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FAUNA OF THE CHILKA LAKE

THE MYSIDACEA OF THE LAKE, WITH THE DESCRIPTION OF A SPECIES FROM THE COAST OF ORISSA.

By WALTER M. TATTERSALL, *D.Sc.*, *Keeper of the Manchester Museum.*

(With 1 text-figure.)

CONTENTS.

MYSIDACEA.

By WALTER M. TATTERSALL.

Dr. Annandale and Mr. Kemp have continued to send me further collections of Mysidae made by them in various parts of the littoral of India, mainly in brackish water. In the present paper I describe two new species, belonging to the genus *Gastrosaccus*, and record a third one, *Rhopalophthalmus egregius*, Hansen (previously known from Japan and the East Indies) for the first time from the coast of India, where it appears to be an abundant form. The number of species of Indian brackish water Mysidae is now raised to five and Dr. Annandale and Mr. Kemp are to be congratulated on the success which has attended their work. My best thanks are due to them for the opportunity of examining and reporting on these specimens.

The majority of the specimens here recorded are from the Chilka Lake, a shallow lagoon on the east coast of India, some thirty miles long and ten miles broad, connected with the sea by a narrow mouth. The salinity of the water in this lake differs very greatly at different seasons of the year,[1] and Mr. Kemp informs me in a letter that "visiting the lake in September (1914) at a time when the water is at its highest, we found that a considerable part of the lake, including the outer channel as far as the sea-mouth, was filled with absolutely fresh water. A great part of the fauna of the lake is thus able for some two or three months each year to exist in perfectly fresh water, and many species exist in salinities ranging from fresh water to water as salt as the Bay of Bengal (sp. gr. 1·0265)." Among such species are all but one of the Mysidae here dealt with, and it is exceedingly interesting to find that they have adapted themselves to such a changing environment. In connection with one of the species, *Potamomysis assimilis*, I have suggested that the great changes in the salinity of the sea-water may account for the relatively great variation in the shape and armature of the telson, but in order to settle this question, a complete series of specimens, taken regularly throughout the year, with notes on the salinity of the water at the time of capture would be necessary. It is possible that the changes in salinity are too rapid to allow of correlated changes in the structure of the species. The other two abundant species, *Macropsis orientalis* and *Rhopalophthalmus egregius*, do not show evidence of such variation.

Of the five species of Mysidae now known from brackish water in India four occur in the Chilka Lake. Three of these (*Rhopalophthalmus egregius*, *Macropsis orientalis*

[1] See Introduction, p. 5.

and *Potamomysis assimilis*) are very abundant in all parts of the lake, the main area as well as the outer channel; while one (*Gastrosaccus muticus*) has been found less commonly in the outer channel and adjacent parts of the main area. The fifth species (*Indomysis annandalei*) is at present known only from the neighbourhood of Bombay

The following key will serve for the identification of the known species of Indian brackish-water Mysidae.

KEY TO THE SPECIES OF INDIAN BRACKISH-WATER MYSIDAE.

1. Both rami of the uropods divided by a transverse joint distal to the centre.

   Thoracic legs without terminal brush of setae: dactylus not developed; pleopods of the male well developed, exopod of the second pair very elongated, rami of the third, fourth and fifth pairs subequal.

   Telson entire, apex armed with four strong stout serrate spines: distal half of the lateral margins armed with about fifteen spines: antennal scale as long as the antennular peduncle with the outer margin entire (*i e.*, without setae) and terminating in a spine, six times as long as broad: carapace very short: eyes large, black, on prominent stalks: eighth thoracic limb in both sexes with the endopod reduced and papilliform .. *Rhopalophthalmus egregius*, Hansen.

2. Both of the uropods undivided.

   (*a*) Outer margin of the exopod of the uropods armed with more or fewer spines, but without setae between the spines and the base: third pair of pleopods of the male with the exopod elongated: first abdominal segment of the female with a pair of lateral lamellae: telson long, as compared with the uropods, cleft at the apex, the cleft armed with sharp serrations.

   Lateral margins of the telson armed with about fourteen spines: no spine on the dorsal surface of the fifth segment of the pleon: posterior dorsal margin of the carapace with a fringe of from six to nine slender processes: exopod of the third pleopod of the male as described in this paper .. .. .. *Gastrosaccus muticus*, W.M.T.

   (*b*) Outer margin of the exopod of the uropods setose, without spines: first abdominal segment of the female without lateral lamellae: telson short, entire, without apical cleft.

   (*c*) Apex of the telson between the terminal spines of the lateral margins truncate, armed with numerous short spines: first, second and third pleopods of the male rudimentary as in the female, exopod of the fourth pair elongate: antennal scale setose all round.

   (1) Antennal scale two-jointed, about seven times as long as broad; lateral margin of the telson armed with 7-10 spines, apex with 12-17 spines not much shorter than the terminal spine of the lateral margin *Potamomysis assimilis*, W.M.T.

   (2) Antennal scale unjointed, about $4\frac{1}{2}$ times as long as

broad; lateral margins of the telson armed with 4-7 spines, apex with numerous quite small spines or teeth much shorter than the terminal spines of the lateral margins .. *Indomysis annandalei*, W.M.T.

(*d*) Apex of the telson between the terminal spines of the lateral margins produced into an obtuse serrated process; third pleopod of the male biramous though small; exopod of the fourth pair elongate; antennal scale setose all round and two-jointed; eyes rather large on long stalks *Macropsis orientalis*, W.M.T.

One species (*Gastrosaccus simulans*) described in this paper, was not found in brackish water, but on the sea-shore a few miles up the coast from the mouth of the Chilka Lake.

Dr. Annandale and Mr. Kemp have supplied notes on the natural colouration, habits, etc., of the different species. These notes I have added in each case at the end of my own observations.

Family MYSIDAE.

Sub-family *RHOPALOPHTHALMINAE*, Hansen.

Genus **RHOPALOPHTHALMUS**, Illig.

Rhopalophthalmus egregius, Hansen.

R. egregius, Hansen, 1910. *R. egregius*, Nakazawa, 1910.

This interesting species was first described by Hansen (1910) from specimens taken on the Siboga expedition in the Sangkapoera Roads, Bawean Island, in the East Indies. It has since been recorded by Nakazawa (1910), from Port Shimizu, Suruga Bay, Japan. Its occurrence on the coast of India therefore marks a considerable extension in its known geographical range, and it is evidently an abundant and widely distributed form.

Hansen's description was based on mutilated specimens, and is therefore incomplete. I am able from the present material to supplement his description and to add some points not hitherto noticed.

The most interesting feature of the species, not noticed by Hansen but described and figured by Nakazawa, is the reduced condition of the endopod of the eighth pair of thoracic limbs in both sexes. In the female, the endopod of these limbs is hardly as long as the basal joint of the exopod, papilliform in shape, obscurely two-jointed, with one or two setae on the outer edge at the obscure junction of the two joints, but otherwise unarmed. In the male, the endopod is more distinctly two-jointed, and the basal joint bear six long setae on its outer margin.

The remainder of the thoracic legs are as described by Hansen. They increase in length and slenderness from the third to the seventh pair and have the sixth joint or tarsus four-jointed in the third pair, five-jointed in the fourth to the sixth pair and seven-jointed in the seventh pair. The carapace is exceedingly short, leaving entirely exposed the last three thoracic segments. The antennular peduncle appears to me to be somewhat stouter than shown in Hansen's figure and has the outer distal

corner of the basal joint more produced. The distal part of the outer margin of the basal joint is armed with numerous long plumose setae in the position indicated by the notches in Hansen's figure and as depicted by Nakazawa.

The antennal scale, which reaches to the distal end of the antennular peduncle, is as figured by Hansen, but the basal joint from which both the scale and antennal peduncle spring, is armed with three strong spines at the inner corner, at the base of the peduncle. These spines are not indicated by either Hansen or Nakazawa. The antennal peduncle is very short, not as long as the basal joint of the antennular peduncle. The Indian examples reach a length of 12 mm.

The natural colouration of this species is described as follows:—Transparent, with a large lateral patch of very pale mauve on each abdominal segment. Brood-pouch tinged with yellow. Two blood-red spots on the telson, one at the base and one near the apex. Eyes pale glaucous green.

Rhopalophthalmus egregius occurs abundantly all over the Chilka Lake, especially on a muddy bottom and among the weed *Halophila ovata*. It has, however, also been taken on clean sandy ground. Although taken at Barkuda Id. within a few yards of the shore, it was usually captured out in the lake in water from 4 to 12 ft. deep. It was never observed close in to the rocks or in very shallow water, and in this respect its habits differ markedly from those of *Macropsis orientalis* and *Potamomysis assimilis*. Apparently it lives mainly at some distance below the surface, perhaps only a few inches above the bottom. The species is gregarious.

Sub-family *GASTROSACCINAE*, Norman.

Genus **GASTROSACCUS**, Norman.

Gastrosaccus muticus, sp. nov.

Locality.—Outer parts of Chilka Lake, Orissa, E. coast of India.

Description.—Very closely allied to *Gastrosaccus spinifer*, Goës.

Dorsal posterior median emarginate border of the carapace with a fringe of from six to nine slender filaments.

Fifth segment of the pleon without a dorsal spine-like projection.

Antennules with three or four short strong spines on the outer edge of the second joint; a single similar spine on the outer edge of the third joint about one-quarter of the length of the joint from the distal end.

Antennal scale reaching to the distal end of the second joint of the antennular peduncle and slightly shorter than its own peduncle; slightly less than four times as long as broad, outer margin terminating in a strong spine beyond which the apex of the scale is not produced.

Telson less than three times as long as broad at its base, with about fourteen spines on its outer margin, only the terminal spines conspicuously larger than any of the remainder and equal in length to one-eighth of the length of the telson; telson cleft for one-sixth of its length.

Inner uropods equal in length to the telson plus its terminal spines, with four

somewhat distantly placed spines on its inner margin, the proximal one of which is on the statocyst.

Large epimeral plate of the first segment of the pleon in the female with its front margin microscopically serrulate.

Tarsi of the third to the eighth thoracic limbs composed of from seven joints in the third pair to eleven joints in the eighth pair. Basal joint of the exopodites of all the thoracic limbs with a prominent tooth at its outer distal corner, except in the eighth pair where this corner is rounded.

Pleopods of the female very similar to those in *G. spinifer* except that the two branches of the first pair are more nearly equal in size than shown in Stebbing's figure (1880).

First, second, fourth and fifth pleopods of the male agreeing closely with those figured by Sars (1877) for *G. sanctus*. With the exception that the exopod of the first pair is eight-jointed, both the exopod and the endopod of the second pair are eight-jointed, and the endopod of the fourth and fifth pairs is seven-jointed, Sars' figures would serve very well to illustrate the present species. The agreement in the general form and proportions is of the closest character.

The third pleopods of the male differ vastly from those of the male of *G. sanctus*. The endopod is similar to that of the preceding and succeeding pairs, seven-jointed, and extending about half way down the second joint of the exopod. The exopod is very elongate, reaching to the base of the telson and divided into five joints. The first joint shows three suture lines representing subsidiary joints, similar to those shown in Sars' figure (1877) of the same appendage of *G. sanctus*. The second joint is shorter than the first, and the third joint is as long as the first and second combined but more slender. The fourth joint is short and has the distal lower margin produced into an obtuse lobe. The terminal joint is longer than the fourth and broadens considerably to an obliquely truncate apex. At one corner of the apex are two short stout spines terminating in two processes, the outer one rather stout and blunt and microscopically ridged, the inner one slender and acutely pointed. At the other corner of the apex is placed a long, strong, slightly curved spine with about eleven spinules on the distal half of its margin. At the base of this long curved spine is situated a smaller, more slender and more sharply curved spine and between this latter spine and the two spines with the bifid apices, there is an obtusely pointed process, microscopically ridged at its apex, which arises from some way inside the distal margin of the fifth joint, on its lower face. The whole of the fifth joint resembles a sub-chelate "hand" with the bifid spines delimitating the palm on one corner, and the long curved spine as the "finger.

Length of an adult female, 7 mm.; of an adult male, 6 mm.

This species is very closely allied to *G. spinifer*, Goës, but differs in the following points:—

(1) The absence of the dorsal spiniform process on the fifth segment of the pleon.

(2) The larger number of spines on the lateral margins of the telson, fourteen as against six to eight in *G. spinifer*.

(3) The fewer spines on the inner margin of the inner uropods, four as against nine to eleven in *G. spinifer*[1].

(4) In having four spines on the outer edge of the second joint of the antennular peduncle instead of three as in *G. spinifer*.

(5) In its smaller size, 7 mm., as against 20 mm.

(6) In the vastly different form of the exopod of the third pleopods of the male. The third pleopod of the male of *G. spinifer* has never been figured, but I find by examination of British specimens that it agrees closely with the same appendage in *G. sanctus* as figured by Sars (1877).

In the possession of a fringe of slender filaments on the central posterior dorsal margin of the carapace, *G. muticus* is at once distinguished from all other described species of the genus except *G. spinifer* and the following new form.

In life the species is described as being not very translucent, with a large brown spot at the base of the lower antenna and another, posterior to the first, near the hinder end of the carapace. Each of these dark spots was connected with a pale yellowish one situated above it. There were two small black spots on each side of the brood-pouch, consisting of single dendritic chromatophores. On the posterior margin of each of the abdominal segments there was a brown dendritic chromatophore on either side, connected with its fellow on the opposite side by a yellow line. The last abdominal segment bore a brown transverse bar at its posterior extremity. The telson was tipped with mingled brown and yellow. The tip of the antennal scale was brown. The eggs were quite colourless.

G. muticus occurs mainly in the outer channel of the Chilka Lake, but was also taken near Nalbano in the main area. It was invariably found either on a sandy bottom or on one in which the mud was mixed with a considerable amount of sand. Although considerable numbers of specimens were sometimes taken in a single haul of the ⊓-net, the species is perhaps less markedly gregarious than the others found in the lake.

