FAUNA OF THE CHILKA LAKE

MOLLUSCA GASTROPODA AND LAMELLIBRANCHIATA.

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(Plates XIV—XVI.)

WITH AN ACCOUNT OF

THE ANATOMY OF THE COMMON *SOLEN*.

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(With 3 text-figures.)

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MOLLUSCA GASTROPODA AND LAMELLIBRANCHIATA.

By N. ANNANDALE *and* STANLEY KEMP.

INTRODUCTION.

Our object in preparing this report has been, not to criticise genera and species from a taxonomic point of view, but to discuss in relation to their biological environment the distribution of the forms that occur in the Chilka Lake, and thus to bring the Mollusca, so far as possible, into line with the other groups dealt with in this volume. So far as nomenclature is concerned, we have in most cases followed that adopted by Mr. H. B. Preston in the series of papers contributed by him to the *Records of the Indian Museum* between 1907 and 1916. Full references to these and to other papers dealing with what von Martens calls the "sub-marine" molluscs of the Indian coasts are given in the bibliography on p. 364.

In the collections from the Chilka Lake that we have sent to Mr. Preston he recognizes no less than 34 species of Gastropods and 45 of Lamellibranchs. Of these he has described 42 species as new. We do not disparage his work, undertaken as it has been with a purely conchological aim, in saying that we expect that many of these species will ultimately prove to be no more than dwarfed or distorted phases of molluscs that occur elsewhere in more normal conditions. Cooke has pointed out with admirable clearness in his volume in the *Cambridge Natural History* (vol. III, p. 82) that a naturalist's concept of species and varieties in Mollusca must be profoundly modified by his point of view. Our point of view is not Mr. Preston's, but unfortunately we lack his special knowledge. We have therefore accepted his conclusions in so far as they do not run counter to the facts we have observed in the field.

In our Introduction to this volume we have dealt at length with the physical conditions of life in the different parts of the lake-system and in particular with the periodic changes in the salinity of the water. It will be as well, however, to recapitulate briefly our statements on these points in so far as they influence the distribution of the Mollusca.

The whole of the lake-system is very shallow, rarely more than 2 fathoms in

depth, and the variations of level that occur at different seasons, though relatively great (about 5 or 6 ft.), are not sufficient to have any appreciable direct effect on the fauna. The bottom of the main area of the lake is covered with soft mud, which probably overlies a deep layer of clean sea-sand, while along the outer shore of this area and round some of the lower islands, sand and mud are mixed. At most places at which this occurs the water becomes excessively shallow in the dry season and is so heated by the sun that conditions are inimical to most forms of animal life; but the admixture is a marked feature of the bottom round the island of Nalbano and a belt of gritty mud extends in fairly deep water out into the channel by means of which the lake is connected with the sea. The outer part of this channel, near the sea-mouth, is scoured by currents at certain seasons and its bottom consists of clean sand. At several points along the inner shore of the main area and on some of the islands there are rocks, partially or entirely submerged in summer and autumn, but in spring exposed and dry owing to the sinking of the water-level. In sheltered spots, where the water near the shore is relatively deep, dense thickets of weed grow up in autumn, dying out almost completely in the rainy season. They consist for the most part of a species of *Potamogeton* that sometimes attains a height of at least five feet in order to flower on the surface. A fine-branched alga also forms somewhat lower thickets at a few places in both parts of the lake-system.

For the greater part of the year the whole of the main area is filled with water that may be called brackish, having a specific gravity (corrected) that reaches a maximum of 1·0150. At this period there is an abrupt change in salinity at the point where the outer channel opens into the main area, the water in the former being, at the height of the season, as salt, or very nearly as salt as that of the Bay of Bengal outside the sea-mouth (sp. gr. 1·02650). Between August and October floods of fresh water pour in from the rivers at the north, driving before them the salter water, until the northern part of the main area and the whole of the outer channel become entirely fresh. In a comparatively small area at the southern end of the lake into which no rivers open, the floods have less effect and the water remains brackish throughout the year, the specific gravity varying from 1·003 to 1·015. The northern boundary of this area is situated close to the island of Kalidai, which forms a land-mark in the distribution of species.

The specific gravities recorded in the table on pp. 332, 333 represent not the full range of salinity in which the species may occur, but merely that in which we found living specimens in the Chilka Lake.

In the collection of the Indian Museum there are specimens of some 37 named species of Gastropods and 47 of Lamellibranchs from the lake. Certain shells that we believe to have been introduced by man or other agents may be dismissed very briefly. We have no reason to include these species among the living fauna, for the Gastropods are merely represented by dead shells, most of which were occupied by hermit-crabs, while of the Lamellibranchs only single valves were obtained, in circumstances which suggested that they had been brought from the coast by man. These introduced shells are:—

GASTROPODA.

Nassidae.
Bullia vittata, Linn.

Strombidae.
Strombus isabella, Lk.

Viviparidae.
Vivipara bengalensis, Lk.

Ampullariidae.
Ampullaria globosa, Swains.

Naticidae.
Natica marochiensis, Gmel.
,, *maculosa*, Lam.

LAMELLIBRANCHIATA.

Veneridae.
Meretrix morphina, Lk.
Meröe scripta, Gray.
,, *chilkaënsis*, Preston.
,, *satparaënsis*, Preston.

Donacidae.
Donax pulchella, Hanley.

Tellinidae.
Tellina barhampurensis, Preston.

Dead shells of the freshwater Gastropods that live in pools and rice-fields are common on the shores of the lake and are occasionally carried into it by winds, by birds and by hermit-crabs of the semi-terrestrial genus *Coenobita*, which also bring marine shells, such as those of *Natica* and *Strombus*, across the sand-hills from the sea. Marine shells, especially those of Lamellibranchs, are commonly collected on the sea-shore by Uriya fishermen and used for the manufacture of lime, lime from this source being highly esteemed as an ingredient in *pán*. Such shells are often dropped in the neighbourhood of villages. They must be carefully distinguished from the sub-fossil shells found at certain places (see p. 338).

The living Mollusca of the lake, omitting Nudibranchs and introduced shells, are listed on pp. 332, 333 and comprise, so far as our knowledge goes, 73 species, 31 of Gastropods and 42 of Lamellibranchs. The Gastropods are distributed among 14 families and 19 genera, the Lamellibranchs among 20 families and 25 genera. No less than 28 species, with one genus (*Chilkaïa*)—that is to say, about 38% of the total number—appear at present to be endemic in the lake-system.

The great majority of the genera are certainly of marine origin, the only exceptions being *Potamides*, *Chilkaïa* (*?*), *Hydrobia* and *Stenothyra*. *Potamides* is essentially an estuarine genus and the two species by which it is represented occur commonly in brackish water all over the Oriental region, in Australia and in Japan. The genus ***Chilkaïa***, as at present known, is represented by a single minute species belonging to a family the other members of which are marine. On the other hand *Hydrobia* and ***Stenothyra*** belong to a family of which most of the species inhabit fresh water, but many make their way into estuarine tracts and are found only in brackish water. This is the case with most of the Indian species. More than half of those of *Stenothyra* known from India have been found in the Chilka Lake.

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[1] The figures in the second column of this table indicate the specific gravity of the water in which living specimens were obtained. Species which, so far as is yet known, are endemic in the lake-system are distinguished by an asterisk.

	Specific gravity of water.	Distribution in Lake.		Further Distribution.
		Main area.	Outer channel.	
Gastropoda.				
TORNATINIDAE.				
Tornatina estriata, Preston	1·000—1·0265	X	X	Cochin backwaters.
BULLIDAE.				
Bulla (Haminea) crocata, Pease ..	1·000 [1]—?	..	X	Indo-pacific.
NASSIDAE.				
Nassa sistroidea, G. & H. Nevill ..	1·000—1·0265	..	X	Andamans.
,, *labecula*, A. Ads.	1·000—1·0265	X	X	Philippines.
,, *marrattii*, Smith	?	..	X	Mekran coast to Solomon Is.
,, *denegabilis*, Preston	1·000—1·0265	X	X	Cochin and Madras backwaters; Gangetic delta.
,, *orissaënsis*, Preston	1·000—1·0265	X	X	Madras backwaters; Gangetic delta.
MURICIDAE.				
Thais carinifera (Lam.)	1·005—1·0265	X	X	E. Africa to Australia.
CERITHIIDAE.				
Potamides (Tympanotonos) fluviatilis, Pot. & Mich	1·000—1·0265	X	X	India to Australia and Japan.
,, *(Telescopium) fuscum*, Schum.	1·0265	..	X	,, ,, ,,
TURRITELLIDAE.				
Vanesia rambhaënsis (Preston).. ..	1·000—1·015	X	X	Cochin backwaters
FOSSARIDAE.				
Chilkaïa imitatrix,* Preston	1·000—?	..	X	
LITIOPIDAE.				
Litiopa (Alaba) kempi,* Preston ..	1·000—1·015	X	X	
,, ,, *copiosa*,* Preston ..	1·000—1·0265	X	X	
HYDROBIIDAE.				
Hydrobia (Belgrandia) myliacea, Nevill ..	?	?	?	Gangetic delta.
Stenothyra blanfordiana, Nevill.. ..	?	?	?	Gangetic delta; Madras.
,, *minima* (Sowerby)	1·000—1·0265	X	X	Western India; Ceylon.
,, *chilkaënsis*,* Preston ..	1·000—1·0265	X	X	
,, *orissaënsis*,* Preston ..	1·000—1·0265	X	X	
,, *trigona*,* Preston	1·000—1·015	X	X	
,, *obesula*,* Preston	1·000—?	..	X	
SCALARIIDAE.				
Epitonium hamatulae,* Preston ..	?	..	X	
PYRAMIDELLIDAE.				
Pyrgulina humilis (Preston)	1·000—1·0265	X	X	Cochin backwaters; Ceylon.
Chrysallida (Mormula) ecclesia,* Preston ..	?—1·015	X	..	
,, ,, *nadiensis*,* Preston	1·000—?	..	X	
Odostomia chilkaënsis,* Preston ..	1·0265	..	X	
NERITIDAE.				
Neritina (Theodoxus) souverbiana, Montr.	1·000—1·0265	..	X	China Sea; New Caledonia.
CYCLOSTREMATIDAE.				
Cyclostrema (Tubiola) innocens,* Preston ..	?	..	X	
Tinostoma variegatum,* Preston ..	1·0265	..	X	
TROCHIDAE.				
Umbonium vestiarium (Linn.)	1·0265	..	X	Warm and tropical seas.
Solariella satparaënsis,* Preston ..	1·000—1·0265	..	X	
Lamellibranchiata.				
OSTREIDAE.				
Ostrea virginiana, Gmel.	1·000—1·0265	X	X	W. coast of N. America; ? all tropical seas.
,, *cucullata*, Born.	1·000—1·0265	..	X	Indo-pacific.
,, *lentiginosa*, Sowerby	1·0265	..	X	?

[1] A single dwarfed specimen.

SPECIES.

	Specific gravity of water	Distribution in Lake. Main area.	Distribution in Lake. Outer channel.	Further Distribution.
MYTILIDAE.				
Mytilus smaragdinus, Chemn.	?	..	X	Arabian Sea to Hongkong; ? N. Zealand.
Modiola undulata (Dunker)	1·000—1·0265	X	X	Moluccas; Gangetic delta.
,, *striatula*, Hanley	1·000—1·0265	X	X	Arabian Sea to Philippines.
ARCIDAE.				
Arca (*Anadara*) *granosa* (Linn.)	1·003—1·015	X	?	Arabian Sea to Japan and Australia.
,, (*Fossularca*) *lactea* (Linn.)	1·0265	..	X	E. Atlantic to Burma; ? Philippines.
ERYCINIDAE.				
Kellya chilkaënsis,* Preston	1·000—1·0265	X	X	
,, *mahosaënsis*,* Preston	1·007	..	X	
GALEOMMIDAE.				
Scintilla chilkaënsis,* Preston	1·000—?	..	X	
CARDIIDAE.				
Cardium (*Fulvia*) *rugatum*, Gronov.	1·0265	..	X	Bay of Bengal to New Britain.
VENERIDAE.				
Meretrix meretrix (Lam.)	1·000?—1·0265	..	X	
,, *casta*, Chemn.	1·000?—1·0265	..	X	Indian Seas; Ceylon; Singapore.
,, *ovum*, Hanley	1·000?—1·0265	..	X	Indian Seas.
Tivela dillwyni (Deshayes)	1·000—?	..	X	
Tapes pinguis, Chemn.	1·000?—1·0265	..	X	Eastern Indian Ocean.
,, *ceylonensis*, Sowerby	1·000?—1·0265	..	X	Indian Seas; Ceylon.
Clementia annandalei, Preston	1·000—1·0265	X	X	Gangetic delta.
PETRICOLIDAE.				
Petricola esculpturata,* Preston	1·000—1·0265	..	X	
UNGULINIDAE.				
Diplodonta satparaënsis,* Preston	1·009—1·0265	X	X	
,, *barhampurensis*,* Preston	?	..	X	
,, (*Felania*) *annandalei*,* Preston	1·009—1·0265	X	X	
,, ,, *ovalis*,* Preston	1·0265	..	X	
,, ,, *chilkaënsis*,* Preston	1·0265	..	X	
PSAMMOBIIDAE.				
Psammobia mahosaënsis,* Preston	1·000—1·0265	X	X	
SOLENIDAE.				
Solen ? *fonesi*, Dunker	1·000—1·0265	X	X	Cochin backwaters; Philippines; Cebu.
,, *annandalei*,* Preston	?	X	X	
,, *kempi*,* Preston	?—1·0265	X	X	
MACTRIDAE.				
Standella annandalei,* Preston	1·008—? 1·0265	X	X	
MYIDAE.				
Corbula chilkaënsis,* Preston	*ca.* 1·010	X	..	
PHOLADIDAE.				
Martesia striata (Linn.)	?	?	?	Cosmopolitan.
TEREDINIDAE.				
Xylotrya stutchburyi, Sowerby	1·000—1·0265	..	X	Malay Archipelago.
TELLINIDAE.				
Tellina chilkaënsis,* Preston	?	..	X	
,, *confusa*,* Preston	?	?	?	
SCROBICULARIIDAE.				
Theora opalina (Hinds)	1·000—1·0265	X	X	Indian coasts to Philippines.
Cumingia hinduorum,* Preston	1·000—1·0265	X	X	
CUSPIDARIIDAE.				
Cuspidaria annandalei, Preston	1·000—1·0265	X	X	Madras and Cochin backwaters; Gangetic delta.
LYONSIIDAE.				
Lyonsia samal-insulae,* Preston	1·000—1·0265	X	X	
ANATINIDAE.				
Anatina granulosa,* Preston	?	?	?	
,, *barkudaensis*,* Preston	1·000?—1·0265	X	X	
,, *barkulensis*,* Preston	1·000—1·010	X	X	

Several of the genera represented in the lake fauna, though essentially marine, include species characteristic of an estuarine environment. As examples of these we may mention *Nassa* and *Thais* among the Gastropods and, among the Lamellibranchs, *Modiola*, *Arca*, *Meretrix*, *Corbula*, *Martesia*, *Clementia* and *Theora*. The species of Pholadidae, Teredinidae, Arcidae and Solenidae are, however, quite distinct from those that have established themselves in the Ganges and other Indian rivers.

