weedy ponds near Gamboa and in one of the arms of Miraflores Lake. Texas, Brazil, Ceylon.

COPEPODA

Pseudodiaptomus culebrensis Marsh

This species occurred in 11 collections, all from Miraflores Lake. It was described by Marsh from material collected in brackish water in the "Rio Culebra, a branch of the Rio Chepo in Panama." Its presence as an important part of the fauna of the brackish water of Miraflores Lake, representing a genus largely inhabiting such waters, is of significance.

Diaptomus leoninicollinus Marsh

This is the most abundant species of the genus in the region, being found in 64 collections, often in considerable numbers.

It lives under diverse conditions, being abundant in both the open waters of Gatun Lake and the enclosed waters of small ponds, often among water lilies and other vegetation. It was not found in Miraflores Lake, a matter of significance, especially as it was collected in the canal at the north entrance of the Pedro Miguel Lock, from whence it must constantly be carried into the lake during the operation of the locks. The species was described by Marsh from near Lion Hill, a location now inundated by the waters of Gatun Lake, which in the intervening 12 years has become well populated with this species, probably over its entire area.

Diaptomus gatunensis Marsh

This species was found in 40 collections, usually associated with the preceding one. Both species are common in ponds and enclosed bodies of water, but this one is almost wanting from collections made in the open waters of Gatun Lake, where the former is abundant. Unlike the former species, this one was collected in Miraflores Lake. This species also was described by Marsh from regions that are now covered by the waters of Gatun Lake.

Diaptomus marshi Juday

This species was found in 7 collections from shores and ponds, always in small numbers, except in a very dirty and plant-grown pond between Gamboa and Summit, where it was the most abundant of 9 species. The species was described from material collected in Guatemala and was also collected in the Canal Zone by Marsh.

Cyclops albidus Jurine

Found in 13 collections from widely distributed weedy ponds and marshes. It has a world-wide distribution and was reported by Marsh from the Canal Zone.

Cyclops ater Herrick

A few specimens of this species were found in two localities, the one a weedy pond near Darien, the other along the reedy

shore of one of the arms of Miraflores Lake. This species is widely spread in the United States and was collected by Juday near Mexico City. Its discovery in Panama is an important extension of the range.

Cyclops dentimanus Marsh

This is one of the common species of the Canal Zone, being found in 28 collections from ponds, marshes and weedy shores of lakes. The characters agree well with Marsh's description from rather meager material. I found the length of the egg-bearing females up to 0.8 mm. It is usually collected only in small numbers but was found in abundance in a small pond with much vegetation near Frijoles.

Cyclops leuckarti Claus

This seems to be the most common Entomostracan of the region, being found in 85 collections from all sorts of conditions, but most abundantly in collections from Agua Clara Reservoir and certain ponds and marshes. The species is found in all parts of the world and was collected by Marsh in the Canal Zone.

Cyclops panamensis Marsh

This species was found in 19 collections, all from Miraflores Lake, where it is by far the most abundant Copepod. Marsh wrote the description of this species from material "found on the savannas between Panama and Old Panama" but does not state just what the conditions were. That I have collected it only in the slightly saline water of Miraflores Lake along with *Diaptomus culebrensis,* places it among the inhabitants of brackish water.

Cyclops phaleratus Koch

This species was found in 12 collections from the shore zone of lakes and ponds, in only one instance in more than very small numbers. The species is found throughout the world, but has not been reported previously from the Canal Zone.

Cyclops prasinus Fischer

Small numbers were found among reeds along the shore of an arm of Miraflores Lake. A widespread species, previously found in the Canal Zone.

Cyclops serrulatus Fischer

A fairly common species, but never abundant, being found in 39 collections from shores and bottoms of lakes and ponds, but always in small numbers. World wide in its distribution.

Cyclops tenuis Marsh

This species was found in 81 collections. It is just a little less wide spread than *C. leuckarti,* with which it is almost always associated, and of the two is the more abundant in individuals. It is prevalent in all situations from open waters of Gatun Lake to the smaller ponds, but is less abundant among the vegetation than in the open waters, while *C. leuckarti* rather favors weedy situations. As pointed out by Marsh, who first reported it from the Canal Zone, it is of interest that this species, described from Arizona, should be found in the Canal Zone, and it is of further interest that it now proves to be one of the abundant and characteristic species of the region. It was the sole and abundant species in a reservoir 300 years old at Ft. Lorenzo.

Canthocamptus staphylinus Jurine

A few specimens of this species were found in a small stream near Gold Hill. The species has a wide distribution.

A few specimens of undetermined species of this genus were also found in other similar situations, but in all there were not more than a dozen specimens of Harpactidae found in my collections.