The type specimens are preserved in the Indian Museum and are numbered 8664/10 in the Museum register.

Since this paper went to press, I have received specimens of this species from Madras, where they were collected by Dr. Annandale in the Ennur backwater, in water of specific gravity varying from 1·000 to 1·0045 (corrected). The species was apparently quite abundant in this locality.

Since this paper left my hands, I have received further material of this species from the Chilka Lake, and its examination necessitates the following additional notes. The material altogether comprised 24 males and 46 females. A point of perhaps minor importance is that the number of spines on the outer margin of the second joint of the antennular peduncle is not invariably four. Quite a number of the specimens in this additional material have only three spines in this position. The main interest centres in the form of the exopod of the third pleopods of the male.

[1] There is apparently some variation in this character.

Of the male specimens fifteen are adult and have the exopod of the third pleopods as I have described it above. This may for convenience be known as form A. Two of the males, while apparently adult (that is, they are quite as big as the other specimens and are apparently, therefore, fully grown) have the exopod of the third pleopods of a quite different form, which may be known as form B (fig. 1*d*, p. 157). The last two joints are longer and not so stout as in form A and the bifid spine-like processes are absent, being replaced by two simple spines. The single microscopically ridged process is present as in form A, and the terminal curved spine is of the same proportional length. In all other characters these two specimens conform to the type, and it is to be noted that even in the exopod of the third pleopods, the same parts are present on the last joint in both forms, *viz.*, two spines and a single ridged process on the inner lateral margin and a longer and a shorter spine at the apex. It is in the shape of the last two joints and the character of the two lateral spines that the two forms differ. Now the remaining seven males in this material are immature and the exopod of the third pleopods is of a form which will ultimately result in the form B of male pleopods, with further growth. It seems to me, therefore, that the two largest specimens of form B cannot be quite adult, in spite of their size compared with the size of form A and their mature look, and that the form B of male pleopods is a growth stage in the formation of the form A type. It cannot, I take it, be a case of "seasonal dimorphism" of the males (as for instance has been found by Wollebaek for the males of *Pandalus montagui*, in which the shape of the endoped of the first pleopods is of two forms, identified with the breeding and non-breeding seasons of the species) because forms A and B were found mixed together in the one bottle and therefore presumably captured together. It is possible that it is a case of definite dimorphism in the males but, if so, I cannot understand why the exopod of the third pleopods in the undoubtedly immature males should in all cases be of the form B type. A fourth explanation is possibly open, that we have here a case of high and low dimorphism among the males of this species, but the available data are insufficient to decide the question. I incline to the opinion that forms A and B are the final and penultimate stages in growth. It is unfortunate that the brush of setae on the antennules, which in most other Mysidae is well developed in adult males, should be feebly developed in *Gastrosaccus* so that this additional external mark of sexual maturity is not here available as a guide. Moreover the separation of species becomes more difficult because of the high systematic value hitherto set on the characters displayed by the pleopods of the male. At the same time, the form B of *G. muticus*, while resembling *G. simulans* more than form A in the shape of the exopod of the third pleopods of the male, offers no possibility of confusion with the latter because, apart from the differences in these appendages, the number of spines on the margins of the telson affords an additional distinguishing character.

Gastrosaccus simulans, sp. nov.

Locality.—Puri Beach, Orissa coast, washed up on shore, January, 1911, coll. F. H. Gravely, three adult females, 7-8 mm., one adult male, 7·5 mm., one imma-

ture female, 6·5 mm., and four newly hatched young. TYPES.—Regd. No. 8433/10, Ind. Mus.

Description.—This species is intermediate in its characters between *G. spinifer*, Goës, and the species described above, *G. muticus*. Like both these species it possesses a fringe of from six to eight slender spine-like filaments on the central dorsal posterior margin of the carapace and is therefore distinguished from every other described species of the genus.

In the three adult females and single adult male, there is no spine-like process on the fifth segment of the pleon. But in the single immature female and in all the newly-hatched young, this spine-like process is present, well developed and exactly as seen in adult specimens of *G. spinifer*. The inference is naturally that in the present species, the spine-like process is characteristic of the young and immature forms, and disappears with the attainment of sexual maturity. My material is too scanty to be definite on this point, but either my inference is the correct interpretation of the facts, or there are two closely allied species present in the gathering. I have judged of the maturity of my specimens by the state of development of the marsupial lamellae in the female and of the third pleopods of the male. It is certainly suggestive that the single female with the marsupial lamellae just appearing and the four newly-hatched young should all have the spine-like process well developed, while the obviously adult male and females should be without that process. The value of the presence or absence of this process as a specific character is likewise very much impaired if the above interpretation of the facts is the correct one. More material of the species is greatly to be desired to settle this point. In the character of the antennules, antennal scale, inner and outer uropods, and thoracic limbs, *G. simulans* agrees exactly with the description given for *G. muticus* above. The telson, however, has only from eight to ten spines on its lateral margins and is thus intermediate in this respect between *G. spinifer*, where the number is six to eight, and *G. muticus* with fourteen.

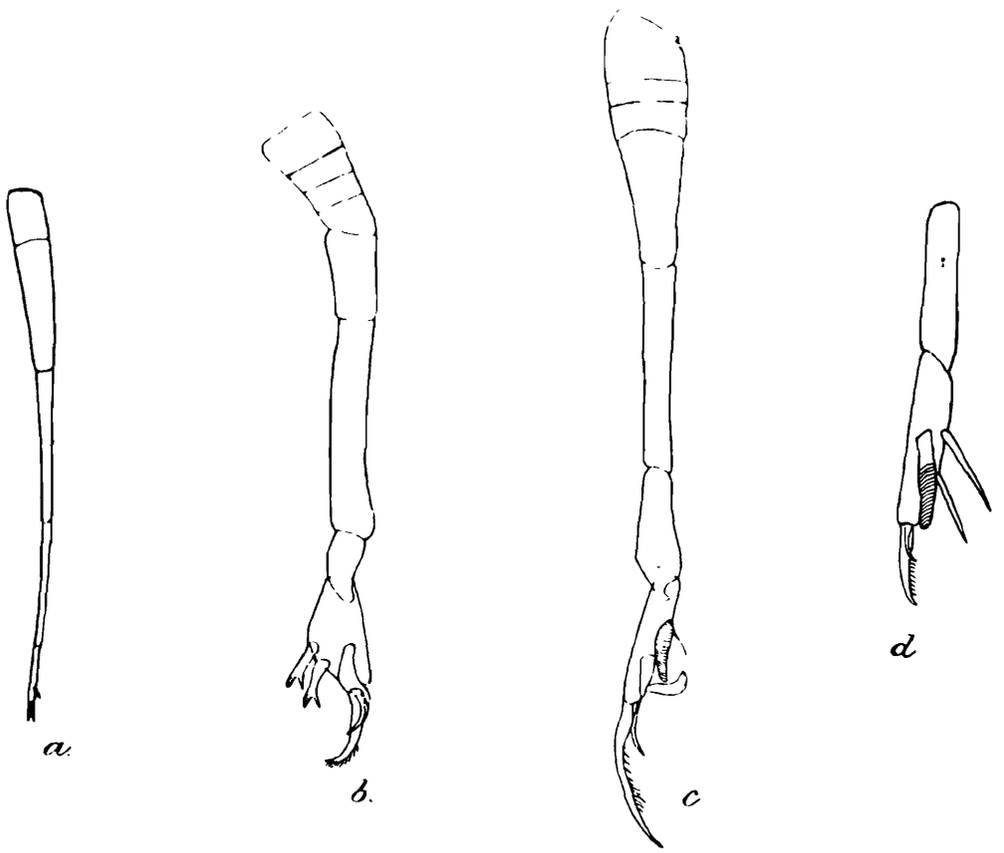
The pleopods of the male and female agree essentially with those described for *G. spinifer*, *G. sanctus* and *G. muticus*, except in the form of the exopod of the third pair in the male, and it is on the character of this appendage that I have relied for the institution of this new species.

The exopod of the third pair of pleopods of the male is elongate, reaching to the base of the telson. It is five-jointed, like the same appendage in both *G. muticus* and *G. spinifer*, but stouter than in the latter species, and perhaps slightly more slender than in the former. The first two joints are longer than the same joints in *G. muticus*, and combined are longer than the third joint instead of being equal to it as in *G. muticus*. The third joint is the longest and most slender. The fourth joint is markedly longer than in *G. muticus*, but has the lower distal margin produced into an obtuse lobe as in the latter species. The fifth joint is only slightly longer than the fourth, but more slender and not broadened out at its apex as in *G. muticus*. The apex of this joint bears a long slender curved spine minutely spinulated along the distal half of its inner margin. This spine is considerably longer than is the same

spine in *G. muticus* and bears at its base a similar shorter curved spine as in the latter species. The inner margin of the fifth joint bears two long obtusely-pointed and microscopically-ridged processes, but there are no signs of the prominent stout spines with the bifurcated tip so characteristic of *G. muticus*.

The length of adult male and females is 7-8 mm.

The following text-figures, showing the exopods of the third pleopod of the males of *G. spinifer*, *G. muticus* and *G. simulans*, will illustrate the fundamental differences in these organs in the three species and indicate the main characters on which the three forms are to be separated :—



TEXT-FIG. 1.—Exopod of third pleopod of male in three species of *Gastrosaccus*.
a. G. spinifer, Goës (× 25). *b. G. muticus*, n. sp. (× 60) Form A. *c G. simulans*, n. sp. (× 60).
d. G. muticus, n. sp. (× 90) Form B.

I provisionally refer to this species, the specimens from the following locality :—

Estuary of the river Bassein, Burma, coll. Marine Survey of India, two adult females, 7 mm.

There are no adult males or immature specimens from the same locality, but these two females agree absolutely with the adult females of *G. simulans*, and I cannot see any reason for separating them at present.

The discovery of these two new species of *Gastrosaccus* illustrates, still further, the difficulty which exists in accurately discriminating the various species of the

genus. Hansen (1910 and 1912), who has in these publications instituted four new species of *Gastrosaccus*, frequently remarks on the close similarity between the females of the various species and the difficulty of separating them. As a result, however, of his researches on the genus he came to the conclusion that the character of the pleopods in the male afforded excellent specific characters and, following his lead, I have used these characters to separate the new species here described.

The genus now comprises the following twelve species :—

G. sanctus, van Beneden.
G. spinifer, Goës.
G. normani, G. O. Sars.
G. erythraeus, Kossman.
G. indicus, Hansen.
G. parvus, Hansen.
G. bengalensis, Hansen.
G. pacificus, Hansen.
G. vulgaris, Nakazawa.
G. kojimaensis, Nakazawa.
G. muticus, sp. nov.
G. simulans, sp. nov.

Of these twelve species, *G. spinifer* and the two species here instituted are immediately distinguished by the possession of a fringe of spine-like filaments on the central dorsal posterior margin of the carapace. The three species, *G. spinifer*, *G. muticus* and *G. simulans*, may be distinguished among themselves by the character of the exopod of the third pleopod of the male as shown in the text-figure and otherwise by the following characters :—

	G. spinifer.	*G. muticus.*	*G. simulans.*
Spine on fifth segment of the pleon.	Present at all sizes.	Absent.	Present in young, absent in adult.
Spines on the second joint of antennular peduncle. ..	3	3 or 4	4
Spines on lateral margin of telson ..	6-8	14	8-10
Spines on inner margin of inner uropod	9-11	4	4
Size of adult specimens	20 mm.	6-7 mm.	7-8 mm.

The species of the genus *Gastrosaccus* may be arranged in two groups, according to the structure of the pleopods of the male, as follows:—

I. Endopod of the third pair, either rudimentary or a simple unjointed lobe.—
G. indicus, *G. parvus*, *G. bengalensis*, *G. normani*, *G. pacificus*, *G. erythraeus*.

In this group the endopod, or both endopod and exopod of the second pair of pleopods in the male, are not normal in shape and more or less reduced.

II. Endopod of the third pair of pleopods in the male, normal in form and armature and multi-articulate.

G. spinifer, G. sanctus, G. muticus, G. simulans, G. kojimaensis (as far as can be gathered from Nakazawa's meagre description).

In this group the second pair of pleopods of the male has both the exopod and endopod of normal form and armature and multi-articulate.

Group I represents the old genus *Haplostylus* instituted by Kossmann for *G. normani* and later cancelled by Hansen (1910) and merged in the genus *Gastrosaccus*. Group II represents the old genus *Gastrosaccus*. *G. vulgaris* would seem to provide the connecting link, since, according to Nakazawa's figures, the endopod of the third pair of pleopods of the male is much reduced and only two-jointed, while the second pair of pleopods of the male have both the endopod and exopod normal in form and armature and multi-articulate.

From the point of view, therefore, of the pleopods of the male, *G. muticus* and *G. simulans* agree with *G. spinifer* and *G. sanctus* and are readily distinguished from all the Indo-pacific species except possibly *G. kojimaensis*, the description of which is somewhat meagre.

The specimens of *G. simulans*, obtained at Puri, were found at night at the water's edge on a sandy beach facing the open sea. Their presence was detected in the first instance owing to their brilliant luminosity, which was of a general nature.

Sub-family *MYSINAE*.

Genus **MACROPSIS**, G. O. Sars.

Macropsis orientalis, Tattersall.

M. orientalis, Tattersall, 1908, 1914.

Further records:—Chittagong, pond at N.E. end of the town near the river, January, 1913, coll. N. Annandale and S. W. Kemp. Abundant.

Chilka Lake, abundant everywhere.

Madras Harbour, 4-6 feet, October 1913, coll. N. Annandale. One.

Cochin backwater, near Ernakulam, September 1914, coll. F. H. Gravely. Fifty-eight.

The last two records indicate an extension of the known distribution of this species in the littoral of India, and it has now been found at a number of localities situated at the head of the Bay of Bengal and on both sides of the Indian peninsula. At Chittagong in the Gangetic Delta, and apparently at all suitable localities as far south as Vizagapatam on the east coast, it is enormously abundant. It ascends some at any rate of the larger rivers on this coast for a great distance, at least 40 miles above tidal influence; but has not as yet been found in any isolated body of water. In many places it occurs in water that is permanently fresh; but it also occurs in sea-water.