GEOGRAPHICAL DISTRIBUTION.

With the exception of *Chilkaïa*, all the genera that comprise the molluscan fauna of the Chilka Lake have a very wide geographical distribution, whereas, as we have already pointed out, more than one third of the species at present appear to be endemic. Apart from apparently endemic species the Mollusca of the lake fall, with one or two possible exceptions, into two categories, (*a*) those that are found only in other localities of a similar nature on the Indian coasts and (*b*) those of wide distribution. The number of the former is comparatively small, but with further exploration it is probable that many of the apparently endemic species will be transferred to this category. The following forms are known to occur both in the Chilka Lake and in estuarine tracts in other parts of India, but have not been found elsewhere:—

GASTROPODA.

Tornatina estriata.
Vanesia rambhaënsis.
Nassa denegabilis.
,, *orissaënsis.*
Hydrobia (*Belgrandia*) *myliacea.*
Stenothyra blanfordiana.

LAMELLIBRANCHIATA.

Clementia annandalei.
Cuspidaria annandalei.

A considerable amount of work has been done by Nevill, W. T. Blanford, Benson, Stoliczka, von Martens and Preston on the aquatic shells of estuarine tracts in India and the Malay Archipelago; but (except in the case of the last author) most of their papers refer exclusively to species found at the edges of creeks and backwaters or in small pools of brackish water. This is probably one of the reasons why our collection from the Chilka Lake differs very greatly from those previously described from similar localities, a very large proportion of the species having been obtained by dredging. A real difference, namely the scarcity in the lake of certain thick-shelled amphibious forms, such as *Neritina*, *Littorina* and *Pythia*, is probably explained by the absence of mangroves and semi-aquatic palms to the stems of which such species frequently attach themselves. It is less easy to explain the entire absence of the almost terrestrial mud-loving genus *Onchidium* and the absence or scarcity of the aquatic genera *Iravadia* and *Corbula*, which are remarkably abundant in the Gangetic delta. The occurrence of *Cyclostrema* is, however, interesting, as we believe that Nevill's "*Valvata? microscopica*," a species very abundant at Port Canning, also belongs to this genus.

Some years ago a considerable collection of shells was made in shallow water off

the coast of Orissa by the S.S. 'Golden Crown,' but not a single species is common to this collection and to our own, while most of the genera are different, a fact due perhaps in the main to the nature of the bottom on which the two collections were obtained.[1] So far as we have been able to discover, the molluscan fauna of the Chilka Lake, at any rate in the matter of Lamellibranch genera, is nearer to that collected, in shallow water and mainly on muddy ground, by the Danish Expedition to Siam[2] than to any other on which a comprehensive report has yet appeared. Eighteen Lamellibranch subgenera and genera are common to the two collections, representing two thirds of those found in the lake.

BIOLOGICAL DISTRIBUTION.

Less than 50 % of the living Mollusca of the lake are found in the main area, and even this percentage is somewhat reduced if we omit the island of Nalbano. With two exceptions, *viz. Corbula chilkaënsis* and *Chrysallida ecclesia*, each represented by a single specimen, all species found in the main area were also found in the outer channel, but the great majority did not occur on the clean sandy bottom of the seaward part of the latter. By far the richest tract in the whole lake-system is the southern end of the outer channel between Barhampur I. and Satpara Point (see map, Pl. II of this volume).

The following species have a great numerical preponderance throughout the main area, except where the water is excessively shallow:—

GASTROPODA.	LAMELLIBRANCHIATA.
Tornatina estriata.	*Modiola undulata.*
Nassa denegabilis.	*Clementia annandalei.*
,, *orissaënsis.*	*Solen ? fonesi.*
Stenothyra spp.	*Theora opalina.*

With the exception of the species of *Nassa* and *Stenothyra*, all of these are much less abundant in the outer channel. In the channel the following species may perhaps be regarded as predominant:—

GASTROPODA.	LAMELLIBRANCHIATA.
Nassa labecula.	*Meretrix casta.*
Potamides fluviatilis.	,, *ovum*
Litiopa copiosa.	*Tapes pinguis.*
Pyrgulina humilis.	,, *ceylonensis.*

In this part of the lake it is much more difficult to select predominant species than in the other, for a large number of forms are represented by considerable numbers of individuals, whereas in the main area most of the species are either very rare or else extremely abundant.

[1] Jenkins, *Rec. Ind. Mus.*, VII, p. 51 (1912).

[2] Lynge, *Danske Vid. Selsk. Skrift.* (7) Nat. og. Math., V, pp. 100-299 (1909).

The chief reasons for the difference between the molluscan fauna of the two regions appear to be two,—differences in salinity and differences in the nature of the bottom, the latter factor being perhaps more important in the case of Mollusca than in that of some other groups.

Apart from these distinctions between the two regions, there are other divisions in the fauna dependent on other causes: certain species are abundant in restricted localities. *Potamides fluviatilis*, for example, is extremely common in very shallow water on all ground in which the mud is mixed with sand, being apparently able to endure a high temperature fatal to other species, but avoiding soft mud. The same kind of bottom is also the only one that attracts the species of *Lyonsia* and *Anatina*, but they are burrowing forms not so easily observed.

The number of rock-haunting molluscs is very small; indeed, only two species, *Modiola striatula* and *Thais carinifera*, can be assigned definitely to this category. Both of these are abundant, but their distribution in the main area of the lake is not the same; for while the mussel is found in large numbers on all rocks that are submerged for more than a few months in the year, the *Thais* is restricted to those south of Kalidai, being found only in water the specific gravity of which never falls below 1·003. This species is also found on the oyster-beds at Manikpatna in salt water; its distribution in the lake evidently depends not only on salinity, but to some extent on the presence of mussels or other thin-shelled molluscs on which it preys.

The oysters that occur in the Chilka Lake belong to at least three species, but only one, *Ostrea virginiana*, is at all common Oyster-beds are found only in the neighbourhood of Manikpatna. At this place several small sandy islands are so arranged as to form a bay sheltered from currents that would prevent the deposition of spat, while the fact that the bay is situated at no great distance from the sea-mouth is of importance, both because the greater part of the silt from the flood-waters has already settled before the floods reach it, and because it obtains immediate benefit from the irruption of sea-water that occurs when they subside.

In March we occasionally found single living individuals of *O. virginiana* attached to rocks in the neighbourhood of Patsahanipur; in some of them the shell was as much as 3 cms. in diameter. Later in the year apparently fresh but empty shells of a similar size were noted in the same place. We believe that this indicates that a certain number of larvae make their way into the main area of the lake, on the rocks of which, as we will show later, the oyster was once abundant. They are able to settle down and to grow considerably, but are ultimately killed by the summer floods. If this is so, the rate of growth must be very rapid, but the Uriya fishermen state that when the oyster-beds at Manikpatna are overwhelmed with sand, as sometimes occurs in the flood-season, they are entirely renovated in a single year. The bulk of the beds are formed of living and dead shells of *O. virginiana*, to which a few individuals of *O. cucullata* and *O. lentiginosa*, with large numbers of *Modiola striatula*, attach themselves, while *Petricola esculpturata* esconces itself in cavities between them. So far as we were able to observe, the last-named species was entirely free from the necessity of constructing borings of its own.

Two species of molluscs were found only in or on wooden posts set up to mark the fairway in the outer channel near Satpara. These were the ship-worm *Xylotrya stutchburyi* and an oyster (*Ostrea* sp.) of which a few large individuals were obtained but have unfortunately been mislaid.

The periodic growth and decay of the thickets of weed to which we have alluded above is an important factor in the distribution of the Lamellibranchs *Modiola undulata* and *Cuspidaria annandalei*. The former is known to breed in the lake at all seasons and is found on filamentous algae growing on stones, but by far the greater number of the individuals observed were attached to thicket-forming weeds. Almost as soon as these weeds begin to grow up they are covered with young mussels, which increase in size rapidly and evidently become mature before the plant dies down. The same fact was noted to a less extent in the case of *Cuspidaria*. It is of importance to the fisheries of the lake, in that several of the more abundant edible species of fish haunt the thickets and devour weeds and molluscs together.

Several Gastropods also frequent weeds, notably the species of *Stenothyra*, *Litiopa*, *Pyrgulina* and *Chrysallida*; but these are also found in large numbers among algae of less luxuriant growth and do not form so characteristic a feature of the thickets. *Nassa denegabilis* and *N. orissaënsis* apparently crawl indifferently among weeds or on bare mud.

The great majority of the Mollusca found in the lake inhabit it throughout the year; but it was observed in the case of several of the commonest species, *e.g. Tornatina estriata*, *Clementia annandalei* and *Theora opalina*, that a very large number of individuals died in the latter part of the freshwater season—a fact of particular interest in view of the marine origin of the fauna. It would seem that in the Mollusca, as also in other groups, certain individuals are more tolerant of changes in salinity than the majority of their kind, and that the effect of fresh water on the organism, in at least some forms, is cumulative rather than suddenly fatal. The small Opisthobranch *Bulla crocata* affords interesting evidence. It was originally described from sheltered positions in the sea and is not uncommon, at any rate in certain seasons, in the Madras backwaters. The only living specimen we found in the Chilka Lake was taken in fresh water (in September, 1914), but was scarcely half the normal size, though the shell was fully formed. Full-sized specimens that had not long been dead were obtained, in the same month and in the same part of the lake, among decaying weed cast up on the shore. It would seem probable that the species makes its way into the lake either in the larval stage or before its growth is completed and that the majority of the individuals which have attained their full size in the salt-water season succumb to the freshwater floods. An unusually hardy individual, however, occasionally survives throughout the year, but is dwarfed by the unfavourable character of its environment.

A number of other species are represented in our collection only by fresh but empty shells, found in the outer channel in September in circumstances that did not suggest their having been introduced artificially. As examples we may mention *Cyclostrema* (*Tubiola*) *innocens* and *Epitonium hamatulae*. In several cases, notably

that of the species of *Diplodonta*, living molluscs were found in the salt-water season, but only dead shells in that of fresh water.

Several species, notably *Cardium* (*Fulvia*) *rugatum* and *Mytilus smaragdinus*, evidently make their way at a young stage from the sea into the outer channel, but are unable to survive until maturity; they must be classed merely as occasional visitors of no faunistic interest in so far as the lake-fauna is concerned.

Many species belonging to freshwater genera, such as *Ampullaria*, *Vivipara* and *Planorbis*, are very abundant in rice-fields and even in small pools of rain-water near the margin of the lake; but we did not observe a single instance in which molluscs of this kind made their way into the lake itself, even when its waters were quite fresh. This fact is particularly remarkable in the case of *Melania tuberculata*, which is common in pools of both fresh and brackish water near Rambha and occurs in great abundance in water of considerable salinity in the Gangetic delta.

SUBFOSSIL SHELLS.

The late Dr. W. T. Blanford drew attention in 1859 to the fact that there were large beds of subfossil estuarine molluscs in the neighbourhood of Rambha. The species best represented in these beds, as he noted, are *Arca granosa*, Linn., and *Meretrix casta*, Chemn. *Thais carinifera* is also fairly common. Worn shells of *A. granosa* and *M. casta* are also very abundant on the shore of Barkuda I.; the latter species, though common in the outer channel, is now extinct in the main area, in which *A. granosa* is very scarce.

Another species found in the main area in a subfossil condition is the common "window-pane oyster", *Placuna placenta* (Linn.), beds of which, of very limited extent, were proved to have existed near Samal I. and at other points. This mollusc no longer lives in any part of the lake, though it is collected for commercial purposes in lake Tamblegam (Tampalakaman), a smaller lagoon on the coast of Ceylon, the water of which probably also undergoes great seasonal changes in salinity.[1] A detailed comparison of the conditions in the two lagoons in this and in other respects would be of great interest.

We have already alluded to the young oysters occasionally found on rocks in the main area; at the southern end of the lake single valves, evidently long dead, were frequently observed, while at the edge of the water near Ganta Sila we found the remains of an oyster-bed. The species (*O. virginiana*) was the same as that now found living at Manikpatna, but the beds differed in that shells of the genus *Chama* were abundant on the oysters. On the rocks at the same place skeletons of solitary corals belonging to the family Turbinolidae were occasionally seen (pl. xiv, fig. 3). *Chama* was not found on the Manikpatna beds, but is usually associated with oysters taken in shallow water off the coast of Orissa, while the Turbinolidae are characteristically marine and are particularly abundant off the same coast.

[1] Hornell, *Ceylon Marine Biol. Reps.*, I, p. 41 (1906). According to Mr. Hornell the specific gravity of the water of this lake in the dry season varies from 1·015 to 1·019 at temperatures from 86° to 90° F. No observations have been made as to the conditions in the wet season.

It is probable that these subfossil species do not all belong to the same period in the history of the lake, though all are undoubtedly recent. The oyster-bed at Ganta Sila (in the presence of *Chama*) and the corals on the rocks evidently date from a time when this part of the lake was in direct communication with the Bay of Bengal; Ganta Sila and the hills near it then forming an island or group of islands in the sea. On the other hand the beds of *Arca* and *Meretrix* at the head of Rambha Bay mark the position of a channel or creek of later date, probably containing brackish water and representing all that then remained of the sea-passage that once separated the islands from the mainland. The beds may possibly have been laid down when the lake-area, though closed to the south, still remained an open bay with a purely marine fauna; but doubt is cast on this view by the existence of precisely similar shells in a subfossil condition on the shores of Barkuda I.

The only case in which we have been able to observe a difference between subfossil and living shells is that of *Arca granosa*. The subfossil shells of this species exhibit considerable variety of form (some being much more nearly bilaterally symmetrical than others) and are never of more than moderate size, the largest having a breadth of 50 mm. The few living examples we obtained were much smaller, the greatest breadth being 26 mm. They differ somewhat in form from any of our subfossil examples in being relatively broader and less inflated (*cf.* figs. 3-6, pl. xvi). Von Neumayer has described a variety of this species under the name "*Arca granulosa* var. *minuta*",[1] from a point some distance up the Yang-tse-Kiang river. It was taken with shells of freshwater genera such as *Vivipara*, *Bythinia*, *Melania* and *Corbula*; the specimens were found in silt and were apparently in a subfossil condition.[2] Our own examples from the main area of the Chilka Lake bear a general resemblance to his figures, but are a little larger and more symmetrical. The variation in *A. granosa* may thus be compared with that recorded by Bateson in the case of *Cardium edule*[3]; but, except in the points noted, we are unable to correlate it definitely with changes in environment.

SPECIAL CHARACTERISTICS OF THE MOLLUSCAN FAUNA.

In the general facies of the molluscs of the lake the most noteworthy characters are small size, lack of bright pigment and thinness of shell.

Among the Gastropods the only shells that commonly attain a length of more than 1 cm. are *Nassa labecula*, *N. marrattii*, *Potamides fluviatilis*, *P. fuscum* and *Thais carinifera*; of these only three occur in the main area, the majority of the shells in this region being less than 5 mm. long. In the case of Lamellibranchs a few fairly

[1] *Wiss. Ergebn. Reise Béla Széchenyi in Ostasien*, 1877-80, II, p. 641, pl. i, fig. 4 (1898).