Table 1. *List of localities, number of collections from each, and number of collections in which each species was found*

Names of Species	Gatun Lake			Brazos Brook Res.	Agua Clara Res.	Comacho Res.	Rio Grande Res.	12 ponds, etc.	Miraflores L.	Total records
	Open water	Shore	24 ponds							
Gatuna spinifera	.....	.....	5	.....	.....	.....	.....	.....	.....	5
Pseudosida bidentata	.....	2	12	.....	.....	.....	.....	3	7	24
Diaphanosoma brachyurum	19	8	21	5	4	1	1	.....	17	76
Simocephalus exspinosus	.....	.....	.....	.....	.....	.....	.....	1	1	2
Simocephalus serrulatus	.....	.....	2	.....	.....	.....	.....	.....	2	4
Ceriodaphnia cornuta	24	7	18	4	.....	.....	.....	1	.....	54
Moinodaphnia macleayii	.....	.....	9	.....	.....	.....	.....	1	.....	10
Moina micrura	18	2	12	4	.....	2	1	2	11	52
Bosmina longirostris	19	16	21	4	5	.....	.....	1	.....	71
Bosmina longispina	8	4	9	3	5	.....	.....	.....	.....	29
Bosminopsis dietersi	10	4	4	5	1	.....	.....	.....	15	39
Grimaldina brazzai	.....	.....	.....	.....	.....	.....	.....	1	1	2
Ilyocryptus spinifer	.....	3	18	1	.....	.....	.....	.....	1	23
Macrothrix squamosa	.....	.....	3	.....	.....	.....	.....	3	.....	6
Macrothrix rosea	1	3	17	3	.....	.....	.....	4	8	35
Euryalona occidentalis	.....	.....	.....	.....	.....	.....	.....	.....	1	1
Oxyurella tenuicaudatus	.....	.....	1	.....	.....	.....	.....	.....	.....	1
Leydigea acanthocercoides	.....	.....	.....	.....	.....	.....	.....	.....	1	1
Alona affinis	.....	1	3	.....	.....	.....	.....	.....	.....	4
Alona costata	.....	.....	.....	.....	.....	.....	.....	3	.....	3
Alona intermedia	.....	.....	.....	.....	.....	.....	.....	2	.....	2
Alona rectangula	7	4	26	1	1	1	.....	1	10	51
Dunhevedia setigera	.....	1	2	.....	.....	.....	.....	.....	.....	3
Dunhevedia odontophlax	.....	.....	1	.....	.....	.....	.....	.....	.....	1
Chydorus barroisi	.....	.....	5	.....	.....	.....	.....	.....	.....	5
Chydorus hybridis	.....	.....	5	.....	.....	.....	.....	1	.....	6
Chydorus sphaericus	.....	1	7	3	2	.....	.....	1	.....	14
Alonella dadayi	.....	.....	1	.....	.....	.....	.....	.....	.....	1
Alonella dentifera	.....	.....	1	.....	.....	.....	.....	.....	.....	1
Dadaya macrops	.....	.....	3	.....	.....	.....	.....	.....	2	5
Kurzia latissima	.....	.....	.....	.....	.....	.....	.....	1	.....	1
Pseudodiaptomus culebrensis	.....	.....	.....	.....	.....	.....	.....	.....	10	10
Diaptomus leoninicollinus	15	9	30	5	.....	.....	.....	.....	.....	59
Diaptomus gatunensis	2	5	23	.....	.....	2	.....	.....	8	38
Diaptomus marshi	.....	1	4	1	.....	.....	.....	1	.....	7
Cyclops albidus	.....	1	7	1	.....	.....	.....	1	3	13
Cyclops ater	.....	.....	1	.....	.....	.....	.....	.....	1	2
Cyclops dentimanus	.....	3	13	.....	.....	.....	.....	8	4	28
Cyclops leuckarti	14	5	36	4	4	2	1	5	16	85
Cyclops panamensis	.....	.....	.....	.....	.....	.....	.....	.....	19	19
Cyclops phaleratus	.....	.....	6	.....	.....	1	.....	3	1	11
Cyclops prasinus	.....	.....	.....	.....	.....	.....	.....	.....	2	2
Cyclops serrulatus	2	2	17	5	5	.....	.....	3	5	39
Cyclops tenuis	24	10	27	3	5	2	1	2	7	81
Canthocamptus staphylinus	.....	.....	.....	.....	.....	.....	.....	1	.....	1
Number of species	13	21	34	16	9	7	4	23	24	45
Number of collections		101		5	5	2	1	16	27	157