In the Chilka Lake it is found everywhere, but most abundantly in the main area,

where the specific gravity of the water does not exceed 1·0150. Its presence is particularly noticeable at places where rocks rise out of comparatively deep water and masses of dead weed find lodgment and probably afford it food. Decaying algae seem to be attractive to it, and when it is in their vicinity its stomach and alimentary canal are filled with an opaque white substance that renders it relatively conspicuous.

Macropsis orientalis swims in large shoals a short distance below the surface. Each shoal, at any rate in the neighbourhood of rocks, has its own "beat" to which the majority of its members confine their movements. As a rule each individual swims for the whole length of the "beat" and turns when it comes to the end of it, but sometimes single members of the swarm turn halfway and there seems to be a tendency for all to move in an elongated figure-of-eight. The "beat" is never more than a foot wide and may be from 3 to 6 ft. long. Its limits are determined to some extent by the limits of the shadows cast by the rocks, for the animals evidently avoid strong light. A few adventurers occasionally break from the shoal and swim out sideways from it, but they always return to their company after a short trip. Similar movements were noticed in specimens captive in an aquarium.

Near the rocks at Ganta Sila at the south end of the lake a small cetacean, *Orcealla brevirostris*, was noticed swimming backwards and forwards among shoals of *M. orientalis* with its mouth open and apparently feeding upon them. Unfortunately opportunity for a post mortem examination of the animal was lacking.

Uriya fishermen of the lake catch large numbers of this Mysid by straining water through a cloth. They mix them with turmeric, boil and dry the mass, and eat it with rice. They say it is "very sweet" and the dish is known by the name of *netha*; the animals are called *sridhar*.

Genus **POTAMOMYSIS**, Czerniavsky.

Potamomysis assimilis, Tattersall.

P. assimilis, Tattersall, 1908, 1914.

Further records:—Chittagong, pond at N.E. end of town, near the river, January 1913, coll. N. Annandale and S. W. Kemp. Common.
Chilka Lake, abundant everywhere.

The telson of this species is subject to a considerable amount of variation. In the Chilka Lake, the apex of the telson tends to be much narrower than in the types and to have fewer spines, in some specimens as few as seven, which are larger than in the type specimens and not arranged in series at all. The spines on the lateral margins may be as many as thirteen. This range in variation naturally gives the shape of the telson a vastly different appearance in separate individuals, but all stages of intermediates may be found. The amount of variation in the telson may possibly be correlated with the enormous range in density of the water in the lake at different times.

Neomysis vulgaris in Britain is subject to variations in the arrangement of the armature of the telson, which Norman suggests is influenced by the quantity of

sewage in the water in which it lives. However this may be, it is a brackish water form and must live in water which is liable to great changes in salinity at different times and seasons of the year.

Potamomysis assimilis, which has not as yet been found on the west coast of India, is, as a rule, less abundant than *Macropsis orientalis* with which it usually occurs; but in pools at Chittagong it was actually the commoner of the two. In the Chilka Lake it is as widely distributed as the preceding species and has similar habits. It does not, however, form such large shoals and usually remains nearer the bottom. At the head of Rambha Bay it was found in comparatively large numbers among weeds growing in a few inches of water.

I have recently received specimens of this species from Madras where Dr. Annandale collected it in the Ennur backwater, in water of specific gravity varying from 1·000 to 1·0045 (corrected). This record represents an extension of the known geographical distribution of the species, which probably extends at least all down the west coast of India in suitable localities.

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FAUNA OF THE CHILKA LAKE

MAMMALS, REPTILES AND BATRACHIANS.

By N. ANNANDALE, *D.Sc.*, *F.A.S.B.*

CONTENTS.

MAMMALS, REPTILES AND BATRACHIANS.

By N. ANNANDALE.

Only eleven species were found in the Chilka Lake of aquatic vertebrates other than fish. A large proportion of these species are distinctly estuarine rather than marine or fluviatile, and the only limnic form is the mud turtle *Emyda granosa intermedia*. The sub-species of this Chelonian that occurs in the lake is a Peninsular rather than an Indo-Gangetic form, while the snake *Chersydrus granulatus*, though its geographical range is very extensive, does not occur, so far as I am aware, in the deltas of either the Ganges or the Indus. The sea-snake *Hydrophis obscurus* is, of course, like other members of its family, a marine animal, as is also the Cetacean *Orcaella brevirostris*; but both have established themselves in estuarine tracts, the latter, indeed, living in rivers hundreds of miles above tidal influence as well as in the sea.

MAMMALS.

The only mammals that have any claim to be included in the aquatic fauna of the Chilka Lake are, if we except the domestic buffalo,[1] the otter *Lutra macrodus* and the small Cetacean *Orcaella brevirostris*. We have to thank Mr. Oldfield Thomas[2] for confirming our identification of these species, both of which are common and have a fairly wide geographical range.

Order *CARNIVORA*.

Lutra macrodus, Gray.

1888. *Lutra ellioti*, Blanford, *Faun. Brit. Ind.*, *Mammalia* (pt. 1), p. 185, fig. 49.
1891. *Lutra macrodus*. *id.*, *ibid.* (pt. 2), p. 601.

An adult male was obtained at Barkul Point in March, 1914.

This otter is common in all parts of the lake at which rocks occur. It is presumably to it, and not to *L. vulgaris*, that McMaster's note quoted by Blanford on

[1] Herds of buffaloes, which are of less massive build and have less heavy horns than those reared in Bengal, often wade or swim far out into the lake; the island of Nalbano, which is submerged for a part of the year and lies more than a mile off the mainland, is covered in the dry season with their tracks.

[2] Mr. Thomas has also been kind enough to name a small collection of terrestrial mammals and bats made incidentally, mostly at Satpara, in the course of our survey. The following species were obtained at Satpara, *Felis viverrina*, Bennett; *Viverricula malaccensis*, Gmelin; *Mungos auropunctatus*, Hodgson, and *Lepus ruficaudatus*, Geoffroy. The bat *Scotophilus kuhli*, Leach, was found in large numbers in small caves among the rocks of the islands at the south end of the lake, while the allied species *S. wroughtoni*, Thomas, had taken possession of the bungalow on Barkuda. A pigmy shrew, *Pachyurus hodgsoni*, Blyth, was taken under dead stems of cacti and screw-pines lying at the edge of the lake at Barkul. Its stomach was full of the sandhoppers (Amphipoda Gammaridea) abundant in such positions.

p. 184 of his volume in the "Fauna" properly refers. This note describes the concerted action of six individuals in fishing. Otters were seen swimming at some distance from shore in Balugaon Bay, but they were more commonly observed among the rocks at Barkul Point. The specimen shot at this place had a number of ticks on its feet; these have been identified by Prof. G. H. F. Nuttall and Mr. C. Warburton as nymphs of a species of *Aponomma*.

The precise distribution of this otter is uncertain, but it probably occurs all over the Indian Peninsula.

Order *CETACEA*.

Orcaella brevirostris (Owen).

1878. *Orcella fluminalis* and *O. brevirostris*, Anderson, *Zool. Anat. Results Yunnan*, pp. 358-416, pls. xxv, figs. 4, 5, xxv*a*, xxvii, figs. 3, etc.

1891. *Orcella brevirostris* and *O. fluminalis*, Blanford, *Faun. Brit. Ind., Mammalia* (pt 2), pp. 578, 579, fig. 189.

1891. *Orcella brevirostris*, Oldfield Thomas, *Ann. Mus. Civ. Stor. Nat. Genova* (2) X (XXX), p. 947.

1912. *Orcella brevirostris*, Turner, *Marine Mamm. Anat. Mus. Edinburgh*, p. 109.

A large male was found in a decomposing condition on the shore of Kalidai Id. in February, 1914. There was no indication of the manner in which it had met its death and only the skeleton could be preserved.

O. brevirostris lives in the outer channel of the Chilka Lake at all times of the year, in fresh as well as in salt water. In this part of the lake-system it was usually seen in small parties of three or four. When the lake was full, these parties kept to the middle of the channel, but in March they hung round the fishermen fishing close inshore with small seine-nets, swimming within a few feet of the men and being apparently attracted by their shouts. At Satpara, individuals were frequently observed rolling over and over on a shelf of sand at the margin of the lake; the water was so shallow that it did not cover more than half their bodies, but the animals, though apparently abandoning themselves to play, slipped over into deeper water instantaneously on the slightest movement on shore. They seemed to be far more suspicious in this direction than of any danger from the water. Out in the channel they commonly follow boats, and we were told that there was a man living near Satpara who could call them up to his boat and spear them for the sake of their oil, which in Orissa, as in other parts of India, is regarded as a cure for rheumatism, applied externally.

In the main area of the lake their habits are somewhat different, probably on account of the different nature of the shore and of differences in the distribution of the food-supply. They seem to desert this area completely in the latter part of the rains and none were observed in it in August, September or October. They were seen, however, in July and November. Off Ganta Sila and Barkul Point they frequently swim up and down opposite some rock or groups of rocks and a single individual would often seem to reserve to itself, at any rate for some days at a time, a special beat. This was noted both in February and March and in July. The Cetacean

would often rush in straight towards the rocks, as if about to land upon them, and on one occasion we saw an individual strand itself on a flat shelf and remain for some seconds with its flippers and the forepart of its body practically out of the water. At other times it swam along more slowly with its mouth open and the upper part of its head exposed. In this case it was probably feeding on the shoals of small Crustacea (*Macropsis orientalis*, Tattersall) that swarm along the edge of the rocks.

Oldfield Thomas (*op. cit.*, 1891) has given good reason for regarding the Irrawaddy form of this genus (*O. fluminalis*, Anderson) as identical with the marine one and Anderson's statement that it does not occur in the lower reaches of the river seems to be based on insufficient evidence. The species is found in the Bay of Bengal, the Straits of Malacca, Borneo and the Gulf of Siam. It ascends the Irrawaddy for hundreds of miles and occurs in the Gangetic delta with *Platanista gangetica*, though it apparently does not penetrate very far inland on the west side of the Bay of Bengal.

REPTILES AND BATRACHIANS.

The following is a list of the reptiles and batrachians found in the Chilka Lake:—

REPTILIA.

OPHIDIA.
- *Chersydrus granulatus.*
- *Cerberus rhynchops.*
- *Hydrophis obscurus.*

EMYDOSAURIA.
- *Crocodilus palustris.*
- *Gavialis gangeticus.*

CHELONIA.
- *Chelone imbricata.*
- *Chelone mydas.*
- *Emyda granosa intermedia.*

BATRACHIA.

Rana cyanophlyctis.

The three snakes all belong to the family Colubridae, but to three different groups of that great assemblage: *Chersydrus granulatus* to the Aglypha, *Cerberus rhynchops* to the Opisthoglypha and *Hydrophis obscurus* to the Proteroglypha. As all three are modified to a greater or less extent—*Cerberus* less than the others—for an aquatic existence, and as the modifications are the same or tend in the same direction, the species afford an interesting instance of convergence.

From a geographical point of view the three snakes have some interest. *Chersydrus granulatus*, which is a true estuarine species sometimes found out at sea, is widely distributed in the Malay Archipelago, but in Indian waters is apparently restricted to the east coast of the Peninsular Area and the southern part of the Malabar Zone. *Cerberus rhynchops*, which ascends rivers far higher than the limits of their estuaries, has a similar general distribution, but is found in the Gangetic and other Indian river-systems beyond the range of *Chersydrus*. *Hydrophis obscurus* is, so far

as we know, an exclusively Indian and Burmese snake, occurring on both sides of the Peninsula and on the coast of Tenasserim. It particularly affects brackish water and occurs in the Gangetic delta.

Thus we may say that the snakes of the Chilka Lake represent an essentially estuarine element in its fauna and one of wide, or fairly wide, dispersion in the Oriental Region.

Crocodilus palustris has a range similar to but even wider than that of *Cerberus rhynchops*, and is more of an up-country animal. *Gavialis gangeticus*, on the other hand, is entirely confined on the east coast of India to river-systems that open into the upper part of the Bay of Bengal; it is probably not found, even on this coast, further south than the Chilka Lake. On the western side of India it occurs, like *Orcaella brevirostris*, in the Indus.

Of the Chelonia of the lake the two Chelonidae are widely-distributed marine species, while the Trionychid is an essentially limnic form somewhat restricted in range —a local race, confined to the river-systems of the Mahanaddi and the Godavari and a few adjacent valleys, of a species that occurs all over Peninsular India, the Indo-Gangetic plain, the greater part of Burma and the plains of Ceylon. Its genus, which is monotypic, is not found, except in Ceylon, beyond the limits of the Indian Empire.

Rana cyanophlyctis, the only frog or toad found in the lake, occurs over an area extending from Arabia to the Malay Peninsula, and is known to avoid brackish water less than most of its congeners.

Considered as a whole, the herpetological fauna of the Chilka Lake may therefore be regarded as an essentially estuarine one, in which most of the species are of wide distribution; there is no endemic element. In so far as it is peculiarly Indian, it is, as might be expected, Peninsular as opposed to Indo-Gangetic.[1]

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[1] A word may be said as to the terrestrial reptiles and frogs that haunt the margins of the Chilka Lake. The most conspicuous is the Indian Monitor (*Varanus bengalensis*), which was seen on several occasions on the stony beach of Barkuda Island, but is much more often to be observed, in Orissa and Ganjam, in holes in the walls of wells or among the trunks of fallen trees. It does not wander over the mud-flats, as *V. salvator* and *V. nebulosus* do in some parts of the Malay Peninsula, and probably obtains little if any of its food from the lake. A small skink (*Lygosoma punctatum*) was found under dead Pandanus-leaves at the edge of the lake near Barkul. Its stomach contained amphipodous crustacea of the group Gammaridea. The same animals are eaten by two species of Gecko (*Hemidactylus brookei* and *H. frenatus*) that are abundant among stones and rocks just above the water-level and occur even on the smallest islands in the lake. They also feed largely on the Saldid bug *Leptopus assuanensis*, which, without being exactly aquatic or even amphibious, is extremely abundant round the lake among rocks and stones in the immediate neighbourhood of water. The four lizards all have a wide range in the plains of India.