[2] In the markets of Shanghai, Soochow and the smaller towns in the same district a dwarfed form of *A. granosa* is commonly on sale in a living condition. It is said to come from near Ningpo. The shells are covered with fine mud and sometimes bear dead or living *Balani*. With them I found mixed, in some instances, shells of Cerithiidae and Nassidae of distinctly brackish-water facies. The largest *Arca* shells of this form are about 30 mm. broad and about 20 mm. high.—*N. A.*; *Soochow*: 7-xii-15.

[3] *Phil. Trans. Roy. Soc.*, CLXXX (B), p. 297 (1889).

large forms, such as the species of *Ostrea*, *Meretrix*, *Tapes* and *Standella*, occur in the outer channel and in some cases make their way in small numbers into the northern part of the main area. The only species of even moderate dimensions that occur in the southern part of this area are, however, the almost extinct *Arca granosa* and the species of *Modiola* and *Anatina*.

It is only in a few cases that it is possible to compare individuals from the lake with those from more favourable localities, but in those instances in which this can be done, as in *Modiola striatula*, *Arca granosa* and *Nassa orissaënsis*, a distinct dwarfing can be detected. In *Arca granosa* all individuals are affected in the same way, and the dwarfing may be due entirely to changes in salinity, while in *Modiola striatula* different individuals are influenced in different ways and other causes, such as confined position and periodic desiccation, seem sufficient to account for the results observed (see pp. 362, 363). We have provisionally accepted Mr. Preston's identification of the small *Solen* common in the lake on a muddy bottom as *S. fonesi*, Dunker. If this be correct, the race is evidently dwarfed, for shells of sexually mature individuals are always under 30 mm. in length, whereas specimens of nearly 6 cms. have been found in the sea. Shells from the lake are relatively much broader than any of those noticed by von Martens, who remarks that larger shells are proportionately narrower than smaller ones. *Nassa orissaënsis* is represented in backwaters near Madras and also in canals of brackish water in the Gangetic delta by a form (var. *ennurensis*, Preston) with a considerably larger and more deeply sculptured shell; but it is difficult to see in what respects the conditions in these localities are more favourable.

None of the shells from the lake, with the exception of those of *Modiola*, are brilliantly coloured and dense pigmentation is the exception rather than the rule. Its absence is particularly noteworthy in the Lamellibranchs, among which colourless forms such as the species of *Kellya*, *Clementia*, *Petricola*, *Diplodonta*, *Psammobia*, *Standella*, *Theora*, *Cumingia*, *Cuspidaria*, *Lyonsia* and *Anatina*, greatly predominate. Among the Gastropods the commonest colours are dull brown and dull green, as in *Vanesia*, *Litiopa*, *Nassa*, *Stenothyra* and *Potamides*. The number of colourless species is comparatively small, comprising those of *Tornatina*, *Pyrgulina* and *Chrysallida*. The only species in which well-defined and conspicuous markings occur on the shell[1] are *Neritina souverbiana*, *Tinostoma variegatum* and *Umbonium vestiarium*; even in these the markings are almost microscopic. The only mollusc in which the living tissues are brilliantly coloured is *Scintilla chilkaënsis*, in which the mantle is yellow and orange.

In the absence of bright colours the fauna resembles that of fresh water and differs from that of the coast immediately outside the lake, where brilliantly painted species such as *Siliqua radiata*, *Eburna* and *Sunetta scripta* are abundant. The complete lack of colour in many of the Lamellibranchs is doubtless correlated with their burrowing habits.

It is among the Lamellibranchs also that thinness of shell is most noteworthy.

[1] Young shells of *Meretrix ovum* are marked with radiating lines of conspicuous brown spots, but these practically disappear in adults.

Such forms as those of *Kellya*, *Scintilla*, *Diplodonta*, *Solen*, *Standella*, *Theora*, *Cumingia*, *Cuspidaria*, *Lyonsia* and *Anatina* are remarkable in this respect, while the shell of the *Clementia* is so fragile that we had great difficulty in preserving perfect specimens. Thick-shelled species such as those of *Arca*, *Meretrix* and *Tapes* are few and have almost completely disappeared from the main area. Except possibly in the case of *Modiola*, we have, however no evidence that individuals from the lake have thinner shells than those of the same species living elsewhere. Among the Gastropods, *Thais* and *Potamides* are exceptional in the thickness of their shell; there is no form comparable in the opposite direction to *Clementia*.

The thinness of shell in the lake species can hardly be due to lack of dissolved calcareous matter, for considerable quantities of *kankar*' (nodular concretions of carbonate of lime) are dug from the bed of the lake when the level of the water is low. In the case of many of the Lamellibranchs (*e.g. Clementia* and *Theora*) it is associated with life in peculiarly soft and adhesive mud, through which the animals progress with considerable rapidity. It is noteworthy, moreover, that all the thick-shelled burrowing Mollusca found in the lake inhabit sand or sandy mud and that there is no evidence that the shells of such forms are thinner than those found in pure salt water.

These facts are of some interest because instances are well known in the Baltic and elsewhere, in which the shells of marine species related to the Chilka forms become greatly attenuated in brackish water. Gibbons[1] has, however, pointed out that though this is the general rule, the shells of true brackish water species may tend to become thicker in correlation with decrease of salinity.

We have already alluded to the fact that, especially in the main area, a comparatively small number of species predominate greatly in respect to number of individuals. It is probable that if a census of the Mollusca of the main area could be taken, the great majority would fall into some eight or nine species and some half dozen genera. This feature is also characteristic of other groups of animals found in the lake and, indeed, generally of animals living in abnormal conditions.

LIST OF SPECIES.

Class GASTROPODA.

Order *OPISTHOBRANCHIATA*.

Family Tornatinidae.

Tornatina estriata, Preston, 1914, p. 303, figs. 7, 7*a*; 1915, p. 297; 1916, p. 27 (as *Retusa*); syn. *T soror*, Preston, 1914, p. 303, figs. 8, 8*a*.

This is one of the commonest Gastropods on a muddy bottom in both sections of the lake-system. Shells from the outer channel tend to be a little larger than those from the main area and to have a less ovately cylindrical form. Mr. Preston separated the latter under the name *T soror* in 1914, but has now found inter-

[1] Gibbons, *Quart. Journ. Conch.*, I, p. 339 (1878.)

mediate specimens in our collection and regards this name as a synonym. The species is found in a living condition at all seasons of the year, but at the end of the freshwater season dead shells are extremely abundant. *T estriata* has also been found in backwaters on the west coast of India.

Family **Bullidae.**

Bulla (Haminea) crocata, Pease, *Proc. Zool. Soc. London*, 1860, p. 19.

This species, which is common among weeds in the backwaters near Madras, does not appear to have become thoroughly acclimatized in the Chilka Lake. Dead shells, some of which contained remains of the soft parts, were found among drift weed on the shore at Satpara in September, and a single small but apparently full-grown living individual was taken in the same month in Seruanaddi. A dead and much eroded shell was found on the shore of Barhampur I. in March.

Our largest shell is about 14 mm. long, but the one from Seruanaddi is less than 5 mm. long. We have discussed the significance of these facts on p. 337.

The species was described from the Sandwich Is., where it was found "usually on sand-flats, but occasionally on seaweed." It was noted by Pease that shells were much more abundant on the leeward than on the windward islands.

Order *PROSOBRANCHIATA.*

Family **Nassidae.**

This family is represented by five species of the genus *Nassa*, all of which are small, none exceeding 16 mm. in length. Only two of the species, *N. orissaënsis* and *N. denegabilis*, are widely distributed in the main area, but *N. labecula* is not uncommon on sandy ground at Nalbano. The other two were taken on a few occasions in the outer channel. The shells were frequently inhabited by the hermit-crabs *Diogenes avarus* and *Coenobita cavipes.*

Nassa sistroidea, G. and H. Nevill, *Journ. Asiat. Soc. Bengal* (2), XLIII, p. 24 pl. i, fig. 6 (1874).

A few living specimens of this species were taken in the outer channel in March and September. *N. sistroidea*, which was described from the Andamans, is probably only an occasional visitor from the sea, though it is apparently able to survive the freshwater season.

Nassa labecula, A. Ads., *Proc. Zool. Soc. London*, 1851, p. 98.

This species is common in the outer channel at all times of the year and was found in abundance with *Potamides fluviatilis* on the shore of Nalbano in March. It is apparently an arenicolous form.

Nassa marrattii, Smith, *Journ. Linn. Soc., Zool.*, XII, p. 543, pl. xxx, fig. 4 (1876).

A single shell was dredged, in a fresh condition, in the outer channel off Satpara Point in September. The species, which has been recorded from the western Pacific,

the Malay Archipelago, the Andamans and the Maldives, is perhaps a casual visitor but the shell may have been brought from the sea by a hermit-crab.

Nassa denegabilis, Preston, 1914, p. 297, fig. 9; 1915, pp. 290, 480; 1916, p. 28.

This species occurs all over the lake-system on a bottom of mud or muddy sand. The type, which was named, but not described by the late Mr. G. Nevill, is in the British Museum. *N. denegabilis* is found at all times of the year in an active condition. The species is evidently common in estuaries and backwaters on the Indian coasts.

Nassa orissaënsis, Preston, 1914, p. 299, figs. 10, 10*a*; 1915, p. 290.

This is perhaps the commonest and most widely distributed Gastropod in the main area and in the inner part of the outer channel, occurring on a muddy bottom usually among weeds. When placed in a dish of water, specimens often float shell downwards adhering to the surface film by means of the expanded foot. The foot does not conform to the description of the genus given by Fischer[1], for the two posterior lobes, instead of being produced and pointed, are very short, broadly rounded and separated merely by a shallow notch (see fig. 1). This peculiarity may be correlated with the softness of the mud on which the animal frequently crawls. We are under the impression that the foot of *N. denegabilis* is similar, but have no definite note on the subject.

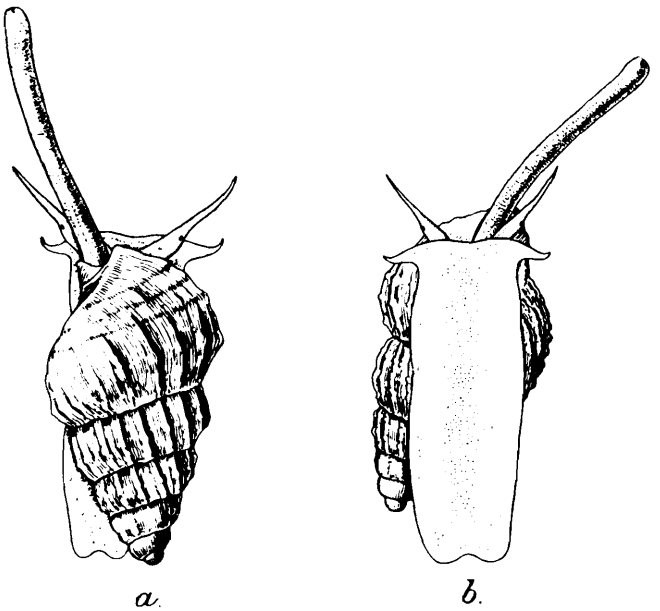

FIG. 1.—*Nassa orissaënsis*, Preston.
Living specimens: *a*, from above: *b*, from below.
(*From sketches made by Mr. G. M. Henry.*)

N. orissaënsis is represented in the Madras backwaters and in canals of brackish water at Calcutta by a large and well-developed variety (var. *ennurensis*, Preston, *Rec. Ind. Mus.*, 1915, p. 479; 1916, p. 28, fig. 2).

Family **Muricidae.**

Thais carinifera (Lam.), Reeve, *Conch. Icon.*, III, *Purpura*, pl. vi, fig. 26 (1845).

In the main area of the lake this species is confined to the rocks at the southern end and to the islands south of Kalidai. It was also found in the outer channel in the salt-water season, but was apparently unable to live in pure fresh water and is not found on the rocks near Patsahanipur. On the oyster-beds at Manikpatna it is fairly abundant in March, but in other places is usually found crawling on rocks. A few

[1] *Manual de Conchyliologie*, p. 633, fig. 389, Paris, 1887.

living individuals were dredged in the middle of the southern part of the lake, perhaps making their way from one set of rocks to another.

T carinifera is the only Gastropod obtained in the main area whose shell is of any considerable size; the range of the hermit-crabs of the genus *Clibanarius* is therefore co-terminous so far as the main area is concerned with that of *Thais*. The boring sponge *Cliona vastifica* sometimes attacks living shells and the Polyzoa *Alcyonidium mytili* and *Membranipora hippopus* are sometimes found on its surface.

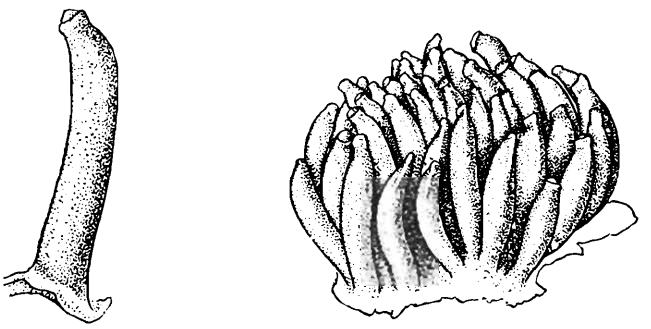

Fig. 2.—*Thais carinifera* (Lam.).

A cluster of egg-capsules (× $2\frac{3}{4}$), with a single capsule more highly magnified.

Eggs, of which we figure a cluster, were observed on the rocks at Ganta Sila in February and on oyster-shells at Manikpatna in March. They were of a dirty yellowish colour when living, but their contents became deep purple when they were placed in alcohol.

Family **Cerithiidae.**

Potamides (*Tympanotonos*) *fluviatilis*, Pot. and Mich., *Gal. de Moll.*, p. 363, pl. xxxi, figs. 19, 20; 1838 (as *Cerithium*).

P. fluviatilis occurs in great abundance along the outer shore of the main area, at Nalbano and in the outer channel. A few specimens were also seen in a small ditch opening into Rambha Bay; but the species is very scarce along the inner shore of the main area. It seems to prefer a bottom of sand or sandy mud and to be able to endure temperatures that are fatal to most other species; it occurred in enormous numbers near the mouth of the outer channel in the freshwater season. Its shell is very commonly occupied by the hermit-crab *Diogenes avarus* and living individuals were occasionally found to which young oysters (*Ostrea* sp.) or small examples of a barnacle (*Balanus amphitrite*) were attached. The hydroid *Clavactinia gallensis* was found on several shells occupied by hermit-crabs, while others, still occupied by their proper owners, were covered by the Polyzoon *Alcyonidium mytili*.

The species is widely distributed in the Indian Ocean and the western parts of the Pacific, occurring usually in brackish water; but according to Mr. Townsend is a distinctly marine form in the Persian Gulf.[1] It was described from the Malabar Coast.

Potamides (*Telescopium*) *fuscum*, Schum., Reeve, *Conch. Icon.*, XV, fig. 1 (1866).

Living specimens were common on some of the islands in the outer channel in March. They appeared to be comatose and many of them were half buried in

[1] See Melvill and Standen, *Proc. Zool. Soc. London*, 1901, p. 375.

caking mud. No specimens were seen in the freshwater season. Mr. Townsend draws attention to the tenacity of life exhibited by this mollusc.[1]

The species is abundant in mangrove swamps on the coasts of India and the Malay Archipelago: in the Gangetic delta the shell is one of those most commonly used for making lime. Dead shells in the outer channel of the Chilka Lake were sometimes occupied by the hermit-crab *Clibanarius padavensis*.