Two burrowing frogs (*Rana breviceps* and *Microhyla ornata*) live commonly in holes near the edge of the lake and breed in the rainy season in small pools of rain-water close to the margin; but we have never seen them enter the lake itself. At Barkul, one night in September, we saw a young Chunam Frog (*Rhacophorus maculatus*) seated on dead weed at the margin. All these are common frogs in the plains of Peninsular India and the Indo-Gangetic tract.

OPHIDIA.

Family COLUBRIDAE.

Subfamily *ACROCHORDINAE.*

Genus **Chersydrus**, Cuvier.

1890. *Chersydrus*, Boulenger, *Faun. Brit. Ind., Rept.*, p. 355.
1912. ,, Barbour, *Mem. Mus. Comp. Zool. Harvard*, XLIV, No. 1, p. 106.

Barbour (1912) doubts whether this genus is really distinct from the type-genus of the subfamily *Acrochordus*, Hornstedt. His doubts are probably well founded, but I have no specimens of *Acrochordus* for comparison; the only species (*A. javanicus*) occurs in fresh water in the Malay Peninsula and Archipelago.

Chersydrus granulatus (Schneider).

1890. *Chersydrus granulatus*, Boulenger, *Faun. Brit. Ind., Rept.*, p. 355, fig. 104.
1912. ,, ,, *id., Faun. Malay Peninsula, Rept.*, p. 116, fig. 38.
1912. ,, ,, Barbour, *Mem. Mus. Comp. Zool. Harvard*, XLIV, No. 1, p. 106.
1914. ,, ,, Wall, *Journ. Bombay Nat. Hist. Soc.* XXIII, p. 372.

Barbour (1912) has noted the more conspicuous colouration in the young of this snake, a common feature of young reptiles,[1] and also the increased stoutness of the adult. Wall has recently (1914) put on record a Siamese specimen 4 ft. 4 inches long and with a maximum girth of $7\frac{1}{4}$ inches, presumably in spirit.

The range of the species extends from the Malabar coast to New Guinea, but apparently omits the Gangetic delta and fails to extend far up the west coast of the Indian Peninsula. It is common in estuaries and backwaters on the east coast and is sometimes found at sea. In the Chilka Lake it is not restricted to any particular locality.

C. granulatus may often be seen thrusting its head from the surface of the lake, where it is usually found some little distance from shore. On land it is sluggish and unable to progress rapidly; probably it never leaves the water unless forced to do so. Barbour found it abundant in the fish-market at Macassar, under platforms on which the fish were sold, but thought it probable that it had been introduced accidentally into such positions. It was taken in our trawl on several occasions and probably often rests on the mud at the bottom. Fishermen frequently brought it to us at Rambha, Barkul and elsewhere. Some of them distinguished it from *Hydrophis* as not being poisonous. No large specimens were obtained.

Subfamily *HOMALOPSINAE.*

Genus **Cerberus**, Cuvier.

1890. *Cerberus*, Boulenger, *Faun. Brit. Ind., Rept.*, p. 374.
1907. *Hurria*, Stejneger, *Bull. U.S. Nat. Mus.* LVIII, p. 307.

Stejneger has revived the long obsolete name *Hurria* for this genus. In the strict letter of the law of priority he may be right, but the change is not adopted by Boulenger in his volume on the Fauna of the Malay Peninsula (1912).

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[1] See Annandale in Boulenger's "Report on the Batrachians and Reptiles", *Fasciculi Malayenses (Zool.)* I, p. 156.

Cerberus rhynchops (Schneider).

1912. *Hurria rhynchops*, Barbour, *Mem. Mus. Comp. Zool. Harvard*, XLIV, No. 1, p. 123.

This species has an even wider range than *Chersydrus granulatus*, for it occurs in all the Indian rivers and estuaries and throughout the Malay Archipelago as far as New Guinea. In the extreme east of its range it is, however, scarce.

Less exclusively aquatic in its habits than *Chersydrus*, it probably never goes far from water. In estuarine tracts it is particularly abundant, but it also makes its way far up rivers. In the Gangetic delta it is one of the commonest snakes in suitable localities, that is to say in ditches, creeks and swamps of brackish water, in which it either lies at the bottom or remains concealed among vegetation at the edge. It also frequents the deep cracks formed in mud exposed to the heat of the sun at low tide. I have watched it, from a stranded boat, emerging from those cracks below water as the tide covered them. Round the Chilka Lake it lies under the felted algae left at the edge as the water-level sinks in the dry season, and also conceals itself among submerged stones on islands such as Kalidai and Barkuda. Its habits render it less liable to be caught in fishermens' nets than either of the other snakes of the lake, for it rarely swims in the open. On land it is less awkward than *Chersydrus*.

The type-specimen of Schneider's *Hydrus rhynchops* was from the Ganjam district.

Subfamily *HYDROPHIDINAE*.

Genus **Hydrophis**, Daudin.

1890. *Hydrophis* and *Distira*, Boulenger, *Faun. Brit. Ind., Rept.*, pp. 398, 407.
1909. *Distira*, Wall, *Mem. Asiat. Soc. Bengal*, II, p. 193.
1912. *Hydrophis*, Boulenger, *Faun. Malay Peninsula, Rept.*, p. 181.

Boulenger has recently accepted the view that the two genera *Distira* and *Hydrophis* cannot be separated. The former was described one year later than the latter.

Hydrophis obscurus, Daudin.

1890. *Hydrophis coronatus*, Boulenger, *Faun. Brit. Ind., Rept.*, p. 402.
1909. *Distira obscura*, Wall, *Mem. Asiat. Soc. Bengal*, II, p. 201.
1912. *Hydrophis obscurus*, Boulenger, *Faun. Malay Peninsula, Rept.*, p. 188.
1914. *Hydrophis coronatus*, Wall, *Journ. Bombay Nat. Hist. Soc.* XXII, p. 374.

There has been considerable confusion in the synonomy of this species. Wall set the matter right, so far as the specific name was concerned, in 1909 and is followed in this respect by Boulenger. Unfortunately the former author has revived the name *coronatus* in a recent note (1914), but without giving reasons. This name was applied by Günther in his *Reptiles of British India* (1864) to the young snake, of which he gives an excellent figure (pl. xxv, fig. M., *op. cit.*), and is more than half a century younger than Daudin's "*obscurus*", which is wrongly applied by Boulenger, as he himself has pointed out (1912), in the "Fauna" and the British Museum *Catalogue of Snakes*.

In scaling and proportions *H obscurus* is more constant than most sea-snakes, but, like many other reptiles, it is more conspicuously coloured when young than when fully mature. In the young the pale bands and the markings on the head are bright yellow, which contrasts brilliantly with the blue-black of the ground-colour. In older individuals the contrast is much less striking, for the yellow fades to dirty white and the black to grey. On the hinder parts, indeed, all markings completely disappear. The largest specimen I have seen, a male killed at Satpara, was (when fresh) 122 cm. long.

This snake is mainly but not exclusively an inhabitant of brackish water. It occurs at least up to the limits of tidal influence in the Gangetic delta and is common all over the Chilka Lake. It has also been recorded from the coasts of Madras and Tenasserim and from Karwar in the Bombay Presidency. The last seems to be the only locality outside the Bay of Bengal whence it has been reported.

In the Chilka Lake it frequents both open water and the margin, where the latter is low and weedy. We saw it on several occasions thrusting its head and the forepart of its body vertically upwards out of the water, and specimens captured in seine-nets, sometimes with *Chersydrus granulatus*, were brought to us at Rambha, Barkul and Satpara. Like other true sea-snakes, and also like *Chersydrus* and *Cerberus*, it feeds on fish. It does not hesitate to swallow even *Triacanthus brevirostris*, which has a pair of long and stout spines that can be thrust out from the sides of the belly and firmly locked in position in such a way that they cannot be bent back without being broken. It sometimes happens that when the snake has swallowed a fish of this kind, the spines of the latter become locked in its stomach and pierce both the walls of the alimentary canal and those of the body. I have seen, both in Orissa and on the coast of the Malay Peninsula, sea-snakes with these spines protruding through the skin. Apparently digestion proceeds normally in these abnormal circumstances and the fish is disintegrated in the process. The spines are then set free and fall out from the body of the snake, which seems to be little the worse for the perforation.

H. obscurus, probably because of its frequenting brackish water, is apparently free from the hydroids and barnacles (*Dichelaspis grayi* and other species) that often attach themselves to other sea-snakes of the same and other genera; we did not find any parasites in its internal organs

EMYDOSAURIA.

Genus **Crocodilus**, Laur.

Only the smaller of the two Indian crocodiles was seen in the lake in circumstances that made identification possible, and we obtained no evidence as to the occurrence of *C. porosus*.

Crocodilus palustris, Lesson.

The short-nosed crocodile is common near Barkuda and Cherriakuda, on the sandy parts of the shores of which we occasionally saw it. Our *serang* told us that

he had seen young on the latter island. The individuals that frequent these places are, however, extraordinarily timid and rarely leave the water for more than short periods. As a rule they lie in it at the edge. The fishermen do not seem to be much afraid of them. At Satpara we saw men, women and children bathing in a tank within a few yards of a couple of crocodiles which were floating on the surface, the larger being 6 to 8 ft. long. They said that the crocodiles only eat fish. Generally speaking, these animals, though they do not avoid village tanks, seem to be confined in the lake to those parts that are low and have sloping shores and are at the same time remote from human habitations. Possibly they fear the formidable fish-spears carried in the fishing boats.

Genus **Gavialis**, Günther.

1864. *Gavialis*, Günther, *Rept. Brit. Ind.*, p. 63.
1876. *Gharialis*, Theobald, *Cat. Rept. Ind.*, p. 37.

The name *Gavialis* is a latinized form of a misreading of the Hindustani "gharial", just as the name *dugong* is a misreading of the Malay *duyong*; but Theobald's emendation has not been accepted by most recent herpetologists.

Gavialis gangeticus (Gmelin).

We were informed on good authority that this species occurs in the lake in the neighbourhood of Satpara, and on less good authority that one is known to the fishermen to frequent Kalidai Id. If the information is correct, this must be practically the southern limit of the range of the species and genus, which is not known further down the coast of India than the Mahanaddi river-system. It is found in all the rivers that flow into the head of the Bay of Bengal, including the Koladyne in Arrakan, but not in the Irrawaddy. Like the mud-turtle *Trionyx gangeticus* and the porpoise *Platanista gangetica*, it occurs in the Indus as well as in the east coast systems.

CHELONIA.

Family CHELONIDAE.

The two species of this family here recorded from the outer channel of the Chilka Lake are probably mere casual visitors. Very possibly the third Indian species, *Thalassochelys caretta*, also enters the sea-mouth occasionally. We obtained no evidence as to any turtle breeding on the shores of either the outer channel or the main area of the lake, and it is only those of the former that would be at all suitable for the purpose.

Genus **Chelone**, Brougniart.

Chelone imbricata (Linn.)

A large shell of the Tortoiseshell Turtle was seen on the shore of Barhampur Id. in the outer channel in March, 1914.

[1] An interesting account of the nest of this crocodile has recently been published by W. Schultze in the *Philippine Journ. Sci.* (D) IX, pp. 313-315, pl. i (1914).

Chelone mydas (Linn.).

A male of this species was taken in the otter-trawl in fresh water in the inner part of the outer channel (Sept., 1914). Its carapace was 102 cm. long. The stomach and the entire intestinal tract were tightly packed with weed. No external or internal parasites were found on or in the specimen.

Family TRIONYCHIDAE.

Genus **Emyda**, Gray.

This genus is monotypic but the single species is divided into five subspecies or local races:—the *forma typica*, which occupies the Indo-Gangetic plain and ranges eastwards to Arrakan; *scutata*, which occurs in the Irrawaddy and Salween systems; *intermedia*, practically confined to the Mahanaddi and Godavari systems; *vittata*, widely distributed over the remainder of Peninsular India and in Katch; *ceylonensis*, only found in the plains of Ceylon.

Emyda granosa (Schoepff) subsp. **intermedia**, Annandale.

1912. *Emyda granosa intermedia*, Annandale, *Rec. Ind. Mus.*, VII, p. 172, pl. vi, fig. 2.

The races of *E. granosa* as a rule occur only in fresh water, but the typical form has been taken on a small island off the coast of Arrakan. The Mahanaddi Pond Turtle, as the race *intermedia* may be called, is common in ponds all over the Mahanaddi system and at any rate on the lower reaches of the Godavari. It also occurs in the valleys of some of the smaller rivers that make their way from the south or south-west into the estuary of the Hughli, although in the Hughli itself the subspecies is the *forma typica*. In the neighbourhood of the Chilka Lake *intermedia* is common in ponds and rice-fields. A specimen was brought to us at Barkul in September that had been found under a stone in the jungle some distance from water. In the thickets of submerged weeds in the lake near Balugaon it is not uncommon. Specimens were obtained both in September, when the water was quite fresh, and in March, when its specific gravity (at 15° C.) was 1·008. It is somewhat remarkable to find a soft-skinned Chelonian living in brackish water, but the sole species of an allied Indian and Malayan genus (*Pelochelys cantoris* [1]) is exclusively estuarine and marine.

A leech was found infesting the soft parts of the pond-turtle in the lake in March. It has been identified by Mr. W A. Harding as a new species of *Placobdella*.

BATRACHIA.