The distribution is similar to that of the former species.

Family **Turritellidae**.

Vanesia rambhaënsis, Preston, 1914, p. 297, figs. 5, 5*a* (as *Terebra*); 1915, p. 289; 1916, p. 32.

V. rambhaënsis is widely distributed on the bed of the main area of the lake and was also taken at the inner end of the outer channel. Although it was originally described from a single specimen the species appears to be gregarious. It was found in large numbers among dead vegetation in Madarchua Bay at the south end of the lake in July. We obtained no specimens in the outer channel in the salt-water season. The species is also known from the Cochin backwaters.

Family **Fossaridae**.

Chilkaïa imitatrix,* Preston, 1915, p. 291, figs. 1, 1*a*.

Four specimens, including the type of the genus and species, were taken in the inner part of the outer channel in September. Preston remarks on the superficial resemblance of the shell to that of certain forms of *Paramelania* characteristic of the fauna of Lake Tanganyika; but there can of course be no real affinity. The species is evidently very scarce.

Family **Litiopidae**.

Litiopa (*Alaba*) *kempi*,* Preston, 1914, p. 300, figs. 3, 3*a*; 1915, p. 292.

This species occurs sparingly all over the main area of the lake and was found in the outer channel in the freshwater season. It lives among weeds on either a sandy or a muddy bottom.

Litiopa (*Alaba*) *copiosa*,* Preston, 1915, p. 292, figs. 2, 2*a*.

L. copiosa was found in enormous numbers at both seasons of the year in the channels between Barnikuda and Satpara, between the latter place and Mahosa and in Seruanaddi. It also occurred more sparingly in the neighbourhood of Nalbano.

Family **Hydrobiidae**.

This family is represented by one species of *Hydrobia* and six forms of *Stenothyra*, all of which Mr. Preston regards as distinct species. Eleven Indian species of *Stenothyra* are now recognized by him[2], most of which were described from brackish water. It seems not improbable to us that, when large series from different localities

[1] See Melvill and Standen, *Proc. Zool. Soc. London*, 1901, p. 375.

[2] *Faun. Brit. Ind., Freshwater Mollusca*, p. 79 (1915) and *Rec. Ind. Mus.*, XII, p. 31 (1916).

are compared, the number will suffer reduction. It is noteworthy that we found no specimens of *Hydrobia myliacea* or *Stenothyra blanfordiana*, both of which were recorded many years ago from the Chilka Lake and are abundant in other localities. Unfortunately we have no information as to the part of the lake in which they were found.

Hydrobia and *Stenothyra* are the only genera of Molluscs represented in the fauna of the lake that can be said to have limnic affinities.

Hydrobia (*Belgrandia*) *myliacea*, Nevill, *Journ. As. Soc. Bengal* (2), XLIX, p. 161 and L, p. 158, pl. vii, fig. 7 (1880-1881).

Nevill records from the Chilka Lake specimens of a form of this species to which he gave, without description, the name "subvar. *subangulata*." Both this form and the typical one were found at Port Canning in the Gangetic delta.

Stenothyra blanfordiana, Nevill, *Journ. As. Soc. Bengal* (2), XLIX, p. 160 (1880) and L, p. 156, pl. vii, fig. 10 (1881).

This species, which was not recognized by Mr. Preston among the specimens we sent him from the Chilka Lake, was described from it by Nevill in 1880. The same author also recorded the species from Port Canning in the Gangetic delta and from Madras. He noted that specimens from the former locality agreed more closely with individuals from the lake than did those from Madras. In parts of the Gangetic delta it is very abundant among weeds.

Stenothyra minima (Sowerby), Preston, *Faun. Brit. Ind., Freshw. Moll.*, p. 81 (1915).

We found this species common among weeds in both parts of the lake-system on both a muddy and a sandy bottom and at all times of the year. It was originally described from western India.

Stenothyra chilkaënsis,* Preston, 1914, p. 300, fig. 1; 1915, p. 293.

S. chilkaënsis is even more common in the lake than the preceding species, together with which it occurs.

Stenothyra orissaënsis,* Preston, 1914, p. 300, fig. 2; 1915, p. 293.

This form occurs with the two preceding; it is perhaps no more than a variety of *S. chilkaënsis*.

Stenothyra trigona,* Preston, 1915, p. 293, fig. 3.

Occurred with the preceding species, but was not found in the outer channel in the salt-water season.

Stenothyra obesula,* Preston, 1915, p. 293, fig. 4.

S. obesula is represented in our collection by a single specimen only; it was obtained in the outer channel in the freshwater season on a bottom of muddy sand.

Family **Scalariidae.**

Epitonium hamatulae,* Preston, 1915, p. 294, fig. 5.

A single dead shell of this species (the type) was found in the outer channel off Barhampur I. in the freshwater season. Its small size renders its introduction by a

hermit-crab improbable and we may suppose that the species is a marine one that occasionally enters the channel in the salt-water season.

Family **Pyramidellidae.**

Pyrgulina humilis (Preston), *Journ. Malacol.*, XII, p. 6, pl. ii, fig. 27; 1905 [as *Pyramidella* (*Mormula*)]; 1915, p. 294 [as *Chrysallida* (*Mormula*)]; 1916, p. 32.

P. humilis, with its variety *chilkaënsis*, Preston (*loc. cit.* 1915) was found in large numbers in the outer channel at all times of the year. A few specimens were also taken S. of Kalidai and off Nalbano. The variety appears to be more common, at any rate in July, than the typical form.

Chrysallida (*Mormula*) *ecclesia*,* Preston, 1915, p 295, figs. 7, 7*a*.

A single living specimen was taken in Madarchua Bay at the south end of the lake in July.

Chrysallida (*Mormula*) *nadiensis*,* Preston, 1915, p. 296, figs. 8, 8*a*.

This species was only found in the outer channel in the freshwater season; it is, however, very scarce and probably occurs at all times of the year in this part of the lake.

Odostomia chilkaënsis,* Preston, 1914, p. 301, fig. 4; 1915, p. 296.

Only two specimens were obtained, both in the outer channel, one at Manikpatna in March and one near Mahosa in September; the latter, however, was a dead shell.

Family **Neritidae.**

Neritina (*Theodoxus*) *souverbiana*, Montrouzier, Montr. and Souverb., *Journ. Conch.* (Paris), XI, pp. 75, 175, pl. v, fig. 5 (1863).

Specimens were found in the outer channel both in March and in September; they were common near Mahosa in the freshwater season, living among weeds. The species, which was described from the China Sea and New Caledonia, is apparently a marine one that in the sea lives among algae.

Family **Cyclostrematidae.**

Cyclostrema (*Tubiola*) *innocens*,* Preston, 1915, p. 296, figs. 9, 9*a*, 9*b*.

A single dead shell (the type of the species) was obtained in Seruanaddi in the freshwater season.

[The shell described by G. Nevill[1] as *Valvata*? *microscopica*, of which we have examined a long series of co-types, clearly belongs to the same genus as *C. innocens*. It appears to differ from that species only in its smaller size, reddish colour and in the sculpture on its surface; but the type of Preston's species is bleached and perhaps somewhat eroded. We figure (fig. 3) one of the co-types of Nevill's species.]

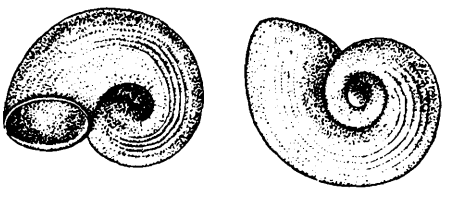

FIG. 3.—*Cyclostrema microscopica* (Nevill).

[1] *Cat. Moll. Ind. Mus.*, fasc. e, p. 21 (1877).

Tinostoma variegatum,* Preston, 1914, p. 302, figs. 6, 6*a*, 6*b*.

A few specimens (including the type) were obtained at Manikpatna in the outer channel in March.

Family **Trochidae.**

Umbonium vestiarum (Linn.), Preston, 1915, p. 297.

Several specimens were found in the outer channel in the salt-water season on sandy ground near the mouth of the lake.

Solariella satparaënsis,* Preston, 1914, p. 302, figs. 11, 11*a*, 11*b*; 1915, p. 297.

This species occurs in the outer channel in the vicinity of Satpara and Barhampur I. at all times of the year, but is rather scarce.

Class **LAMELLIBRANCHIATA.**

Order *TETRABRANCHIATA.*

Family **Ostreidae.**

Ostrea virginiana, Gmelin, Reeve, *Conch. Icon.*, XVIII, *Ostrea*, pl. vi, fig. 9; 1873 (as *O. rostrata*). Plate xiv, fig. 2.

We have already discussed the beds formed by this oyster in the outer channel of the lake (p. 336). It is an extraordinarily hardy species and can endure desiccation, even when exposed to a tropical sun, for considerable periods as well as immersion in fresh water. We have also observed it living in similar conditions in backwaters near Madras, at the head of Port Blair harbour in the Andamans and in a lagoon on the Gulf of Siam.

We have to thank Mr. E. Vredenburg of the Geological Survey of India, who is engaged in a study of the oysters of this group, for the information embodied in the following note.

The specimens from the four localities referred to above seem to belong to a smaller race of a very large oyster (probably the largest living species) which is known to occur abundantly at many points along the south coasts of Asia, from the Mekran to the Malay Peninsula. Mr. Vredenburg is of opinion that, taking into account the variability in the shape of oysters generally, it is not possible to discover in the shape, the build, the ornamentation, the proportions or the dimensions of these shells, any differences sufficiently precise to afford an excuse for separating the form specifically from *Ostrea virginiana*, Gmelin, a very common shell along the Atlantic coast of North America. The species seems to be practically cosmopolitan throughout the warmer seas.

Certain forms occurring in the Bay of Bengal, including that named *O. gryphoides* var. *cuttackensis* and found on the Orissa coast, were separated from *Ostrea virginiana* by Messrs. Newton and Smith (*Rec. Geol. Surv. Ind.*, XLII, pp. 1-15; 1912) (*a*) on account of differences in shape or build which Mr. Vredenburg considers inadequate for specific distinction in such variable organisms, and (*b*) on account of the absence of the deep purple-black or purple-brown colour which, in North

American shells, suffuses parts of the valves, especially the muscular scar. This pigment is certainly absent in the large variety from Cuttack, but it is developed[1] to a most pronounced degree in the specimens which we have lately obtained from the Chilka Lake, the Andamans, Madras and Siam. The absence or presence of the colour is probably due to circumstances of environment. Amongst many species of *Ostrea* the colour is very variable.

The Cuttack shell is regarded by Newton and Smith as specifically identical with a fossil form from the miocene of Europe, *Ostrea gryphoides*, Schlotheim (better known as *Ostrea crassissima*, Lamarck) the close affinity of which to the species living along the coast of North America has been commented upon by every palaeontologist who has had occasion to deal with the form. In most instances specific identity between the fossil form and the living *Ostrea virginiana* has not been admitted. The identity would, nevertheless, have to be conceded, if, on the one hand, we accept Mr. Vredenburg's identification of the living Indian shell with the North American *Ostrea virginiana*, and, on the other hand, Messrs. Newton and Smith's reference of the living form to a miocene species. Mr. Vredenburg, while admitting that there exists the closest relationship between the living and tertiary forms, is not prepared to admit actual specific identity without further research. In any case, as regards nomenclature, if the identity of the Indian and American species is accepted, the specific name *virginiana* is older than any of the others bestowed upon its fossil relatives.

Mr. Preston regards the small Indian form with deep pigmentation of the inner surface as specifically distinct and has described it under the name *O. madrasensis*.[2]

Ostrea lentiginosa, Sowerby, Preston, 1910, p. 36.

A few shells of this species from Manikpatna have been identified by Mr. Preston.

Ostrea cucullata, Born, *Test. Mus. Caesarei Vindobon.*, p. 114, pl. vi, figs. 11, 12 (1780).

Individuals of this common oyster are sometimes found attached to clumps of *O. virginiana* on the beds at Manikpatna (see pl. xiv, fig. 2).

Ostrea sp.

Several shells of a flat circular form were found attached to the post in the channel off Satpara to which reference has already been made. Unfortunately they have been mislaid, but there can be no doubt that they represent a species different from any of those recorded above.

Family **Mytilidae**.

Mytilus smaragdinus, Chemnitz, Reeve, *Conch. Icon.*, X, *Mytilus*, pl. vii, fig. 28 (1858).

A single small shell, in a fresh condition but empty, was found on the oyster-beds at Manikpatna in fresh water. The animal had evidently entered the lake in a larval condition, but had been unable to survive the floods. The species is very com-

[1] The corresponding soft parts of the animal are similarly pigmented.

[2] *Rec. Ind. Mus.*, XII, p. 33, figs. 11, 11*a* (1916).

mon on the east coast of India and grows in great luxuriance on the stone-work of Madras Harbour. The distribution extends from Hong Kong to the Arabian Sea.

Modiola undulata (Dunker). *See* p. 358.

Modiola striatula, Hanley. *See* p. 360.

Family **Arcidae.**

Arca (*Anadara*) *granosa*, Linn., Lamy, *Journ Conch.*, LV, p. 210 (1907). Plate xvi, figs. 3-6.

Shells are abundant in a subfossil condition at the head of Rambha Bay, on Barkuda I. and at many other places in both parts of the lake; but the animal is extremely scarce in a living condition. Living and fresh specimens with the epidermis still complete were taken on only three occasions,—off Samal I., off Kalidai and near Barkul, in March and September. The largest of these is only 26 mm. in breadth, whereas a large shell from the Nicobars exceeds 75 mm. The subfossil specimens are intermediate in size, not exceeding 50 mm., while shells of about this size were seen with the epidermis still present in the outer channel in March.

We have referred above (p. 339) to von Neumayer's observations on a dwarfed form of this species that occurs in a subfossil condition in the Yang-tse-Kiang delta. *A. granosa* is frequently found living in brackish water on the coasts of India and Malaysia, but the larger specimens in the Indian Museum all seem to come from marine localities. It may therefore be assumed that dwarfing is correlated in this species with decrease in the salinity of the water; in the Chilka Lake the process seems to have been progressive and to have commenced while the south end of the lake was still in communication with the sea. The case is one of the best illustrations with which we have met, of the gradual change that has taken place in the fauna of the lake in the course of its comparatively short geological history.

The species has a distribution extending from the Arabian Sea to Japan and Australia.

Arca (*Fossularca*) *lactea*, Linn., Lamy, *Journ. Conch.*, LV, p. 97 (1907).

A few living specimens were dredged in the channel between Satpara and Barhampur I. in March and a dead shell was taken at the same locality in September. They occurred on a bottom of muddy sand. It seems probable that the species is killed off annually towards the close of the monsoon by the irruption of fresh water. *A. lactea* is a common European and E. Atlantic mollusc and has been recorded from Ascension I., S. Africa, the Red Sea and various Indian localities; also somewhat doubtfully from the Philippines.

Family **Erycinidae.**

Kellya chilkaënsis,* Preston, 1915, p. 298, figs. 10, 10*a*.

This species is apparently scarce, but living specimens were found in both parts of the lake,—near Kalidai and Patsahanipur in March and in the inner part of the outer channel, both in this month and in September.