The only batrachian that we saw in the lake was the common and widely distributed frog *Rana cyanophlyctis*, Schneider. In the rainy season and for as long thereafter as the water remains fairly fresh, this frog sits in large numbers at the edge both of the outer channel and of the northern part of the main area, at places where the margin is swampy, and skips over the surface of the water in its characteristic fashion

[1] See Boulenger, *Faun. Malay Peninsula, Rept.*, p. 12 (1912.)

when alarmed.[1] We obtained no evidence, however, that it ever breeds in the lake. Its tadpoles were observed, with those of *R. breviceps* and *Microhyla ornata*, in pools of rain-water on the banks in September.

[1] *Ibid.*, p. 229 (1912).

FAUNA OF THE CHILKA LAKE

AQUATIC INSECTS, OTHER THAN COLEOPTERA, WITH NOTES ON SOME MARGINAL SPECIES.

By N. ANNANDALE, *D.Sc.*, *and* STANLEY KEMP, *B.A.*

ODONATA by F. F. LAIDLAW, *F.Z.S.*

(Plate XI.)

CONTENTS.

AQUATIC AND MARGINAL INSECTS.

By N. ANNANDALE *and* STANLEY KEMP.

In the case of the insects it is particularly difficult to draw a line between aquatic and terrestrial species. Strictly speaking, indeed, all those that occur in water or on its surface should be called amphibious rather than either aquatic or terrestrial, for all insects, at any rate in adult life, are air-breathing animals. Moreover, though many species and larger groups are specialized for peculiar modes of life, the class as a whole is remarkably tolerant and not easily deterred from occupying all situations available. In considering the fauna of any body of water, the doubtful status of a number of insects that can hardly be rejected as terrestrial animals or claimed as true aquatic species must, therefore, be decided—the status, that is to say, of forms that frequent the damp margins, concealing themselves under stones and jetsam, burrowing in sand or mud, or crawling on damp rocks. Some of these species are essentially moisture-loving terrestrial forms, found also in other situations, while a few occur only at the edges of rivers, lakes, ponds or lagoons.

In discussing the insect fauna of the Chilka Lake we have found it convenient for this reason to devote a section of our paper to "marginal" species, in addition to annotating the insects that may legitimately be called aquatic. We are indebted to Mr. F. F. Laidlaw for an account of the only dragon-fly that breeds habitually[1] in the lake.

I. AQUATIC INSECTS.

Apart from Coleoptera,[2] which we are unable to consider at present, the aquatic insects of the Chilka Lake include at least twenty species, the majority of which (15 species) belong to the order Rhynchota. Only a very small minority of these insects can be regarded as anything but casual visitors. Except for a moth, a dragon-fly and three Diptera, the only species that we know to complete its metamorphosis in the lake is the Hydrometrid bug *Euratas formidabilis*, and it is quite clear that all the former deposit their eggs indifferently either on the surface of the lake or on any other body of water they may chance to encounter in their flight.

There are thus only six forms that we know to breed in the Chilka Lake; particulars of these species are given in the following table:—

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[1] We found cast nymphal skins of two other species, an Aeschnid, probably *Anax guttatus* (Burm.), and a Libellulid, adhering to rocks at the edge of the lake, but the species of these families that are often seen flying over its surface usually breed elsewhere.

[2] About six species of Dytiscidae, ten of Hydrophilidae and one of Gyrinidae are found in the lake.

	Breeds in water of sp. gr.	General distribution.
Odonata ..		
Pseudagrion microcephalum	1·001—1·008	India and Malaysia.
Rhynchota ..		
Euratas formidabilis ..	1·000 – 1·0265	Bay of Bengal.
Diptera		
Eristalis arvorum	1·0035—1·007	Oriental region.
Palpomyia sp	1·008	
Anopheles rossii	1·000—1·015	Tropical and subtropical countries.
Lepidoptera ..		
Nymphula diminutalis	1 008	Northern India to Celebes.

Unlike the other groups of animals with which we have to deal in this volume, the insects are for the most part immigrants from fresh water and drift or fly into or on to the lake from the neighbouring ponds or rice-fields. *Euratas formidabilis* is possibly the only exception, belonging to a marine group and having been taken at sea in the neighbourhood of land.

A phenomenon that exercises considerable influence on immigration in the case of both surface-living and sub-aquatic species is the periodic growth and decay of a weed of the genus *Potamogeton* that forms dense submerged thickets during the dry season in certain sheltered bays of the main area of the lake, dying down almost completely in the "rains." The dry season is also the season at which the water of the lake has the highest specific gravity, that is to say, is saltest; but increase of salinity seems to be of less importance than the existence of adequate shelter. The only situation in which we found insect life at all vigorous was in thickets of this weed, in water of specific gravity varying from 1·001 to 1·008. Both submerged and surface forms were abundant in or over the weed, the latter including *Hebrus bengalensis*, *Mesovelia mulsanti*, *Hydrometra vittata* and several species of *Gerris* among the Rhynchota, the former *Micronecta proba*, and *Sphaerodema rusticum* of the same order, as well as a number of small beetles of the families Dytiscidae and Hydrophilidae, the larvae and pupae of the flies *Anopheles rossii* and *Palpomyia* sp., of the moth *Nymphula diminutalis* and of the dragon-fly *Pseudagrion microcephalum*.

The great majority of the aquatic insects of the lake are species of very wide distribution in the Oriental region, if they do not even extend beyond its borders.

Order *ODONATA*.

By F. F. LAIDLAW.

Family **Agrionidae**.

Pseudagrion microcephalum (Ramb.).

1890. *Pseudagrion microcephalum*, Kirby, *Cat. Odonata*, p. 153.
1900. ,, ,, Ris, *Arch. Naturgesch.*, p. 198.
1902. ,, ,, Laidlaw, *Proc. Zool. Soc. London*, p. 388.
1904. ,, ,, Martin, *Mission Pavie*, p. 18 (sep)

Adult specimens have been examined from off Balugaon and Barkul on the Chilka Lake; the majority were taken in March, but I understand that the species is common at all times of the year. Others are from Balighai on the Sar Lake in the Puri district of Orissa and from Calcutta. Larvae and larval exuviae were sent both from the Chilka Lake and from the Museum tank, Calcutta, in several cases with adults which had been reared in an aquarium.

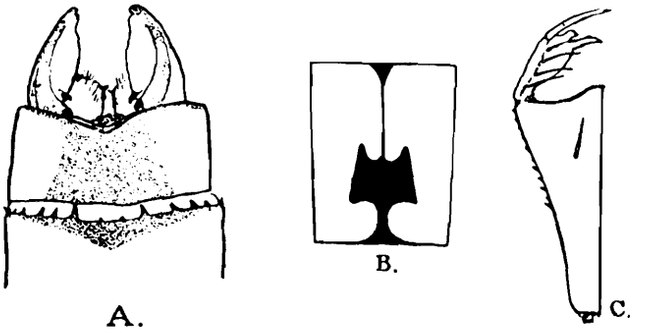

FIG. 1.—*Pseudagrion microcephalum* (Ramb.).
A. Apex of abdomen of male, from above.
B. Pattern on dorsum of 2nd abdominal segment of male.
C. " Mask " of larva.

The species is evidently very abundant in Bengal and Orissa. I believe it to be the true *P. microcephalum* of Rambur. To facilitate identification I have figured the terminal part of the abdomen of the male, as seen from above, and also the colour pattern of the dorsum of the second abdominal segment of the same sex (text-figs. 1A, B). The superior anal appendages of the male are about equal in length to the tenth segment, whereas in the closely allied *P. australasiae* the corresponding appendages are not more than one-half the length of the segment, and differ in shape.

The colouring of young males of *P. microcephalum* is identical with that of the females.

Larva.—Very similar in general to that of European *Erythromma najas* (Hausemann). Body slender, of a pale sandy gray colour.

Total length at time of emergence about 22 mm., of this the caudal lamellae take up about 8 mm.

Head pentagonal, antennae 7-jointed. Mask long (text-fig. 1C), its anterior border gently rounded, extending when folded beyond the insertion of the second pair of legs. Its outer margin carries a few small spines, and there is a single large seta on either side of the body. The palpi bear four stout setae directed inwards and the movable hooks are long and overlap (text-fig. 1C).

The caudal lamellae have nearly parallel sides and are bluntly rounded at their apices. Each is divided into two parts at about its middle by a transverse fold or joint. Of these two parts the proximal has its margins spiny and there is a distinct notch on the lower margin (of the lateral lamellae) between the proximal and distal parts. The last spine on either margin before the transverse fold is the largest of the series. The apical part has its margins smooth.

There are two main tracheal trunks in each lamella. These cross and recross one another; their branches are arborescent near the margins and are marked with a dark brown colour giving the lamella a mottled appearance.

The larvae from Lake Chilka were collected in water which was distinctly brackish, the specific gravity (corrected) of the water being 1·008. I believe no Agrionid larva has been recorded from brackish or salt water. Amongst the Libellulinae

Dr. Ris suspects that the larval forms of the two species of *Macrodiplax* may inhabit salt water (Muttkowski, *Bull. Publ. Mus. Milwaukee*, I, p. 183 note). I can detect no differences between the examples from Lake Chilka and those from Calcutta which were taken in pure fresh water.

In addition to *Pseudagrion microcephalum*, I have received specimens of the following species collected by Dr. Annandale and Mr. Kemp in the neighbourhood of the lake.

AGRIONINAE.

Ceriagrion coromandelianum (Fabr.): Barkuda Id., 2 ♂ ♂, 1 ♀

"Abdomen gamboge yellow, brownish at tip. Legs and face paler; dorsal surface, side of thorax and head, including eyes, emerald green. Ventral surface of thorax whitish."

Ischnura senegalensis, Ramb.: common; probably breeds in the lake.

LIBELLULINAE.

Potamarcha obscura (Ramb.): Satpara, 16-ix-13, 1 ♀; Barkuda Id., 17-vii-14, 1 ♂

Brachydiplax sobrina (Ramb.): Barkuda Id., 17-vii-14, 2 ♂ ♂

Diplacodes trivialis (Ramb.): Barkuda Id., 17-vii-14, 3 ♂ ♂; Cherria Id., 1 ♀; Patsahanipur, i-14, 1 ♂, 1 ♀

Crocothemis servilia (Drury): Barkuda Id., 17-vii-14, 1 ♂, 1 ♀ The male has a deformed wing, with abnormal venation; I hope subsequently to figure the specimen.

Pantala flavescens (Fabr.): Barkuda Id., 18–19-vii-14, 2 ♂ ♂, 2 ♀ ♀

With the possible exception of *Brachydiplax sobrina* all the species are exactly the forms one would expect to meet with in such a locality as the shores of Lake Chilka. In addition I have just received from Dr. Annandale the cast skin of a nymph belonging in all probability to *Anax guttatus* (Burm.). I have not access to Cabot's account of the larval stages of the Aeschninae at the present moment, but I have little doubt but that the identification is correct; the specimen agrees substantially with Needham's description and figure[1] of a nymph from Buitenzorg which he regards as belonging to Burmeister's species. The skin was "found on a rock at the edge (of the lake) near Patsahanipur" and Annandale remarks that the dragon-fly must breed in the lake. This view is further supported by the fact that the skin has attached to it some six very small shells, evidently the young of a species of *Modiola* very likely *M striatula*, Hanley.

Lastly the series includes two females of a species of *Agriocnemis* taken at Barkuda Id., 17-vii-14,—another genus likely to be represented in coastwise country.

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[1] *Proc. U. S. Nat. Mus.*, XXVII, p. 695, pl. xl, fig. 2 (1904).

Order *RHYNCHOTA*.

The aquatic Rhynchotal fauna of the lake comprises fifteen species, representing eleven genera and six families. The majority (8 species, 5 genera) belong to the Hydrometridae; there are three species (2 genera) of Corixidae, while the Hebridae, Nepidae, Belostomatidae and Notonectidae have each a single species.

The aquatic species of this order, to judge from the large number described in Distant's supplement (vol. V, 1910) to his account of the Rhynchota in the *Fauna of British India*, are still imperfectly known so far as the Oriental region is concerned. It is therefore noteworthy that there is only one species in our collection from the Chilka Lake that we have not been able to identify. It is a small apterous Hydrometrid belonging to the subfamily Veliinae and bearing some resemblance to *Rhagovelia nigricans* (Burmeister); but as we have only a single specimen, which is probably immature, we refrain from discussing the species further.

Euratas formidabilis is the only species which we believe to undergo its full metamorphosis in, or rather on, the lake; the only other form of which we found an immature stage was a *Gerris*, probably *G. spinolae*, of which a single larva was obtained.

Descriptions of all the species here discussed will be found in Distant's volumes in the *Fauna of British India and Ceylon*, the volumes in which aquatic families are described being II (1904), III (1906) and V (1910); our references are to this work. The only form on which we have any remarks to offer as to structure or systematic position is *Euratas formidabilis* (see p. 183)

Family **Hebridae.**

Hebrus bengalensis, Distant, vol. V, p. 132, fig. 70.

Mr. Distant has been kind enough to identify specimens of this species. It is not uncommon among rocks and on wet sand at the edge of the lake, occurring both in the main area and in the outer channel at all times of the year. Its original locality is recorded as Lower Bengal.

Family **Hydrometridae.**

Hydrometra vittata, Stål, Distant, vol. II, p. 170, fig. 23 and vol. V, p. 137.

H. vittata is common on the surface of the main area of the lake in winter months, occurring chiefly on thickets of *Potamogeton*. It is a common species all over India and has also been found in the Malay Archipelago and Japan. In the Gangetic delta it often occurs on pools of brackish water.

Mesovelia mulsanti, Buch. White, Distant, vol. II, p. 169, fig. 122.

Another common species found over weeds and also among rocks in the main area of the lake, chiefly in the winter months. It probably occurs all over the Oriental region and has been found also in North and Central America and in the Antilles.

Gerris nitida (Mayr), Distant, vol. II, p. 178 and vol. V, p. 142.

A few specimens of this pond-skater were taken among rocks at the edge of the lake at Ganta Sila in December. It is widely distributed in India, Burma and Ceylon, ascending the Himalayas to an altitude of at least 7000 ft.

Gerris fossarum (Fabricius), Distant, vol. II, p. 178 and vol. V, p. 142.

Specimens were taken at Ganta Sila in winter and at Nalbano in the "rains." The species is common on pools of brackish water in the Gangetic delta and has a wide range in the Oriental region and Australia. It occurs in the Darjiling district at an altitude of 7000 ft.

Gerris tristan, Kirkaldy, Distant, vol. II, p. 179 and vol. V, p. 144.

A few specimens were obtained at Nalbano, Barkul and Ganta Sila in September and December. The species was described from Ceylon and has since been recorded from various localities in India and Burma. It is common on brackish water in the Gangetic delta.

Gerris spinolae, Leth. and Serv., Distant, vol. II, p. 180.

G. spinolae is occasionally found near the inner shore of the main area of the lake in winter; in the "rains" it enters this area in considerable numbers from ditches and flooded rice-fields, in which it is very abundant. The species occurs in many parts of India, Burma and Ceylon, and also in China.

Euratas formidabilis, Distant (see p. 183, *postea*).

Family **Nepidae.**

Ranatra sordidula, Dohrn, Distant, vol. III, p. 22.

A single specimen was taken at Ganta Sila in December. The species is widely distributed in India and neighbouring countries.

Family **Belostomatidae.**

Sphaerodema rusticum (Fabricius), Distant, vol. III, p. 36, fig. 23.

The species is found among weeds in the main area of the lake in the dry season. It is common in India and the surrounding countries.

Family **Notonectidae.**

Anisops ? breddini, Kirkaldy, Distant, vol. V, p. 333, fig. 194.

There is some doubt as to the identity of the Indian species; our specimens from the Chilka Lake agree well with the one figured by Distant. They were taken at the northern end of the main area of the lake in the freshwater season, the only time at which we saw any Notonectid in the lake. The same species is, however, abundant in pools of brackish water at Port Canning in the Gangetic delta, as well as in fresh water at Calcutta. *A. breddini* was described, very imperfectly, from Madagascar.

Family **Corixidae.**

Corixa substriata, Uhle, Distant, vol. V, p. 340.

A single specimen, which apparently belongs to this species, was taken off Barkul Point in March. The species occurs both in the plains and hills of India, in Ceylon and also in Japan.

Micronecta minthe, Distant, vol. V, p. 347, fig. 208.

This species is common in the main area of the lake in the freshwater season and also occurs in the same season near Manikpatna in the outer channel, where it was found among vegetation submerged by the monsoon floods. *M minthe* was originally described from a number of localities in the plains of India and Ceylon.

Micronecta proba, Distant, vol. V, p. 348, fig. 210.

M proba was common among water-weeds in Balugaon Bay in March. It was described from the plains of Northern India and Upper Burma.

NOTE ON THE GENUS *EURATAS*, DISTANT.

The genus *Euratas* was described by Distant (vol. V, p. 154) from specimens long immersed in alcohol and then dried; they were obtained in the Andaman Sea. From the same collection and locality he also described (*loc. cit.*, p. 155) a second supposed genus, *Fabatus*, which, as he himself acknowledged, was based on immature specimens. An examination of co-types of both genera and also of much fresh material has convinced us that *Fabatus* is merely a nymphal stage of *Euratas*. The type specimens of the latter, being mature, suffered comparatively little from the treatment they had received; but the much softer specimens assigned to *Fabatus* had shrivelled considerably and in so doing had become distorted in such a way as to conceal their true generic characters.

Mr. Distant has recently informed us in a letter that his chief reason for regarding *Fabatus* as generically distinct was the emargination of the eyes, that is to say the concavity of their posterior margin. In fresh specimens, however, that agree in all other structural features with co-types of *F. servus*, no such concavity is apparent, but in some specimens that have been preserved for even a few hours in alcohol, shrinkage of the integument of the head and prothorax causes the eyes to protrude in the manner shown in pl. xi, fig. 4. The emargination of these organs is therefore artificial.

Euratas formidabilis, Distant.

(Plate XI, figs. 1—7.)

1910. *Euratas formidabilis* and *Fabatus servus*, Distant, vol. V, pp. 154, 155, text-figs. 82, 83.

1911. *Euratas formidabilis* and *Fabatus servus*, Annandale, *Rec. Ind. Mus.* VI, pp. 111, 112.

Distant's description of the adult of this species is excellent so far as it goes; but unfortunately he makes no mention of the structure of the external genitalia, while, owing perhaps to the position in which they are drawn, his figures of the anterior legs do not fully illustrate their peculiar structure. As regards colour, his specimens in this stage had suffered little and the only shrinkage apparent is in the prothorax in which his figure exaggerates the discal foveations.

At the distal end of the anterior tibia on its proximal side, there is in both sexes a stout blunt process about as long as the segment is wide; it fits into a groove on the ventral surface of the femur when the two segments are approximated. On the process we can find no trace in either sex of the "file" figured by Carpenter in his account of *Halobates herdmani* [1]; but in the male, immediately in front of it at the distal end of the segment, there is, as in that species, a group of slender spines, graduated in length.

The external genitalia do not differ in any important respect from those of *Halobates*. In the male (pl. xi, fig. 5) the horns of the eighth abdominal segment are symmetrical, reaching about to the middle of the ventral plate; they taper regularly to a blunt apex, which is slightly reflected outwards. Their distal ends are covered with scattered thorns that extend further forwards on the external surface than elsewhere. Dorsally, on the posterior margin of the eighth segment, there is a large rounded prominence and at each posterior angle there is a small papilla on which the spiracle opens. The ventral plate is broadly oval, convex below. The sclerite of the ninth abdominal segment is large and has the usual form; the postero-lateral margins are strongly sinuous and on each side behind the lateral prominences there is a patch of about twelve coarse spinules. We figure the female genitalia as seen from the side in an extruded condition and also, as seen from above, when retracted (pl. xi, figs. 6, 7). They resemble those of *Halobates herdmani* as figured by Carpenter (*loc. cit.*), but the ovipositor (outer posterior gonapophysis) is longer and the inner branch of the anterior appendage of larger size, while the posterior appendages extend much further beyond the basal membrane.

The egg is sausage-shaped and very long. One removed from the abdomen of a female is 1·88 mm. in length and fully three times as long as broad.

There appear to be three larval instars. In the first (pl. xi, fig. 1) the thoracic and abdominal sclerites have not yet appeared, except that there is a small chitinous plate at the extreme tip of the abdomen. The tarsus of the first leg is short and relatively broad and is composed of a single segment. The first segment of the antenna is also relatively short.

In the next instar (pl. xi, fig. 2) the prothoracic sclerite is well developed, forming a transverse bar interrupted in the middle line. On each side of the meso-thorax there is a large longitudinally oval chitinous plate, while on the meta-thorax there is a pair of much smaller obliquely transverse plates, widely separated in the middle line. The tergites of the first five abdominal segments are represented by small patches of chitin placed laterally on either side and decreasing in size from before backwards. On the sixth and seventh segments these patches are scarcely distinguishable, but on the eighth there is a pair of larger plates, round and approximated to one another. The apex of the abdomen is in the same condition as in the former instar. The tarsus of the first leg has increased in length, but still consists of a single segment; the femur bears a small projection on the lower surface at

[1] Carpenter, *Ceylon Pearl Fisheries*, V, plate, figs. 5-7 (1906).

its apex, but the sexual characters of this limb are not yet apparent. The first segment of the antenna has increased in relative length.

The third instar (pl. xi, figs. 3, 4) is that described by Distant under the name of *Fabatus servus*. The sclerites are now well developed, although each is still distinctly divided into two halves and separated from those next it by a membranous interspace. The tarsus of the first leg is much longer but still consists of one segment. The tibia exhibits the secondary sexual characters, the large tooth characteristic of the male being well developed. The femur, however, is not yet incrassated. One of us has described the colouration of this instar elsewhere; but we may note that specimens preserved in spirit give as it were a negative picture of those pinned and dried, the latter preserving to a considerable extent the natural colour of the species (*cf.* figs. 2 and 3, pl. XI)

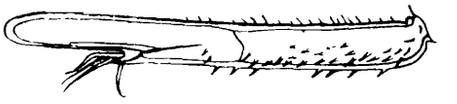

FIG. 2.—*Euratas formidabilis*, Distant. Tarsus of 1st leg of 3rd larval instar, showing the two segments of the adult tarsus within the single larval segment (from co-type of "*Fabatus servus*," Distant): × 30.

We have mounted one of Distant's co-types in Canada balsam, after clearing it with caustic potash, but we can find in it no trace of a joint in the tarsus at a level with the claws (see Distant's fig. *loc. cit.*, p. 156). The specimen was evidently just about to undergo its final ecdysis and the true position of the joint, as it occurs in adults considerably behind the base of the claws, can be detected internally (text-fig. 2). The form of the genital appendages can also be made out, although there is no external trace of them.

Euratas formidabilis occurs at all times of the year both in the main area and in the outer channel, but is perhaps more abundant in the former than in the latter. It has also been found in backwaters at Vizagapatam and Ennur on the Madras coast and was originally described from the Andamans, where it is common in sheltered bays.

It was noticed in an aquarium that disturbance of the surface of the water caused both young and adults to dive. They were, however, apparently unable to remain below for long and floated up again immediately in spite of vigorous efforts. In calm weather the adults were seen chiefly in the middle of the lake, as a rule singly or in pairs; but when the wind was high they congregated among rocks near the edge and in other sheltered spots. The young are markedly gregarious and were, as a rule, found among rocks and weeds.

The food of the species consists largely of insects that fall or are blown into the water. We have seen several individuals sucking a dead dragon-fly, but small insects are seized by single bugs. Fish-fry that swim on the surface, particularly those of *Haplochilus melanostigma*, are also eaten. Prey is held not between the femur and tibia of the first legs, but between the inner surfaces of the two femora.

The male clasps the female with his anterior femora immediately behind her front legs, the spines on the femora assisting in maintaining a hold. It is noteworthy that in *Asclepios annandalei*[1], in which the spine characteristic of the male is situated on the femur instead of on the tibia, the female is gripped much further back, immediately in front of the third pair of legs.

[1] Distant, *Ann. Mag. Nat. Hist.* (8) XV, p. 504, text-figs. (1915).

Order *DIPTERA.*

A large number of species of this order breed during the rains, and especially after their cessation, when the water-level of the lake is sinking, in small pools near the margin of the lake. In the waters of the lake itself we found, however, the immature stages of only three flies—*Eristalis arvorum, Anopheles rossii* and a species of *Palpomyia.* All of these were common in the right season at suitable localities, the larvae of *E. arvorum* in decaying weed at the edge, those of the two Nematocera among thickets of *Potamogeton.* The larvae of all three species are evidently able to endure considerable changes in salinity.

Family **Syrphidae.**

1915. *Eristalis arvorum,* Fabricius, Brunetti, *Rec. Ind. Mus.* XI, p. 228 (pl. XI, figs. 8, 9).

We have to thank Mr. Brunetti for identifying flies of this species, which he states to be the commonest Indian representative of the genus.

The larva (pl. xi, figs. 8, 9) resembles the European species figured by Miall [1], but differs in the following points,—(i) the inner branch of the terminal part of the

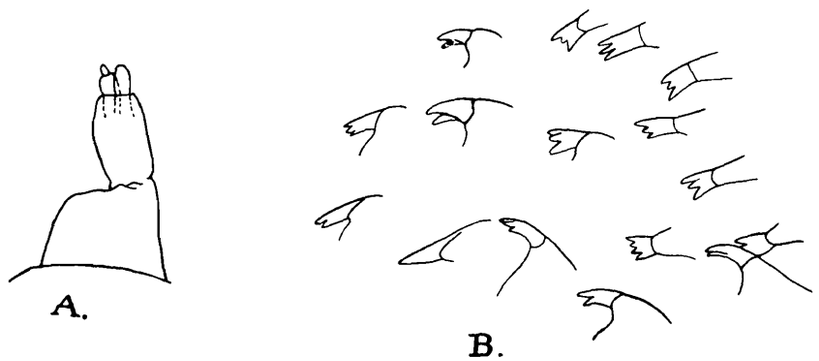

FIG. 3.—*Eristalis arvorum,* Fabricius.
A. Lateral view of sensory papilla of larva: ×75.
B Spines on anterior extremity of body of larva: ×250.

sensory papillae consists of two barrel-shaped segments, of which the basal one is considerably the larger (text-fig. 3 A); (ii) the spines at the anterior extremity of the body are bifid or trifid, except on the posterior part of the area they cover, where they are simple (text-fig. 3 B); (iii) there are about eleven chitinous ridges on each side of the antechamber of the pharynx; (iv) the posterior part of the body is more densely covered with hair which extends on to the base of the tail; (v) the processes at the base of the tail are shorter and concealed by the hair.

Flies of this species were observed in large numbers on two occasions, flying round rocks at the margin of the lake and settling at the edge of the water, in March near Patsahanipur and in November on Kalidai Id. The larvae were found among rotting weed on both occasions. The species is widely distributed in the Oriental region.

[1] Miall, *Nat. Hist. Aquatic Insects,* p. 198, figs. 70-77 (1895).

Family **Chironomidae.**

It is probable that several species of this family breed in the lake during the freshwater season, and we have frequently seen large numbers of larval skins floating on the surface of the main area at this time of year; many species certainly breed in small pools near the edge. This is probably the case with at least one blood-sucking form (*Culicoides peregrinus*, Kieff.) very common at Barkul in July and September.[1] Immature stages of only one Chironomid were, however, taken in the lake itself.

The species belongs to the genus *Palpomyia*, but seems to be distinct from any of those described from India. It is perhaps allied to *P. polysticta*, Kieffer,[2] which it resembles in the colour of its thorax, but all the femora and tibiae are dark brown, only slightly pale at the joints, while the tarsi are white with black rings at the joints and with the distal segment brownish. The abdomen of the female is white below, at any rate in spirit, except for the last two segments, and the dorsal surface appears to be brownish with ill-defined white spots.