Kellya mahosaënsis,* Preston, 1915, p. 298, fig. 11.

K. mahosaënsis is represented in our collection by the type specimen only, a minute shell found with typical *K. chilkaënsis* in the outer channel.

Family **Galeommidae.**

Scintilla chilkaënsis,* Preston, 1915, p. 299, figs. 12, 12*a*.

S. chilkaënsis was not uncommon near Satpara and Barhampur I. in the freshwater season on a bottom of mixed sand and mud, but was not found in salt water.

The mantle closely resembles that of *S. hydatina*, Deshayes, as figured by Lynge[1]; the papillae on its margin being long and finger-shaped. The mantle was yellow and the tentaculiform marginal papillae were pale with deep orange tips, those of *S. hydatina* being described as deep red.

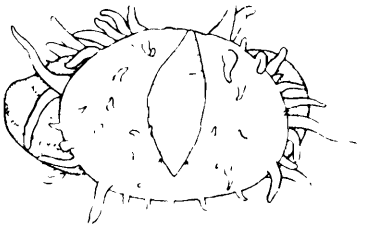

FIG. 4.—*Scintilla chilkaënsis*, Preston.

Specimen with mantle expanded, covering the greater part of the shell (from an example preserved in spirit).

Family **Cardiidae.**

Cardium (*Fulvia*) *rugatum*, Gron., Reeve, *Conch. Icon.*, II, *Cardium*, pl. xii, fig. 63 (1843).

A few young molluscs of this species were taken just inside the mouth of the lake in salt water. *C. rugatum*, like *Mytilus smaragdinus*, is doubtless an occasional visitor to the outer part of the lake-system in the salt-water season.

Family **Veneridae.**

This family is represented by no less than seven species (four genera), but only one form, *Clementia annandalei*, now occurs living in the main area of the lake. At least one other, *Meretrix casta*[2], is abundant in a subfossil condition at the head of Rambha Bay and on Barkuda I.

Meretrix meretrix (Lam.), Reeve, *Conch. Icon.*, XIV, *Cytherea*, pl. iii, fig. 10; 1864 (as *C. impudica*).

Common in the outer channel.

Meretrix casta, Chemn., Reeve, *Conch. Icon.*, XIV, *Cytherea*, pl. vii, fig. 25 (1864); syn. *Corbicula* (*Velorita*) *satparaënsis*, Preston, 1914, p. 306, fig. 22.

Blanford[3] states that this species is characteristic of estuarine waters on the Indian coasts. It is still fairly common in the outer channel of the Chilka Lake, where it buries itself in a bottom of mixed sand and mud, and probably occurs

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[1] *Danske Vid. Selsk. Skr.* (7), *nat. og math.*, V, iii. p. 186 (1909).

[2] There seems to be great confusion as to the Indian species of this genus and it is possible that a further systematic study will considerably alter the synonymy at present accepted.

[3] *Rec. Geol. Surv. Ind.*, V, p. 61 (1872).

throughout the year. Its habits render it difficult to obtain except when the water is low. Both young and old individuals were found.

Meretrix ovum, Hanley, Reeve, *Conch. Icon.*, XIV *Cytherea*, pl. vi, fig. 19 (1864).

This species is more common than the preceding in the outer channel, both young and old individuals occurring in great abundance on the same ground and also on clear sand nearer the mouth of the lake. *M. ovum* was described from Malabar.

Tivela dillwyni (Deshayes), Reeve, *Conch. Icon.*, XIV, *Cytherea*, pl. vii, fig. 24 (1864).

A single small living specimen was obtained in Seruanaddi in the freshwater season.

Tapes pinguis, Chemn., Mart. and Chemn., *Conch. Cab.*, *Veneracea*, p. 126, pl. v, figs. 3-5, 8-10; 1869 (as *Vernes*).

The species is fairly common in the outer channel with *M. casta* and *M ovum* in March and probably at other times of the year.

Tapes ceylonensis, Sowerby, Mart. and Chemn., *Conch. Cab.*, *Veneracea*, p. 236, pl. xl, figs. 10, 11 (1869).

The same remarks apply to this species as to the last.

Clementia annandalei, Preston, 1914, p. 306, figs. 14, 14*a*, 14*b*; 1915, p. 301.

All over the main area of the lake this is one of the commonest molluscs, occurring in mud with *Theora opalina*. In the inner part of the outer channel it is less abundant, its place being taken to some extent by species of *Diplodonta*. Living individuals were dredged at all times of the year, but it was noticed that dead shells were relatively very abundant at the end of the freshwater season. The shell is so brittle that it is difficult to obtain perfect specimens, but is much less transparent than that of the *Theora*.

The species also occurs at Port Canning in the Gangetic delta and has long been represented in the collection of the Indian Museum by large numbers of specimens from this locality labelled with the *nomen nudum* "*Clementia blanfordii*, Benson." The genus is characteristic of estuarine waters in the tropics of Africa and Asia.

Family **Petricolidae.**

Petricola esculpturata,* Preston, 1915, p. 301, figs. 13, 13*a*.

This mollusc was found only in crevices between oyster-shells on the beds at Manikpatna in the outer channel. It was obtained both in fresh and in salt water.

Family **Ungulinidae**

Only two of the five species of *Diplodonta* by which this family is represented were found in the main area of the lake. Considering the fact that several species are known from the Gulf of Siam, all of which have a wide Oriental distribution, it is remarkable that all the Chilka forms should prove to have been undescribed. The first three species in the following list seem to prefer a bottom of sandy mud, but *D. ovalis* and *D. chilkaënsis* live chiefly on clean sand.

Diplodonta satparaënsis,* Preston, 1915, p. 302, figs. 14, 14*a*, 14*b*.

Dead shells of relatively large size were abundant in the inner part of the outer channel at all times of the year. A few living specimens of smaller size were taken in this channel in the salt-water season, and at the same season a few small living individuals were found near Kalidai I.

Diplodonta barhampurensis,* Preston, 1915, p. 302, figs. 15, 15*a*.

Represented only by a pair of empty valves (the type) taken in the inner part of the outer channel in the freshwater season.

Diplodonta (*Felania*) *annandalei*,* Preston, 1914, p. 307, figs 20, 20*a*, 20*b*; 1915, p. 303.

An abundant species at the inner end of the outer channel and also found in the main area in the neighbourhood of Nalbano, off Patsahanipur, near Kalidai and at Maludaikuda. As is the case with *D. satparaënsis*, living specimens were found only in the salt-water season, while fresh but empty shells were obtained in fresh water in September.

Diplodonta (*Felania*) *ovalis*,* Preston, 1914, p. 308, figs. 19, 19*a*, 19*b*; 1915, p. 303.

A few individuals were found at Manikpatna and near the mouth of the lake, while one was taken in the inner part of the channel near Barhampur I. No specimens were obtained in the freshwater season.

Diplodonta (*Felania*) *chilkaënsis*,* Preston, 1914, p. 308, figs. 21, 21*a*, 21*b*; 1915, p. 303.

Except for one living specimen taken on the southern side of the Satpara peninsula, all our examples of this species, which are not numerous, were obtained towards the seaward end of the outer channel on clean sandy ground. A single living individual was found with a number of dead shells in September, 1913. Most of the shells dredged in the freshwater season were dead.

Family **Psammobiidae.**

Psammobia mahosaënsis,* Preston, 1915, p. 303, figs. 16, 16*a*, 16*b*.

This species is not uncommon in the inner part of the outer channel. Living individuals were found in both the salt and the freshwater season.

Family **Solenidae.**

In the Chilka Lake we found three forms of *Solen* that must be provisionally regarded as distinct species, but we believe that until the anatomy of the Oriental forms of the genus has been investigated, it will remain impossible to assign specific limits with any degree of certainty. Our reason for making this statement is the fact that in the collection of the Indian Museum, only a small proportion of which is named so far as this genus is concerned, we find many forms that seem to grade one into the other. Moreover at several localities on the Indian coasts pairs of forms occur, resembling one another closely except in the proportions of their shell, the relative dimensions being less different at some places than at others. Two forms of this

kind, which Mr. Preston has called *S. annandalei* and *S. kempi* occur in the outer channel of the lake and at Nalbano, while a third (*S.* ? *fonesi*) which is relatively shorter than either, is one of the most abundant species of Lamellibranchs in the main area. Shells of the two former are found together and both would seem to burrow only in sandy ground, whereas the third is essentially an inhabitant of soft mud. *S. annandalei* and *S. kempi* are comparatively scarce and, with the exception of a single small specimen of the latter, are represented in our collection by dead shells only. Dr. Ekendranath Ghosh describes the general structure of *S.* ? *fonesi* in considerable detail in the appendix on pp. 367-374.

? *Solen fonesi*, Dunker, Preston, 1916, p. 37; syn. *S. truncatus*, Preston, 1914, p. 309. Plate xvi, fig. 7.

In his paper of 1914 Mr. Preston regarded this shell as a young form of *S. truncatus*, Wood, which it resembles in outline. Many sexually mature individuals were, however, found that were no larger than those examined by him.

We obtained in the Chilka Lake no shell more than 28·5 mm. long and, in a series of specimens that we have measured, we find that the length varies from $3\frac{1}{3}$ to a little more than $3\frac{1}{2}$ times the breadth.

Von Martens[1], who regards *S. fonesi* as synonymous with *S. woodwardi*, Dunker, notes that Dunker's specimens were from 51 to 53 mm. long and 11 to 12 mm. broad; Reeve's figure is 59 mm. long and 12 mm. broad. Von Martens concludes that small specimens are about $4\frac{1}{2}$ times as long as broad, and larger ones as much as 5 times. If Mr. Preston's identification is correct, the Chilka race is evidently a dwarfed one.

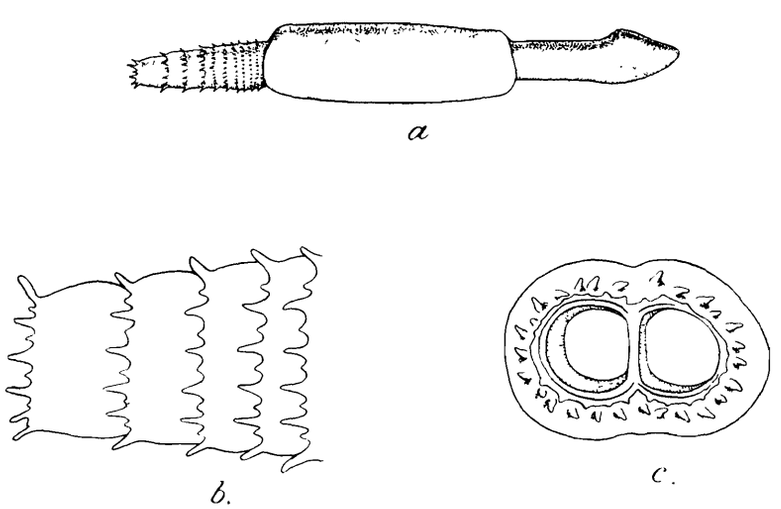

FIG. 5.—Chilka race of *Solen* ? *fonesi*, Dunker.

a. A living specimen, slightly enlarged, with extruded foot and siphon.
b. A portion of the siphon, more highly magnified, lateral view.
c. A cast-off section of the siphon, end view.

The question of proportions in this and closely allied species is, however, one of great difficulty. Three valves found on a sandy beach at the mouth of the Ennur backwater near Madras and identified by Mr. Preston as *S. fonesi*, are respectively about 86, 72 and 71 mm. long. The first of these is $5\frac{3}{4}$ times as long as broad and the other two about $4\frac{1}{2}$ times—measurements and proportions that do not by any means tally with those given by von Martens.

[1] Weber's *Zool. Ergebn. Ned. Ost.-Ind.*, IV, p. 270 (1897).

For the greater part of the year the little *Solen* is extremely abundant in the lake and numbers were brought up in most hauls of our nets. Even when the shells were absent, the peculiar siphons to which we refer below were often found. At the end of the wet season, however it was difficult to obtain living specimens, and only a few were seen at this time of the year.

The animal excavates, in the ordinary manner a vertical burrow that is not very much deeper than its own length, inserting its foot into the mud in a contracted condition and then expanding it so as to force an entrance. If laid on its side it can right itself instantaneously by turning its foot round at an angle and thus getting a purchase on the bottom. It can dart rapidly for some inches backwards by squirting water from its siphon and can also swim forwards with moderate ease, compressing its foot laterally and using it as a paddle.

The most remarkable feature in the structure of the species lies in the great development of the siphons, in their very distinct segmentation, in the arrangement by which the segments are thrown off either singly on in groups by a process of autotomy, and in the existence of a ring of minute tentacles round the distal end of each segment. Apart from the actual shortening effected by the autotomy of one or more segments, it produces no apparent structural or functional disablement of the siphons, and if, as seems not improbable, the tentacles have a sensory function, the new tip is as well equipped as the old.

The small form of *Solen ? fonesi* occurs in the backwaters of Cochin as well as in the Chilka Lake. The species is recorded from the Philippines and Cebu, but without particulars.

Solen annandalei,* Preston, 1915, p. 304, figs. 17, 17*a*. Plate xvi, fig. 8.

The shell of this form is easily distinguished from Chilka specimens of *S. ? fonesi* by its larger size and relatively greater length; in the only two specimens we have seen the length is respectively 4·7 and practically 5 times the breadth. The shells were found on sandy beaches at Nalbano and Satpara, in both cases with examples of *S. kempi*.

Solen kempi,* Preston, 1915, p. 305, figs. 18, 18*a*. Plate xvi, fig. 9.

The shell is still narrower than in *S. annandalei*, the length being from 6·4 to about 7 times the breadth. Several fresh shells were found at Satpara and Nalbano and a single living example was dug from pure sea-sand near the mouth of the lake. The siphons resembled those of *S. fonesi*, but the animal, instead of being practically colourless, had a distinct greenish tinge.

Family **Mactridae.**

Standella annandalei,* Preston, 1915, p. 305, figs. 19, 19*a*, 19*b*.

This species is common on sandy ground at Nalbano, burrowing to a depth of several inches. It also occurs in the outer channel, in which, however, we took only dead shells. The only living specimens we obtained were taken in March, but the habits of the species render it difficult of capture except when the level of the lake

is very low. A polychaete worm of the genus *Diopatra* frequently fixes a single valve of the shell to the upper extremity of its tube, which projects in the form of a vertical funnel above the surface of the sand.

Family **Myidae.**

Corbula chilkaënsis,* Preston, 1911, p. 39, fig. 2.

This species is represented in our collection by a single specimen, the type, taken living under a stone at the edge of the lake near Rambha in March, 1910. It bears a remarkably close resemblance to some species of *Cuspidaria*. The interior of the shell has not been examined and we are by no means certain of the true systematic position of the species.

Family **Pholadidae.**

Martesia striata (Linn.), Reeve, *Conch. Icon.*, XVIII, *Pholas*, pl. viii, figs. 32, *a*, *b*, *c*. (1873).

In the old collection of the Indian Museum there are several small and distorted valves of this species, labelled "Chilka Lake." It is a cosmopolitan form common in drift-wood in the Bay of Bengal and the specimens probably came from a log that had drifted into the mouth of the lake.