Although the pupal stage, of which we give a figure (pl. xi, fig. 10) was common in the *Potamogeton* thickets of Balugaon Bay in February and March, we did not succeed in finding the larva. The fly was seen in considerable numbers on the surface of the water and a few specimens were hatched out in an aquarium.

Family **Culicidae.**

Major A. B. Fry in reference to the Chilka Lake writes as follows[3]:—"Villages are built on the very borders of the lake, and though most of them have a few patches of rice cultivation the vast perennial mosquito population comes from the lake itself. In situations sufficiently protected by weeds and algae from the attacks of fish, anopheline larvae and nymphs are in veritable swarms. The majority were *Pm. rossi* and *N. fuliginosus*, but *M. listoni* were present. My second visit was to look for *Pm. ludlowi*, in consequence of Christophers' observations in the Andamans; but I found none, but discovered *M fowleri* and *M. nigerrimus*."

Notwithstanding a careful search at many localities, the only mosquito larvae we were able to find in the lake were those of *Anopheles rossii*, Giles, which were abundant among weeds off Barkul in February and July in water of specific gravity 1·0075 to 1·008 and also off Nalbano in September in fresh water. The absence of *A. ludlowi* is somewhat remarkable, as it is the common Anopheline in brackish water in the neighbourhood of Calcutta.

Major Fry's visits to the lake were made in January; in March and September we failed to find even *A. rossii* off Satpara, and our impression is that most of the mosquitos breed in small pools of water near the edge rather than in the lake itself.

We have to thank Major Christophers for confirming our identification of *A. rossii*.

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[1] *Rec. Ind. Mus.*, IX, p. 246 (1913). [2] *Rec. Ind. Mus.*, VI, p. 116 (1911).

[3] *First Report on Malaria in Bengal*, p. 35 (Bengal Secretariat, Calcutta, 1912).

Order *LEPIDOPTERA.*

Family **Pyralidae.**

In thickets of *Potamogeton* off Barkul the larvae of a small moth, *Nymphula diminutalis*, Snell, was abundant in the dry season, being able to endure a salinity equivalent to a specific gravity of 1·008. The same species breeds in brackish water in the Gangetic delta, but is found also in many inland localities, having a wide distribution in the Oriental region and beyond.

The caterpillar constructs its case, which closely resembles that of a Caddis-worm, out of the narrow leaves of various water plants, arranging them parallel to one another in a longitudinal direction.

Mr. Meyrick has been kind enough to identify a moth of this species reared from a caterpillar found feeding on *Nais* in brackish water at Port Canning.

II. MARGINAL INSECTS.

The insects to be considered under this heading include three species of Dermaptera, one Orthopteron and three Rhynchota. At least two species of Collembola were also obtained in damp sand at the edge of the lake, but we are unable to express any opinion as to their identity. We may also refer to the curious Heterocerid beetle (*Heterocerus maindroni*, Grouvelle)[1] which burrows in sand and sandy mud to a point well below the water-level of the lake, taking to its wings at night and often flying to the lamps of bungalows in the neighbourhood. It occurs at the margin in places where the water is as salt as that of the Bay of Bengal near the lake, as well as where it is fresh.

The three earwigs are *Labidura bengalensis*, Dohrn, *L. riparia* (Pallas) and *Forcipula quadrispinosa*, Dohrn. Of these the two former are doubtfully distinct. All occur commonly under stones and particularly under alga that has dried on rocks; the *Forcipula* is a good swimmer, while *Labidura* can endure immersion in both fresh and salt water. The species are also found in similar situations at the edges of streams and ponds. *L. riparia* is a cosmopolitan species, while *L. bengalensis*, if it is distinct, is widely distributed in India and Ceylon; *F. quadrispinosa* is found also in Burma and the neighbouring countries.

The Orthopteron is a mole-cricket that agrees in every respect with the specimens identified by the late Mr. Kirby as *Curtilla* (=*Gryllotalpa*) *africana*, Beauv. It is nocturnal in its habits and usually burrows in mud at the edge of water. At Satpara it was found burrowing well below water-level in the salt-water season and its song may be heard at all parts of the lake in the evening. *Gryllotalpa africana* is the common species of the plains of India; its distribution is given as "Africa, Asia, Australia, N. Zealand (introd. ?)"[2]

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[1] Grouvelle, *Ann. Soc. ent. France*, LXXII, p. 345, fig. (1903).

[2] Kirby, *Syn. Cat. Orthopt.*, II, p. 6 (1906).

The three species of Rhynchota that may be classed as marginal forms are *Ochterus marginatus*, Latr., of the family Ochteridae or Pelogonidae, *Pirates lepturoides* (Wolff) of the family Reduviidae and *Leptopus assuanensis*, Costa, of the family Saldidae. The first of these is a diurnal species, often very common on mud at the edge of lakes and ponds. It is abundant in this situation at the Sar Lake in the Puri district, but at the Chilka Lake we only obtained one specimen, found on the surface of floating weeds in Gopkuda Bay. *Ochterus marginatus* occurs in Central Europe and South Africa and is doubtless widely distributed in the Oriental region. *Pirates lepturoides* apparently resembles *Gryllotalpa africana* in its habits. It was found in considerable numbers in damp sandy mud near Barhampur Id. in March and under stones near Barkul in the same month. The species has been recorded from several localities in India, Ceylon, Burma, Java and Borneo. *Leptopus assuanensis* is an active diurnal species very abundant among rocks in the main area; it flies about rapidly from rock to rock and settles just above the water-level. The species was described from Egypt and occurs also in Nubia and Madagascar as well as in many Indian localities, some of which are situated far inland.

From the foregoing notes it is clear that the marginal insects of the Chilka Lake, like most of the aquatic forms, are species of very wide distribution, capable of surviving temporary immersion in salt as well as in fresh water.

EXPLANATION OF PLATE XI.

Euratas formidabilis, Distant.

FIG. 1.—First larval instar, from a specimen preserved in alcohol.

,, 2.—Second larval instar, from a specimen preserved in alcohol.

,, 3.—Third larval instar (= *Fabatus servus*, Distant) from a fresh specimen.

,, 4.—Head and pronotum of third larval instar, from a specimen immersed in alcohol for twenty-four hours and then dried (more highly magnified than fig. 3).

,, 5.—Male genitalia as seen from below, from a preparation mounted in Canada balsam: ×20.

The dorsal sclerite of the ninth segment has been thrust to one side and its lateral angles are somewhat folded inwards in order to show the group of spines near the margin on the dorsal surface.

,, 6.—Female genitalia as seen from above in a retracted condition after removal of the 8th dorsal sclerite, from a specimen mounted in Canada balsam: × 30.

a. Genital aperture.
b. Genital hood.
c. Anterior appendage.
d. Inner branch of anterior appendage.
e. Ovipositor.
f. Posterior appendage.
g. 10th abdominal segment.
h. Anal segment.

,, 7.—Female genitalia, lateral view in extended condition, slightly diagrammatic: ×30.

Lettering as in preceding figure.

Eristalis arvorum, Fabricius.

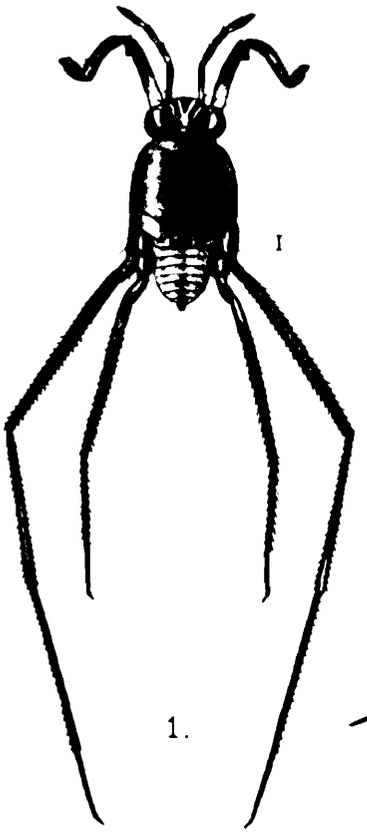
FIG. 8.—Ventral view of larva with tail partly retracted.

,, 9.—Lateral view of anterior extremity of larva, viewed as a transparent object: × 8.

a. Sensory papilla.
b. Anterior extremity of the lateral tracheal trunk.
c. First foot.
d. Pharynx.
e. Chitinous skeleton of pharynx.
f. Antechamber of pharynx.

Palpomyia sp.

FIG. 10.—Dorsal and ventral views of cast pupal skin.



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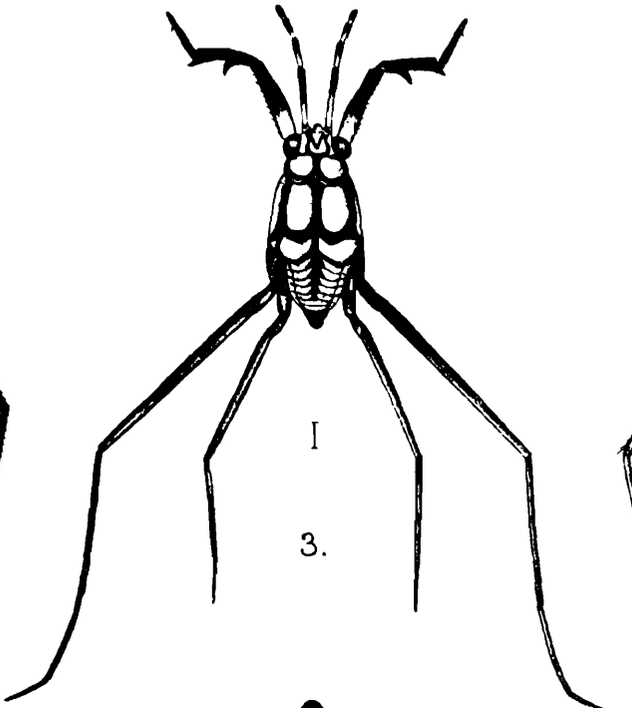

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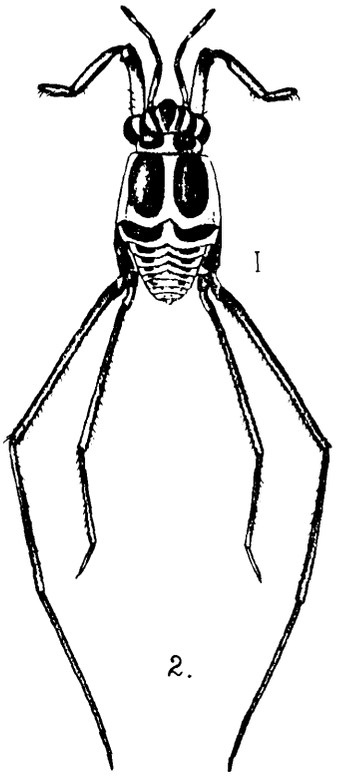

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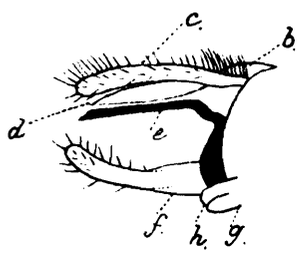

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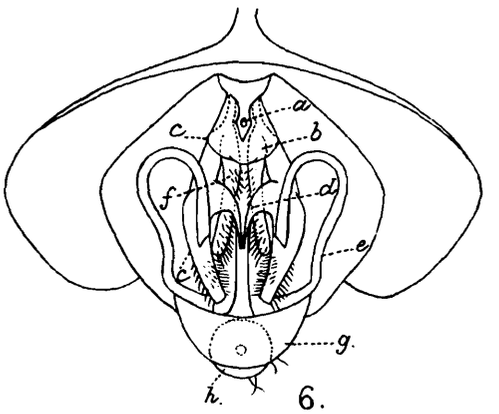

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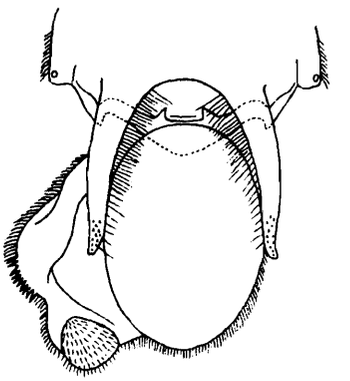

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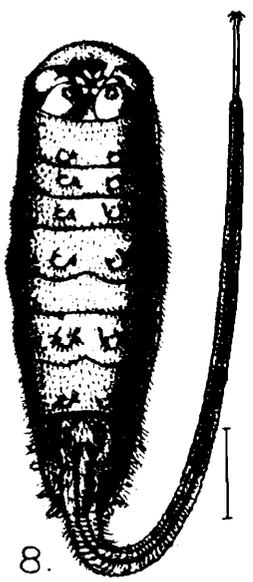

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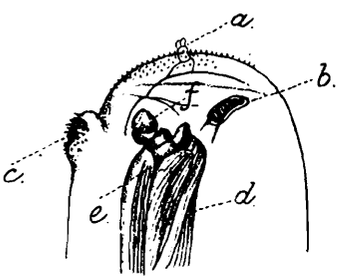

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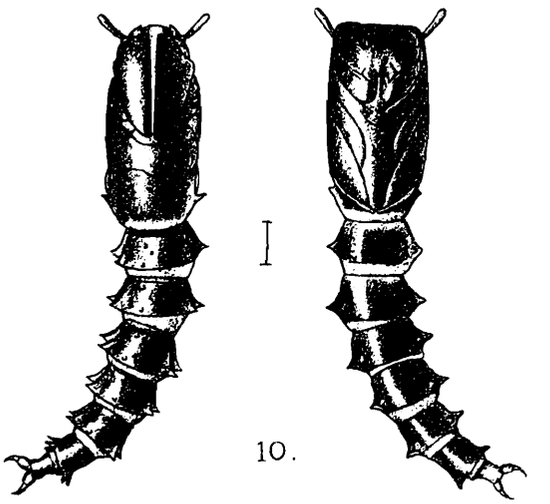

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G. M. Henry & D. N Bagchi, del. A. C. Chowdhary, lith.