Family **Teredinidae.**

Xylotrya stutchburyi, Sowerby, Reeve, *Conch. Icon.*, XX, pl. ii, figs. 5, 5*a*, *b*, *c* (1878).

A post standing in the lake near Satpara was bored through and through by this ship-worm. Many of the tubes were empty and one of them was occupied by a small blenny of the genus *Petroscirtes*; some were lined by the Polyzoon *Membranipora hippopus*.

Order *DIBRANCHIA*.

Family **Tellinidae.**

We obtained no living representatives of this family; but the shells of the following two species were apparently quite fresh at the time they were collected.

Tellina chilkaënsis,* Preston, 1915, p. 306, figs. 20, 20*a*, 20*b*.

A single pair of fresh valves was obtained in the inner part of the outer channel in the freshwater season.

Tellina confusa,* Preston, 1914, p. 309, figs. 18, 18*a*.

We obtained no specimens of this species, which has long been represented in the Indian Museum by examples from the late Dr. Blanford's collection, labelled *T aequistriata*, Sowerby. They are probably from the outer channel of the lake.

Family **Scrobiculariidae.**

Theora opalina (Hinds), *Proc. Zool. Soc. London*, 1843, p. 78.

This is quite the most abundant bivalve mollusc in the main area of the lake. It occurs more sparingly in the inner part of the outer channel. The shell lies buried

in mud, or muddy sand, and the siphons are capable of elongation to at least three times its length; but so far as we could discover the burrow is always quite superficial. The animal is capable of giving sudden leaps by ejecting water. The shell when not eroded is of a glassy transparency (see fig. 6) but becomes somewhat clouded after death

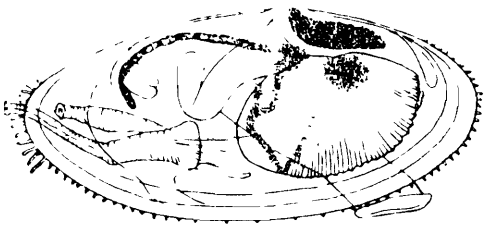

FIG. 6.—*Theora opalina* (Hinds).
Living animal, with siphons contracted and foot partially extruded. From a sketch by Mr. G. M. Henry.

Theora opalina was originally described from a muddy bottom in shallow water in the Philippines. It probably occurs in all estuaries and backwaters on the Indian coasts, at any rate it is fairly common in those of Bengal, Madras and Cochin.

Cumingia hinduorum,* Preston, 1915, p. 308, figs. 22, 22*a*.

This species was found living at the inner end of the outer channel at all times of the year. Living specimens were also obtained off Parikudh in the main area in November in water of very low salinity (sp. gr. 1·00225), the bottom at this point being somewhat sandy.

Family Cuspidariidae.

Cuspidaria annandalei, Preston, 1915, p. 308, figs. 23, 23*a*, p. 482; 1916, p. 39.

This species is common all over the lake-system except at the seaward end of the outer channel. It sometimes occurs on bare mud, but is particularly abundant in thickets of *Potamogeton*, to which young shells are frequently found attached. It seems to flourish equally well in fresh, salt and brackish water. Many shells have a number of small greyish spots on the swollen part; these are more conspicuous in fresh examples. The species has also been found in backwaters at Madras and Cochin and in the Gangetic delta.

Family Lyonsiidae.

Lyonsia samalinsulae,* Preston, 1914, p. 310, figs. 16, 16*a*; 1915, p. 309.

There are not many specimens of this species in our collection; but they were found living at widely separated places in the outer channel and the main area both in the salt and fresh-water seasons. Their scarcity is probably due to the fact that they burrow in sandy mud near the shore and were therefore rarely taken in our nets.

Family Anatinidae.

Broken shells belonging to the genus *Anatina* were observed in considerable numbers on the shore, when the level of the lake was low, wherever a certain amount of sand was mixed with the mud of the bottom. Good specimens were difficult to obtain on account of the fragility of the shells and of the fact that the animals burrow to a depth of at least two feet.

Lynge draws attention to the variability of *A. anatina* (Linn.) and expresses the opinion that many species of the genus will ultimately have to be withdrawn. We

have found it very difficult, with all the types before us, to distribute fresh specimens among Preston's three species.

Anatina granulosa,* Preston, 1914, p. 310, figs. 17, 17*a*.

The species was described from a specimen long in the Indian Museum and labelled merely "Chilka Lake." We attribute to it with some doubt a much larger shell found dead on the shore at Ganta Sila in March.

Anatina barkudaënsis,* Preston, 1915, p. 309, figs. 25, 25*a*.

Under this name Preston includes the majority of our specimens; they were found in all parts of the lake except the sandy area of the outer channel. All our living examples were taken in the salt-water season, but the only manner in which we were able to obtain them was by digging on the shore when the water level was low.

Anatina barkulensis,* Preston, 1915, p. 309, figs. 24, 24*a*.

A living specimen was dug up at Ganta Sila in February, and another was dredged near Mahosa in the outer channel in September. The type, obtained at Barkul Point in March, was dead but in a fresh condition.

NOTE ON VARIATION IN *MODIOLA*.

The great abundance of *Modiola* in the Chilka Lake and the conspicuous nature of the variability exhibited by its species has enabled us to prepare notes on this genus of a more elaborate kind than those we have given on other Mollusca.

Modiola is a genus of cosmopolitan distribution and wide bathymetric range. *M. watsoni* is common in the Bay of Bengal at a depth of over 100 fathoms and several forms have been found in inland lakes in eastern Asia. In the estuaries of Indian rivers at least one species is abundant, *viz.* that referred to below as *M. striatula*, Hanley.

In the large series of specimens we obtained in the Chilka Lake it is possible to select individual shells corresponding with those referred by Mr. Preston to nine species and one variety; but, for the reasons stated below, we are convinced that at most only two variable species of different habits are represented. We should mention that only a comparatively small proportion of the shells were available at the time that the collection was examined by Mr. Preston.

Modiola undulata (Dunker).

(Plate XV, figs. 1—6: plate XVI, fig. 1.)

1856. *Volsella undulata*, Dunker, *Proc. Zool. Soc. London*, XXIV, p. 363.
1858. *Modiola undulata*, Reeve, *Conch. Icon.*, X, *Modiola*, pl. v, fig. 18.
1911. *Modiola chilkaënsis*, Preston, *Rec. Ind. Mus.*, VI, p. 41, fig. 6.
1914. *Modiola undulata* and var. *crassicostata*, Preston, *ibid.*, X, p. 304, fig. 15.
1915. *Modiola undulata* and var. *crassicostata*, Preston, *ibid.*, XI, p. 298.

This species is abundant in the Chilka Lake, occurring at all seasons and in all parts of the lake-system. It is almost invariably attached either to *Potamogeton*, to filamentous or delicately branching algae or to the ropes of fishing traps; in other

words to objects that sway freely in the water. The algae may be growing on stones and of no great length and a few living shells were found apparently lying free on a muddy bottom, but they may have been shaken from weeds by the net. Large numbers of dead shells were noted in December on the shore at Rambha after a strong breeze.

The shell in specimens of *M. undulata* from the Chilka Lake is thin, as a rule semi-transparent and lightly tinged with yellowish-green; markings when present, as they usually are, are of a bright reddish-purple. There is considerable variation in outline; but the upper margin is always strongly elevated at or near the middle and is sometimes subangulate: the exact position of this point is not always the same. On account of the elevation the proportional depth of the shell is always considerable, but in this character also there is much variation. The lower margin of the shell is often quite straight, but perhaps more frequently very slightly concave: it is never emarginate. In some specimens one valve is a little more inflated than the other, but this peculiarity is sometimes so slight as to be almost imperceptible and may exist in either valve. The type of Mr. Preston's *M. chilkaënsis* (pl. xv, fig. 5) is an individual in which it is particularly well marked, but his figure exaggerates the asymmetry.

The surface of the shell is usually devoid of radiating ridges, except immediately in front of and below the umbo, where there are distinct transversely-striated costae. Faint traces of similar costae are, however, often to be observed on the posterior edge of the shell and occasionally extend along its whole length in a well-developed condition. It is to this form that Mr. Preston has given the name var. *crassicostata* (pl. xv, fig. 6).

In the commonest type of colouration the shell is marked with zig-zag purple lines, which run transversely and are frequently interrupted, and also with finer straight radiating lines of the same colour. Lines of both kinds frequently disappear almost completely on the lower half of the shell and the longitudinal ones are almost always most strongly developed on the posterior half. Both kinds of lines may be obsolete or even entirely absent and the whole surface of a uniform pale yellowish-green; shells of this type are not uncommon. On the other hand the purple lines often develop into irregular blotches, and occasionally the whole surface, except the extreme margin, becomes deeply suffused with purple pigment, definite markings being indistinguishable. This type of colouration is, however, very rare. Photographs illustrating variation in colour-pattern are reproduced on Plate xv, figs. 1-4.

The shells described by Dunker evidently belong, so far as colouration is concerned, to the form commonest in the Chilka Lake, but Reeve has figured and described a unicolourous specimen which appears to have been browner than any in our collection. Our descriptions of colour have, however, been drawn up from specimens preserved in spirit, in which the differences are much better seen than in dried shells.

Neither in colouration, shape, degree of asymmetry or presence or absence of ribs on the surface are we able to find correlation of any kind, and specimens from

the same handful of weed may possess any combination of the peculiarities mentioned. It is very probable that the inequality of the valves characteristic of Mr. Preston's *M. chilkaënsis* is due to unequal pressure at an early stage of growth, the crowded condition of the shells (pl. xvi, fig. 1) easily explaining how this may have occurred.

There seems to be very little difference between our specimens of *M. undulata* and those described by Dunker and Reeve. The former author gives the length of the shell as 11 lines (about 23 mm.) and our largest specimens are of exactly the same size. Only a few individuals, however, attain these dimensions, the circumstances in which they live making it impossible for the majority of them to exist for a prolonged period. A large number of those individuals that are attached to the stems of *Potamogeton* must perish with that plant, which dies down in June or July, though it is possible that some are able to transfer themselves to the roots, which of course persist. In this position there is great danger of their being overwhelmed by mud. Those individuals, on the other hand, that are attached to filamentous algae growing on stones are mostly killed by desiccation in spring or early summer.

We have no evidence, therefore, in the case of this species that its abnormal environment in the Chilka Lake has produced anything of the nature of a racial dwarfing or distortion. It is naturally a variable species, as is proved by the apparent discrepancies in Dunker's and Reeve's descriptions, both authors having had before them specimens from the same locality (the Moluccas) and collection. We are not aware that the species has been recorded from any other Indian locality but the Chilka Lake, but we have specimens from Port Canning in the Gangetic delta.

Modiola striatula, Hanley.

(Plate XV, figs. 7-18 ; plate XVI, fig. 2.)

1842-56. *Modiola striatula*, Hanley, *Cat. Recent Bivalve Shells*, p. 241, pl. xxiv, fig. 29.
1858. *Modiola striatula* and *emarginata* (Benson MS.), Reeve, *Conch. Icon.*, X, *Modiola*, pl. x, figs. 72, 73.
1909. *Brachyodontes emarginatus*, Lynge, *Danske Vid. Selsk. Skr.* (7) *nat. og. math.*, V, p. 135.
1909. *Modiola cochinensis*, Preston, *Rec. Ind. Mus.*, III, p. 278, fig. 2.
1910. *Modiola jenkinsi*, Preston, *ibid.*, V, p. 36, fig. 5.
1911. *Modiola annandalei* and *celator*, Preston, *ibid.*, VI, pp. 40, 41, figs. 4, 5.
1914. *Modiola emarginata*, Preston, *ibid.*, X, p. 304.
1915. *Modiola taprobanensis*, Preston, *Ann. Mag. Nat. Hist.* (8), XVI, p. 84, fig.
1916. *Modiola taprobanensis*, Preston, *Rec. Ind. Mus.*, XII, p. 35.

The synonymy of this species presents great difficulties, owing, we are convinced, to the extreme variability of the shell. Among the specimens from the Chilka Lake Mr. Preston has recognized no less than four species, while in our more recent collections we find selected shells that agree precisely with his types of two others. We are by no means certain that the synonymy we give is exhaustive, for it seems not at all improbable that, when large series from estuarine tracts and lagoons in the Oriental region are compared, it will be found that other forms at present regarded as distinct fall well within the limits of variation of *M. striatula*. It is noteworthy, moreover,

that in a small series of *M. lacustris*, von Martens, from the Tung-ting Lake in China, we find variations in the shape of the shell comparable to those that occur in the species from the Chilka Lake.

M. striatula differs from *M. undulata* so far as habits are concerned in that it is usually found attached to rocks, stones, wooden posts or other solid objects. This is the case in the Gangetic delta as well as in the Chilka Lake. Shells are occasionally found in both places fastened to algae growing on stone, but seem to be unable to attain their full development in this position. In the Gangetic delta a favourite situation is on posts partly destroyed by *Xylotrya*; but the mussel is also found on brick-work in the Calcutta docks, where it is stated to do considerable damage by settling in cracks in the bricks and splitting them by its growth. In the Chilka Lake it prefers to settle in crevices in rocks or among oyster-shells. We have noticed on many occasions that the young molluscs show a marked tendency to congregate round the adults (pl. xvi, fig. 2).

In the lake it is extremely abundant in both the outer channel and the main area and occurs at all times of the year, being very common in all suitable places whenever the rocks and oyster-beds are covered with water.

Near Calcutta, where it is very abundant, it is frequently overwhelmed by the sponge, *Spongilla alba*, in which we occasionally found shells in the Chilka Lake. On the bottom of our steam-launch large numbers were also discovered in the sponge *Suberites sericeus*.

The shells that we have included under the name *M. striatula* vary very greatly in shape, sculpturing, size and colouration, but we find from the old collection of the Indian Museum that all, or practically all, were included by G. Nevill under the name *M. emarginata*, Benson. This name seems to have existed in manuscript some time before it was published by Reeve, and it was the one by which the common mussel of the estuaries of the Bay of Bengal was known to Blanford [1] and his contemporaries. Nevill gives *striatula* as a synonym on his labels.

From *M. undulata* the species appears to be distinguished by the following characters, though in certain cases we have found it very difficult to separate individual shells of small size. The shell is always more opaque and as a rule much more densely pigmented, the pigment being of a duller shade. The upper margin is as a rule less strongly elevated and more evenly arched, the proportional depth of the shell being therefore less. The postero-dorsal margin is as a rule more declivous and the posterior extremity more narrowed and less strictly horizontal. In a large number of shells the ventral margin is boldly excavated or emarginate. Radial ridges, which are exceptional in *M. undulata*, are usually present; but the anterior margin is sometimes quite smooth.

The nominal species that we include under *M. striatula* may be divided into two groups, (i) those in which the lower margin of the shell is practically straight and (ii) those in which it is distinctly excavated. The former consists of *M. cochinensis* and

[1] Blanford, however, distinguished some specimens as *M. striatula*.

M. jenkinsi, Preston, the latter of *M striatula*, Hanley; *M. taprobanensis*, Preston; *M. emarginata*, Reeve; *M annandalei* and *M. celator*, Preston. In practically every series of specimens we have examined, either from the Gangetic delta or from the Chilka Lake, there is a complete transition between these two groups, and many of the specimens identified by Blanford and by Mr. Preston as *M. striatula* have the lower margin straight, while in Reeve's figure it is much more nearly so than in Hanley's. In fact, so far as it is possible to say without seeing those of *M striatula* and *M. emarginata*, we believe that the types could be arranged in the following order so as to form an almost complete series in this respect:—

1. *M. jenkinsi.*
2. *M. cochinensis.*
3. *M. striatula.*
4. *M. taprobanensis.*
5. *M. emarginata.*
6. *M. celator.*
7. *M. annandalei.*

With the concavity of the lower margin in these forms a relative narrowing and elongation of the whole shell is often correlated and in those types in which this margin is straightest, the relative depth of the shell is greatest. *M taprobanensis*, however, is a rather broad form.

The type of *M. celator* is remarkable for its abnormal outline as seen in dorsal view and for the thickened and eroded condition of the antero-superior region of the shell. We find precisely similar shells in a number of our series and also others in which abnormalities of a similar nature occur in other parts. Photographs of abnormal shells and of the types of four species described by Mr. Preston are included in the series figured on pl. xv, figs. 7-18.

The development of radial costae is an extremely variable character, but the surface is less frequently quite smooth than in *M. undulata*. In many specimens the costae are quite as fully developed as in the var. *crassicostata* of that species, but they are never branched as in *M. subramosa*, Hanley. Another variable character is the development of concentric growth-lines; abnormal specimens occur, especially in forms resembling *M. celator*, in which they are greatly accentuated. Sculpturing of the shell is not, however, correlated in any way with its shape. It seems to us impossible to recognize *Branchyodontes*, Swainson, even as a subgenus.

The colouration is also very variable, but the variation is not quite of the same nature as in *M. undulata*, the different colours being as a rule more diffused as well as duller. In some specimens, however, zigzag transverse purple lines and longitudinal striae can be detected, but the purple is usually less red and the ground-colour of a bluer green. Young specimens are as a rule brighter than adults and fully developed shells are sometimes of an almost uniform dull brown.

Perhaps the best illustration we possess of correlation between different forms of shell and their environment is a worm-eaten log covered with mussels of this species. It has long been in the Indian Museum and almost certainly came from the Gangetic delta. Among the shells from this log are some that are relatively short and broad and have the lower margins perfectly straight, while others exhibit every degree of

length of shell and concavity of margin. The former are those which repose in comparatively short cavities with a smooth lining and straight or nearly so, while the latter are esconced in deeper holes of irregular shape and are pressed either against one another or against the walls. In each case the shell takes the shape of the space it occupies; in some instances it forms practically a cast of that space and the degree of concavity of the lower margin is most strictly correlated with the degree of curvature of the surface against which it is pressed.

In the Chilka Lake we noticed exactly the same phenomenon. Shells with a straight margin, like the types of *M. jenkinsi* and *M cochinensis*, were those which were attached to flat objects such as the inner surfaces of oyster-shells, while extreme forms such as *M. annandalei* were living in crevices in rocks or on uneven stones. The byssus is always very short and the shell is pressed closely against the object of attachment. In the case of forms resembling Mr. Preston's *M. celator*, we believe that we are dealing merely with abnormalities produced by growth in unusally confined spaces. The shell is always greatly thickened and eroded on the surface, either all over or in parts.

Colouration is to some extent correlated with environment, shells from rocks or logs overgrown with algae being paler and greener than those on bare stone of a dark shade, while those on the inside of oyster-shells are often quite pale; the correlation, however, is not of a precise nature. Specimens from some localities, *e.g.* the Cochin and Madras backwaters, are browner than those from the Chilka Lake. They have been named by Mr. Preston, *M cochinensis* and *M. taprobanensis* respectively.

The shell seems to be thicker in specimens from marine localities than in those from estuaries and backwaters.

All our specimens from the Chilka Lake are small, exceptionally large shells not exceeding 20 mm. in length, while in many series none reach 15 mm. The largest specimen from the log of wood to which we have referred above is 31·5 mm. in length, others from the Andamans are scarcely smaller, while Reeve figures an individual 39 mm. long and von Martens[1] notes that the largest he examined was 36 mm.

It is clear, therefore, that all the individuals we found in the Chilka Lake are dwarfed and we are convinced that our investigations were sufficiently exhaustive in this respect to include the whole range of variation. There is, however, a small series of specimens in Blanford's collection, labelled as coming from the Chilka Lake, some of which are more than 35 mm. in length. It is unfortunate that no precise information is available as to their *provenance*, but in general appearance they bear a remarkably close resemblance to those on the log of wood referred to above; we have good reason to suspect that they may have been introduced on driftwood.

Specimens from the backwaters of Cochin and Madras are even smaller than those from the Chilka Lake, rarely, if ever, exceeding 10 mm. in length, but in these places they live in confined spaces between the valves of dead oyster-shells. Those from the Chilka Lake oyster-beds are almost as small. Among those we have our-

[1] Weber's *Zool. Ergebn. Nied. Ost-Ind.*, IV, p. 227 (1897).

selves found in small pools near Calcutta liable to desiccation, none exceed 23 mm. in length. There are several other series in the collection of the Indian Museum from the Gangetic delta which include shells 31 mm. long, but we are ignorant of the precise circumstances in which they were found.

From all these facts it would seem that the small size of the mussels of this species found in the Chilka Lake is in no sense a racial character, but is due to the direct effect of environment on the individual. We must remember that by far the greatest part of the rock-area available on the shores and islands of the lake is completely dried for several months in the year, at any rate from March until the latter part of June. At the end of the dry season extremely few living individuals are to be found and these are situated in close proximity to the muddy bottom and are therefore liable to be buried. From the situation in which the young mussels establish themselves it necessarily follows that the chief, though not the only, breeding season must occur shortly before the adults are killed by the sinking of the water-level and that the larvae settle down when the lake is full. It is interesting to notice that they do so at a time when the water is quite fresh or but very slightly saline.

The situation most favourable to the growth of *M. striatula* seems to necessitate the following conditions,—(i) a firm support provided with cavities in which the animals may attach themselves; (ii) the absence of any risk of being engulphed in mud or in living sponges and (iii) an uninterrupted supply of water. There is of course the question of food-supply also, but on this we have no information. To judge from the specimens we have examined, ideal conditions are to be found on worm-eaten logs of wood, either fixed beneath the lowest water-level or floating.

It is not improbable that the species is essentially an estuarine one, but in spite of this fact, ideal conditions exist very rarely, if at all, in the Chilka Lake. We are of the opinion that dwarfing in the case of *M. striatula* in the lake is not due to the low salinity of the water and that there is no evidence that the unfavourable conditions noted in the preceding paragraphs have affected the race as distinct from the individual.

M striatula was originally described from the Philippines and has been recorded from the Gulf of Siam, Singapore, Ceylon, Burma and from both sides of the Indian Peninsula (Calcutta, Madras, Cochin, Bombay).

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APPENDIX.

THE ANATOMY OF THE COMMON *SOLEN* OF THE CHILKA LAKE.— ? A DWARFED FORM OF *S. FONESI* DUNKER.

By EKENDRANATH GHOSH, *M.Sc., Asst. Professor of Biology, Medical College, Calcutta.*

The anatomy of *Solen fonesi* has been described briefly by Bloomer[1], but he gives few details of the internal structure and does little more than compare the foot, mantle, etc., with those of *S. vagina*. No detailed account of *S. vagina* is available in Calcutta and there are no specimens in spirit in the Indian Museum. It has therefore seemed best merely to describe the different organs of the form from the Chilka Lake and leave it to other malacologists more favourably situated as regards literature and material to decide whether the identification is correct.

In one point this form differs markedly from that described by Bloomer, *viz.*, in the entire absence of pigment on the external surface of the foot and mantle.

SHELL.

Shell thin, translucent, very brittle, with a brownish epidermis, corroded in its upper anterior portion (upper anterior quadrant), length about three and a half times the breadth; anterior margin straight and directed from above a little forwards, with a rounded antero-inferior angle; posterior margin straight and nearly vertical; a single narrow elongated umbonal tooth just behind the antero-superior margin in the right valve.

Anterior adductor impression elongately triangular, with the base oblique and directed in front; anterior retractor impression small, rounded and just below the anterior end of the anterior adductor impression. Posterior adductor impression small, rounded, just a little in front of the postero-superior angle; posterior retractor impression rounded, of the same size as that of the posterior adductor and placed just in front of the latter.

ANATOMY

In preparing the following description I have had recourse to the following methods:—

(1) Two relatively large specimens have been dissected; the structures have been followed with the naked eye and with the help of the dissecting microscope.

(2) Three medium-sized specimens, taken out of their shells, have been dehydrated in absolute alcohol, and cleared in clove oil. The mantle-lobes, gills, and the

[1] *Journ. Malac. Soc. London*, VII, p. 18 (1906).

labial-palps of one side were then removed and the animal was examined under a low power. The coils of the intestine, the ganglia, some of their commissures, and the general outline of the kidneys were well made out by this method.

(3) Lastly, a complete set of serial sections was cut by the paraffin method from one end of the animal to the other, and stained as usual. The arrangement and the relation of the various structures made out in the serial sections were compared with the results obtained by other methods.

I. MANTLE-LOBES.

The anterior margins are thick and straight and run a little forward from above; they are separate from one another in their full lengths so as to leave an oval gap for the foot. The separation extends beyond the antero-ventral corner for a short distance as a rounded notch. The ventral margins are united and thickened, although less so than the free anterior borders. The posterior margins are thickened and united to form a single siphon containing both the inhalent and exhalent canals.

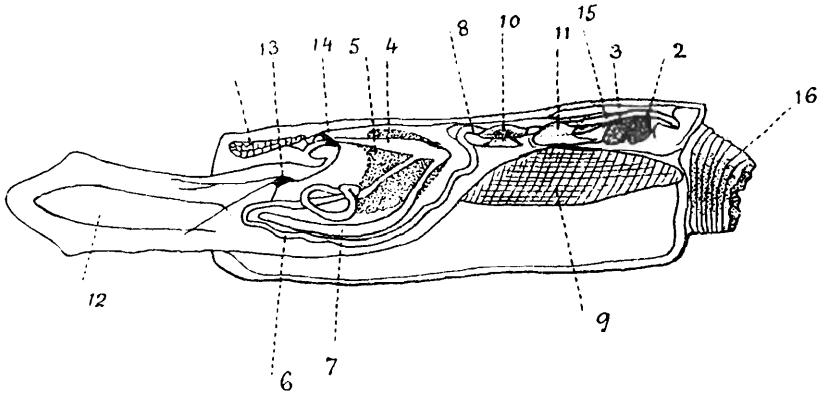

FIG. 1.—*Solen ? fonesi*, Dunker.

1. anterior adductor muscle; 2. posterior adductor muscle; 3. posterior retractor muscle; 4. stomach; 5. liver; 6. intestine; 7. pyloric caecum; 8. rectum; 9. gill (inner); 10. heart; 11. kidney; 12. pedal sinus; 13. pedal ganglion; 14. cerebral ganglion; 15. visceral ganglion; 16. remains of siphons after autotomy.

II. SIPHON.

The siphon consists of the fused inhalent and exhalent canals. When complete it consists of at least ten segments, each of which is wider at the base than at the apex. Each segment is at its distal border fringed with small conical tentacles, about 20 in number and arranged in a single row (see text-fig. 5, p. 354). When complete and fully extended, the siphon reaches a length nearly equal to that of the animal in the shell. When fully retracted and when a part has been thrown off the siphon lies very slightly protruded from the posterior border of the mantle-lobes. In the retracted state, the distal segment is less contracted than the others, forming a tumid rounded border bounding the inhalent and exhalent apertures. The tentacles are retracted and turned inwards towards the apertures.

Minute structure (figs. 2, 3).—In a transverse section, the siphon consists of a thick wall with a transverse band separating the apertures (text-fig. 2).

The wall consists of the following layers :—

(1) An outer layer of columnar cells situated on a distinct basement membrane.

(2) A thick layer of connective tissue with many elastic fibres and connective tissue corpuscles. The fibres are mostly arranged circularly and radially in narrow bundles at regular intervals. They are continued into the next layer.

FIG. 2.—*Solen ? fonesi*, Dunker.

Transverse section of the wall of the siphon.

1. outer epithelial lining; 2. outer layer of connective tissue; 3. longitudinal layer of muscles; 4. transverse layer of muscles; 5. longitudinal layer of muscles; 6. epithelial lining of the inhalent tube of the siphon; 7. part of transverse partition.

(3) A thick longitudinal layer of muscles fibres grouped into radial bundles by radial and longitudinal partitions of connective tissue which extend from the second layer to the next. The muscular layer is divided into an outer and an inner portion by a thin circular layer of connective tissue fused with the radial ones at their points of crossing. This thin layer of connective tissue is united on both sides by a thin layer of the same tissue, which forms the middle of the thick transverse partition between the inhalent and exhalent canals. At the junction of the two lie two blood-sinuses, one on either side. On either side of this median layer lies a narrow longitudinal layer of muscular tissue continuous with the inner portion of the longitudinal layer of muscular fibres in the wall of the siphon.

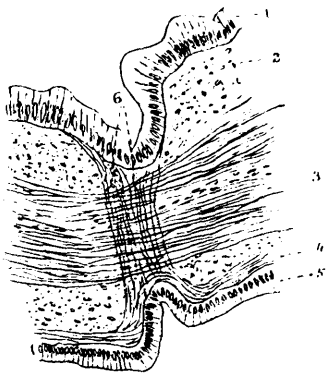

FIG. 3.—*Solen ? fonesi*, Dunker.

Longitudinal section through wall of siphon at junction of two contiguous segments.

1. outer epithelial lining; 2. outer layer of connective tissue; 3. longitudinal layer of muscles; 4. inner longitudinal layer of muscles; 5. inner epithelial lining; 6. radial layer of muscles.

(4) A thin layer of connective tissue which is interrupted at the junction of the outer wall of the siphon with the transverse partition. In this layer and abutting on the next outer muscular layer are blood-sinuses and nerves disposed in the following manner :—The blood-sinuses are 4 in number—two lateral already referred to, and one in the mid-dorsal and one in the mid-ventral line. The nerves are 12 in number, three on each side of the inhalent and three on each side of the exhalent aperture.

(5) A thin layer of transverse muscle-fibres surrounding the inhalent and exhalent canals. This layer is much thicker in the situation of the transverse partition than in the wall of the siphon.
(6) A thin layer of longitudinal muscle fibres.
(7) A thin layer of transverse muscle fibres.
(8) A layer of columnar epithelial lining of the inhalent and exhalent canals.

The structure of the wall of the siphon at the junction of the contiguous segments (text-fig. 3) differs from that of the wall of the segments themselves in the following particulars:—

(1) The wall is much narrowed down.
(2) The connective tissue layer beneath the outer epithelial lining has disappeared.
(3) The inner thin transverse layer of muscles is absent.
(4) A radial layer of muscle fibres pass from beneath the outer epithelial lining inwards to the epithelium lining the apertures.

The process of autotomy which occurs in the siphonal tube between the contiguous segments thus seems to be due to the voluntary contraction of the radial muscles which cut through all the other layers of the body-wall, thus separating one or more distal segments from the proximal portion of the siphon. Even in the case of spirit specimens the segments can be easily separated from one another.