INSECTS OF THE CHILKA LAKE

FAUNA OF THE CHILKA LAKE

STOMATOPODA.

By STANLEY KEMP, *B.A.*

(With 2 text-figures.)

CONTENTS.

STOMATOPODA.

By Stanley Kemp.

Two species and one variety of Stomatopoda have been found in the Chilka Lake, but the only one that is abundant is *Squilla scorpio* var. *immaculata*, a form also common in brackish water in the Gangetic delta. The occurrence both of *S. scorpio* and its variety *immaculata* is of some interest, for the two had not hitherto been found together. No specimens intermediate in character were observed, and it is possible that the two forms should more properly be recognised as distinct species. A knowledge of the early stages might throw light on this point; but all the larvae found in the lake are of one type and, if a difference exists in the structure of the *Alima*, they belong presumably to the more abundant var. *immaculata*. The third form, *Squilla interrupta*, seems to be merely a casual visitor to the lake-system, in which only one example has been found. This species and the typical form of *S. scorpio* have a wide Indo-pacific distribution, while the variety *immaculata* is known from an area extending from the mouth of the Indus to the coast of Burma.

Family SQUILLIDAE.

Genus **SQUILLA**, Fabricius.

Squilla scorpio, Latreille.

1913. *Squilla scorpio*, Kemp, *Mem. Ind. Mus.*, IV, p. 42, pl. ii, fig. 30.

The typical form of this species is very scarce in the Chilka Lake; it is represented in our collection by two males and eight females, the largest 67 mm. in length. The black patch on the lateral process of the fifth thoracic somite is conspicuous in all the specimens, even in the smallest, an individual only 21 mm. long.

Squilla scorpio was found both in the main area and in the outer channel of the lake in water varying in specific gravity from 1·000 to 1·0265. It is known to be distributed over an area extending from the east coast of India to N. Australia and Celebes and has, apparently, hitherto been obtained only in the sea.

var. **immaculata**, Kemp.

1913. *Squilla scorpio* var. *immaculata*, Kemp, *Mem. Ind. Mus.*, IV, p. 45, pl. ii, fig. 31.

Squilla scorpio var. *immaculata* is one of the commonest Crustaceans in the main area of the lake, occurring on a muddy bottom at all seasons of the year. It was also obtained on similar ground at the inner end of the outer channel and is able to exist, and apparently to breed also, in water varying in specific gravity from 1·000 to 1·0265.

Although both the typical form and the variety have been obtained at a number of localities on the Indian coast, this is the first occasion on which the two have been found together. It is therefore interesting to notice that in the Chilka Lake they are very easily distinguished and that in our long series no single individual intermediate in character was obtained. In specimens of the variety in which the pigmentation is unusually dense, the lateral process of the fifth thoracic somite is occasionally somewhat dusky but never dark enough to cause confusion with the typical form, while the correlated structural differences in the shape of the rostrum and carination of the carapace will also suffice to separate the one from the other. It seems, indeed, not by any means improbable that the variety *immaculata* will ultimately be given specific rank; but, apart from colour, the distinctions are so slight that it is inadvisable to take this course with the information we at present possess. A knowledge of the early stages of the two forms will perhaps afford a useful clue, but the series of larvae obtained in our tow-nettings are all of one type. In view of the great numerical preponderance of the variety *immaculata*, it seems probable either that they belong to this variety or that the varietal and typical forms are indistinguishable in their early stages.

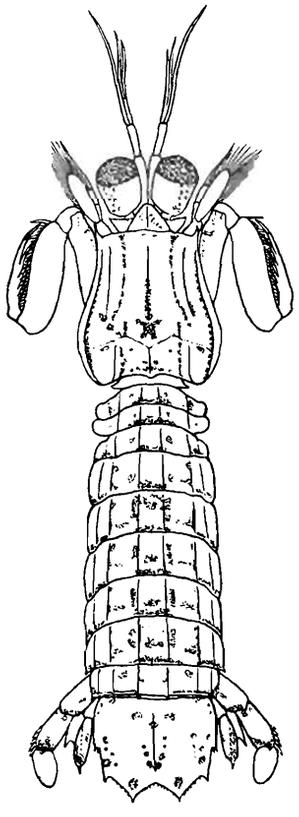

FIG. 1.—*Squilla scorpio* var. *immaculata*, Kemp.
A post-larval specimen about 8 mm. in length.

Specimens of the variety were obtained in the trawl in many places both in the outer channel and in the main area and were found in the salt-water season, when the water-level was at its lowest, under stones on the shore of Barkuda Id., living in burrows. The burrows were about half an inch in diameter and were U or Y-shaped, the distance between the openings being about eight inches. On lifting the stone the whole burrow was sometimes disclosed; it frequently contained practically no water. The *Squilla* occupied a slightly widened chamber at the bend of the U or in the stalk of the Y Specimens were also observed at the head of Rambha Bay, on mud-flats left bare owing to the action of strong wind. They lay at the mouth of their burrows, which were directed vertically downwards for about 3 inches before turning horizontally over a layer of shingle. No individuals with egg-masses were observed.

POST-LARVAL FORMS.

Our collection contains twenty-seven specimens less than 30 mm. in length which may conveniently be termed post-larval. The series apparently comprises four stages, the lengths of which are approximately 7·5—8·0 mm., 11·5—12·0 mm., 15·5—16·0 mm. and 25—27 mm. There are, however, one or two specimens of intermediate sizes.

The youngest post-larval stage (text-fig. 1) bears a close resemblance to the adult, but the eyes are proportionately much larger, the rostrum is broader at the base

and more strictly triangular in outline, the lateral margin of the fifth thoracic somite is scarcely at all produced and the telson still possesses between the marginal teeth the fine widely-separated spinules characteristic of the larval stages.

The single post-larval specimen of the typical *S. scorpio*, an individual 21 mm. in length, is easily distinguished from examples of the var. *immaculata* measuring 16 and 25 mm. by the same characters that serve to separate the adults. All post-larval specimens of 16 mm. in length and under apparently belong to the variety, lacking the characteristic features of the typical form. It appears to me probable that the two are to be distinguished even in the earliest post-larval stages and that such stages of the typical *S. scorpio*, a form comparatively rare in the Chilka Lake, are absent from our collections. There is, of course, a possibility that the two are inseparable until they have reached a length of about 2 cms.

LARVAL FORMS.

The larval forms found in the Chilka Lake are all of one type and the majority are doubtless those of *S. scorpio* var. *immaculata*. The larvae of the typical form were either not obtained or are inseparable from those of the variety.

The largest larvae in the collection (text-figs. 2*a-c*) are from 11·5 to 12·0 mm. in length from the tip of the rostrum to the apex of the telson. The rostrum is not as long as the carapace, the antero-lateral spines are shorter, in length scarcely equal to half the anterior breadth of the carapace, while the postero-laterals are long, about two-thirds as long as the distance between the antero-lateral angles and the posterior margin. The carapace is carinate in the mid-dorsal line, the carina terminating posteriorly in a spine, directed obliquely upwards and backwards, that is fully one-third the length of the postero-laterals. The lower edge of the rostrum, a little behind its middle point, is provided with one, less commonly with two, spinules. On the lateral margin of the carapace are three spinules, one close to the antero-lateral spine and two in the posterior quarter of its length (text-fig. 2*c*). On the inferior aspect of each postero-lateral spine is a sharp spinule and another, which appears to be highly characteristic of this particular larva, is found on each side of the posterior margin midway between the postero-median and postero-lateral spines.

The eyes are comparatively large, the basal portion of the stalk being very slender. The penultimate segment of the raptorial claw bears, on the margin opposed to the dactylus, two stout basal teeth, beyond which is a series of fine pectinations. The dactylus shows no trace of teeth (text-fig. 2*b*).

The appendages of the last three thoracic segments are well developed and biramous; only the last segment is exposed in dorsal view. The postero-lateral angles of the abdominal somites are not provided with spines and there are no spines on the posterior margin of the last segment. The pleopods are well formed but do not bear gills.

The telson is a trifle broader than long and is carinate mid-dorsally. There are eight pairs of spinules between the submedian teeth, five to seven spinules between the submedians and intermediates and one between the intermediates and laterals.

The uropods reach midway between the lateral and intermediate teeth of the telson ; the basal segment of the outer uropod bears a series of spinules on its outer edge.

The two other larval stages in the collection are approximately 9·0—9·5 mm. in total length (text-fig. 2*d*) and 7·3—8·0 mm. in length (text-figs. 2*e*, *f*). At all stages there is a certain amount of variation in the length of the rostral and postero-lateral spines. This variation is most marked in the youngest stage; text-fig. 2*g* is an illustration of a specimen in which the spines are exceptionally long.

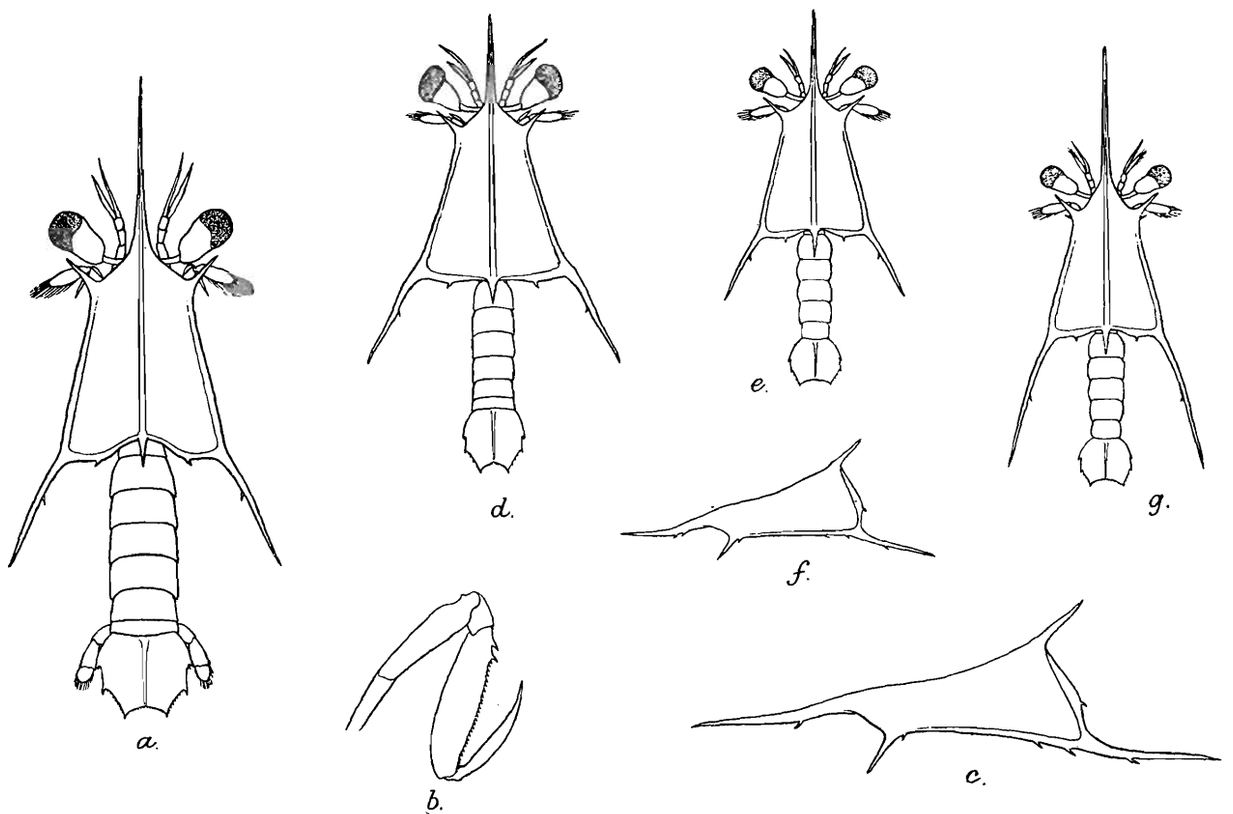

FIG. 2.—*Squilla scorpio*, Latreille.
Larvae presumably belonging to the var. *immaculata*.

a. Larva belonging to the largest stage obtained.
b. Raptorial claw of the same larva.
c. Carapace of the same larva in lateral view.
d. Larva belonging to an intermediate stage.
e. Larva belonging to the youngest stage obtained.
f. Carapace of the same larva in lateral view.
g. Larva belonging to the same stage, with abnormally long rostral and postero-lateral spines.

The pair of small spinules on the posterior margin of the carapace is developed in all three stages ; by this character the *Alima* of *S. scorpio* var. *immaculata* appears to be sharply distinguished from all larvae hitherto described.

All the larvae obtained were found during the months of February, March and July, at a time when the water of the lake was almost or quite at its saltest. Reproduction probably commences early in the year, as soon as the first influx of salt water from the Bay of Bengal has taken place.

Squilla scorpio var. *immaculata* has been recorded from Karachi, from the Gangetic delta and from the Arakan coast. In the vicinity of Calcutta, a locality in which the typical form has never yet been found, it is far from uncommon, living in water of low but variable salinity.

Squilla interrupta, Kemp

1913. *Squilla interrupta*, Kemp, *Mem. Ind. Mus*, IV, p 72, pl. v, figs. 60-62.

A single specimen of this species, a male 77 mm. in length, was obtained by Mr. T. Southwell in August, 1913, from fishermen at Satpara. The specimen was undoubtedly found in the outer channel of the lake, and if, as seems probable, the periodic changes in salinity in 1913 were the same as those of 1914, the individual must have been found in fresh water.

We obtained no specimens during our survey of the lake and are inclined to regard the species merely as a casual immigrant to the outer parts of the lake-system. *Squilla interrupta* is common on the Orissa coast of the Bay of Bengal and is known to have a distribution extending from the Persian Gulf to Formosa and Hongkong.