III. FOOT.

The foot is elongated and cylindrical, and is a little flattened from side to side; it is incapable of retraction within the mantle-lobes. The organ is stouter towards the apex than towards the base, where it forms a distinct rounded annular swelling and still further a conical process at the tip. When fully protruded, the foot has its length a little less than that of the body (mantle-lobe). There is a wide pedal-sinus along the middle of the foot.

IV. LABIAL PALPS.

The labial palps are shaped like an obtuse-angled triangle, the longest side of which is a little curved and forms the lower border of the organ. The shortest side of the triangle is attached to the side of the visceral mass at its junction with the mantle-lobe. The measurements of the palp-margins (in a specimen 2·5 cm. in length) are 0·45, 0·3, and 0·2 cm., respectively.

V GILLS.

The gills are narrow and elongated; their posterior ends are slightly prolonged into the base of the inhalent canal. The outer gill extends from the postero-inferior angle of the labial palp; the inner gill extends further forwards, and begins from behind the postero-superior angle of the palp. This anterior portion of the inner gill is overlapped by the palps.

The attachments of the gills are best described in a table:

Outer gill.

Outer lamella	Attached to the mantle-lobe, the non-glandular portion of the kidney and to the glandular portion behind the visceral mass; to the non-glandular portion at the level of the visceral ganglia, and lastly to the mantle-lobe again.
Inner lamella	Attached to the under-surface of the non-glandular portion of the kidney, and to the glandular portion posteriorly.

Inner gill.

Outer lamella	
Inner lamella	Free; beyond the visceral ganglion attached to the inner lamella of the opposite inner gill.

VI. Digestive System.

The transverse slit-like *mouth* lies just behind and towards the ventral aspect of the anterior adductor muscle.

The *oesophagus* passes horizontally backwards to end in the stomach. Beneath the ventral aspect of the anterior two-fifths of the oesophagus is a space bounded below by the base of the foot, laterally by the labial palps, and behind by the visceral mass. Just behind the upper and lower lips of the mouth the oesophagus has a cuticular lining continuous with a similar, but less prominent, lining of the stomach.

The *stomach* is elongately pyriform in shape, and is rounded posteriorly. Behind and from its ventral aspect is given off a hollow tubular structure, the *pyloric coecum*, which descends into the visceral mass. The pyloric coecum passes to the right side lying on the inner side of the right wall of the visceral mass. It then curves forwards and passes to the front, lying still on the right side and parallel to the coil of the intestine. It then crosses the middle line and passes to the left side where it ends blindly at a point about midway between the junction of the two anterior loops of the intestine and the junction of the foot with the visceral mass. The position of the pyloric coecum varies slightly with the condition of the foot as regards its contractility. When the foot is fully extended, the coecum lies at the same level with the lowest loop of the intestine, but when it is more or less retracted, it lies above the loop.

The *intestine* begins from the ventral aspect of the stomach just in front of the origin of the pyloric coecum. It passes forwards and a little downwards along the right side of the middle line and curves downwards and then backwards in front of the base of the foot. It then runs backwards along the left side of the middle line and then bends upwards lying on the inner side of the first loop. It then takes another curve and passes a little forwards and then suddenly turns backwards and again downwards and forwards, and passes on straightly forwards crossing the middle line to the right side into the foot to the junction of its anterior two-thirds and posterior one third, where it bends downwards and backwards beneath the pyloric coecum. Lastly the intestine curves round the posterior end of the stomach to reach the posterior portion of the dorsal aspect of the latter and then curves out of the visceral mass to enter the pericardial chamber and form the rectum.

The *rectum* as usual passes through the ventricle in the pericardial chamber over the posterior adductor muscle to end in the anus.

The *liver* surrounds the stomach. Ventrally it extends beyond the first loop of the intestine to the dorsal aspect of the pyloric coecum. Anteriorly it extends to the close coils of the intestine.

VII. NERVOUS SYSTEM.

The *cerebral ganglia* are fusiform in shape, and are placed obliquely on the side of the gullet, the posterior lower end lying just behind the groove at the base of the foot. Each ganglion lies just above the junction of the inner and outer lamellae of the outer and inner labial palps.

The cerebral ganglia are joined to one another by an *intercerebral connective* lying transversely over the oesophagus as usual.

The *cerebro-pedal commissure* passes downwards just behind the junction of the foot with the visceral mass and joins the pedal ganglion of the same side. The direction of the cord varies according to the condition of the foot; when the foot is fully extended, the cord is directed downwards and forwards from the cerebral ganglion, but it is directed downwards and backwards when the foot is retracted.

The *cerebro-visceral commissure* passes backwards lying just above the attachment of the inner and outer lamellae of the outer and inner labial palps. As it passes backwards it penetrates the wall of the visceral mass obliquely and comes to lie on the inner side of the wall at the anterior end of the gills. It runs backwards, lying along the attachment of the gills, and is gradually displaced upwards till it comes to lie on the inner side of the kidney between it and the wall of the visceral mass beyond the posterior loop of the intestine. It then comes to lie beneath the kidney towards its outer side. In its further course it is gradually displaced towards the inner side and lies between the kidney and the posterior retractor muscle of the foot. Lastly the two cords lie side by side till they end in the visceral ganglia.

The *pedal ganglia* are closely applied to one another, lying in the middle line towards the dorsal aspect of the foot at its base a little in front of the mouth. When the foot is retracted, the ganglia recede backwards and come to lie considerably behind the cerebral ganglia. Three nerves can be followed from each pedal ganglion:

(1) Passes horizontally forwards and divides into two branches which can be traced beyond the middle of the foot.

(2) Passes obliquely forwards and downwards to the middle of the foot.

(3) Passes downwards and a little forwards towards the ventral aspect of the foot.

The *visceral ganglia* are closely applied to one another and are placed between the two posterior retractors of the foot and beneath the rectum. The ganglia are displaced forwards from the posterior adductor muscles. The two posterior pallial nerves can be traced to the undersurface of these muscles.

VIII. VASCULAR SYSTEM.

The *pericardial chamber* is elongated, and is much narrowed down and compressed posteriorly over the rectum.

The *heart* occupies the anterior half of the pericardial chamber, the *ventricle* corresponding to the posterior end of the last intestinal loop in the visceral mass. The *ventricle* is fusiform in shape. The two *auricles* are trapezoid in shape; of the two parallel sides, the shorter one is attached to the ventricle and the longer one to the base of the gill.

IX. Excretory System.

Each *kidney* is U-shaped with the loop placed posteriorly. The *glandular portion*, lying beneath the pericardium, begins at a point behind the middle of the ventricle. In the first part of its course the kidney is tubular and narrow and is placed on the dorso-lateral aspects of the non-glandular portion and the visceral mass just above the attachment of the gills. It then suddenly widens out into a bulbous portion, pushing the gills downwards and outwards and lying on the outer side of the non-glandular sac and on the dorso-lateral aspect of the hindermost portion of the visceral mass and the ventro-lateral aspect of the rectum, both the two latter structures being applied to the glandular sac. Anteriorly the bulbous portion is crescentic in transverse section, the concave side being placed on the dorso-lateral aspect of the hindermost part of the visceral mass and the cerebro-visceral nerve cord. Just before the formation of the posterior retractor muscle of the foot, the bulbous portion widens out more on the inner aspect and communicates with the opposite one through the inter-renal aperture. At this point the bulbous portion surrounds the rectum on its ventral and lateral aspects. Gradually the inter-renal aperture widens out, while the glandular sac surrounds the rectum more closely and completely. The pericardial chamber is much narrowed down and flattened out, occupying the dorsal aspect of the rectum. The glandular sac now recedes from the rectum and is displaced ventral-wise by the interpolation of the two posterior retractor muscles which lie by the side of the middle line, being separated by a median vertical partition extending from below, where two glandular portions meet at their inner borders to the side of the rectum above, to end in the mantle-lobe. Lastly the glandular portion becomes narrowed down again and ends in the non-glandular portion by a small narrow slit.

From the dorsal aspect of each of the two glandular sacs where they communicate with one another at their ventral aspects, a diverticulum is given off, which passes backwards for a short distance surrounding the ventral and lateral aspects of the rectum, the dorsal aspect being occupied by the pericardial chamber.

The non-glandular portion is very wide at its origin at the level of the visceral ganglia, occupying the whole width between the attachments of the gills on either side. It extends a little backwards beyond the posterior end of the glandular sac. As it runs forwards, it occupies the outer side of the glandular sac and is gradually displaced, at first to the ventral and lastly to the inner side of the glandular sac, separated from each other at this place by a wide interval. The non-glandular sac extends a little beyond the glandular sac at its anterior end.

X. Reproductive System.

The gonads form irregular branching masses beneath the dorsal wall of the foot in its anterior two-thirds and both along the lateral and the dorsal aspects in its posterior one-third ; the lateral group passes upwards to the ventral aspect of the gullet and extends backwards to the anterior end of the liver. The mass extends backwards on the inner side of the lateral walls of the visceral mass in the middle third of its lower half on the outer side of the coils of the intestine. Posteriorly behind the liver and the coils of the intestine, the gonads are more numerous and nearly fill the cavity of the visceral mass.

EXPLANATION OF PLATE XIV

Oysters from Indian backwaters.

FIG. 1.—Shells of *Ostrea virginiana*, Gmelin, from Ennur backwater near Madras: slightly reduced.

,, 2.—A clump of *Ostrea virginiana*, Gmelin, along with a specimen of *O. cucullata*, Born., from the Chilka Lake: slightly reduced.

The inner surfaces of the valves of *O. virginiana* show the deep purple pigmentation characteristic of most living individuals of the species.

Remains of the corals from the Chilka Lake.

FIG. 3.—Portion of a stone from the south-eastern side of Rambha Bay bearing skeletal remains of Turbinolid corals, a group of animals not now found in a living condition anywhere in the lake: natural size.

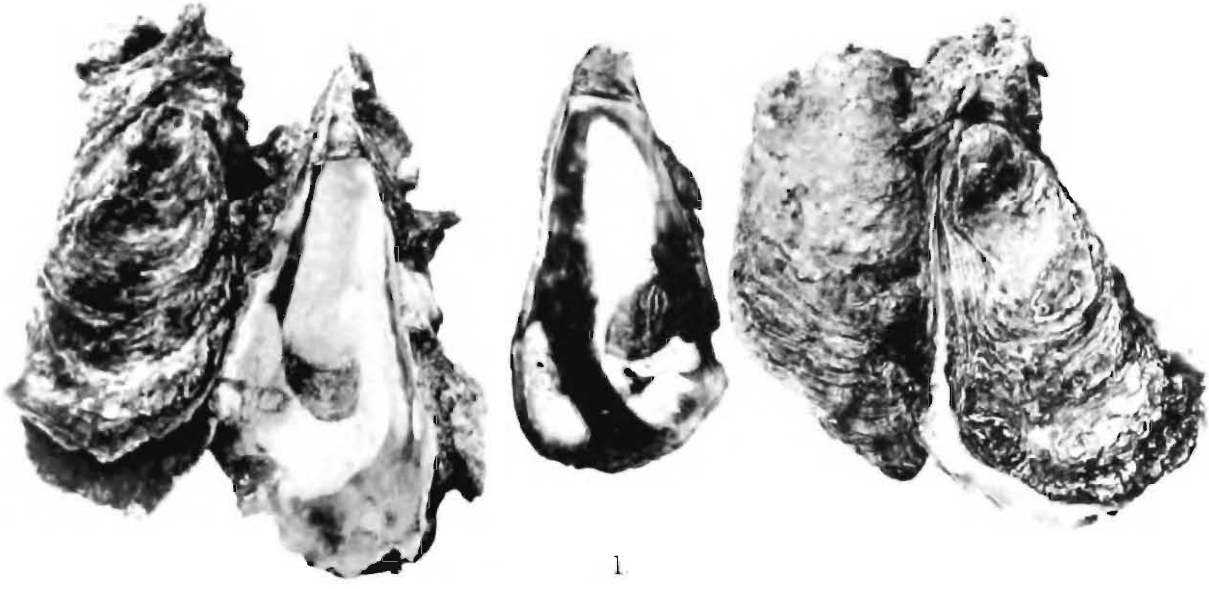

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Photo by S C Marshall.

Bemrose, Colle., Derby

OYSTERS AND REMAINS OF CORALS.

EXPLANATION OF PLATE XV.

Photographs of shells of *Modiola* from brackish water on the coast of India.

Modiola undulata (Dunker).

FIGS. 1-4.—Variously coloured specimens from a single handful of weed from the outer channel of the Chilka Lake (September, 1914).

FIG. 5.—Type of *M. chilkaënsis*, Preston, from algae growing on stones at Breakfast I., Chilka Lake.

,, 6.—Type of *M. undulata* var. *crassicostata*, Preston, from weeds growing on bottom off Samal I., Chilka Lake.

Modiola striatula, Hanley.

FIG. 7.—Type of *M jenkinsi*, Preston, from oyster-shell from Manikpatna, Chilka Lake.

,, 8.—Specimen from the Chilka Lake identified by Blanford as *M. striatula* var. (identification confirmed by Preston).

,, 9.—Type of *M. cochinensis*, Preston, from oyster-shell from Cochin backwaters, near Ernakulam.

,, 10.—Specimen from the Chilka Lake identified by Blanford as *M. emarginata*, Benson.

,, 11.—Type of *M. annandalei*, Preston, from stone from Chilka Lake near Rambha.

,, 12.—Type of *M. celator*, Preston, from worm-eaten driftwood from the beach at Puri, Coast of Orissa.

FIGS. 13-15.—Three specimens from a worm-eaten log, probably from the Gangetic delta.

,, 16-18.—Abnormal specimens from Port Canning, Gangetic delta, identified by Nevill as "*M. striatula*, Hanley (= *M. emarginata*, Benson)."

Specimens 1—4 were photographed in spirit; the other figures are from dried shells. The line below each figure shows the actual length of the shell.

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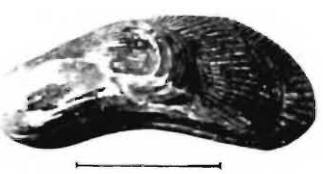

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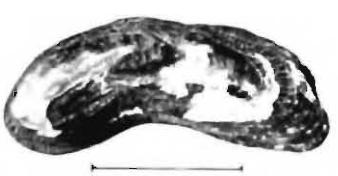

18.

Photo by S. C. Mondul.

VARIATION IN MODIOLA.

Bemrose Colln. Derby

EXPLANATION OF PLATE XVI.

Modiola undulata (Dunker).

FIG. 1.—Cluster of young shells on weed from off Barnikuda I., obtained in September, 1914.

Modiola striatula, Hanley.

FIG. 2.—Dead oyster-shell from Manikpatna, taken in December 1914, showing young mussels settling round adults.

Arca granosa, Linn.

FIG. 3.—Subfossil valve from Barkuda I., Chilka Lake.
,, 4.— ,, ,, ,, head of Rambha Bay, Chilka Lake.
,, 5.— ,, ,, ,, Manikpatna, Chilka Lake.
,, 6.—Fresh valve from off Samal I., Chilka Lake.

Solen ? fonesi, Dunker.

FIG. 7.—A specimen from the southern end of the Chilka Lake.

Solen annandalei, Preston.

FIG. 8.—Type specimen.

Solen kempi, Preston.

FIG. 9.—Type specimen.

All the figures are natural size.

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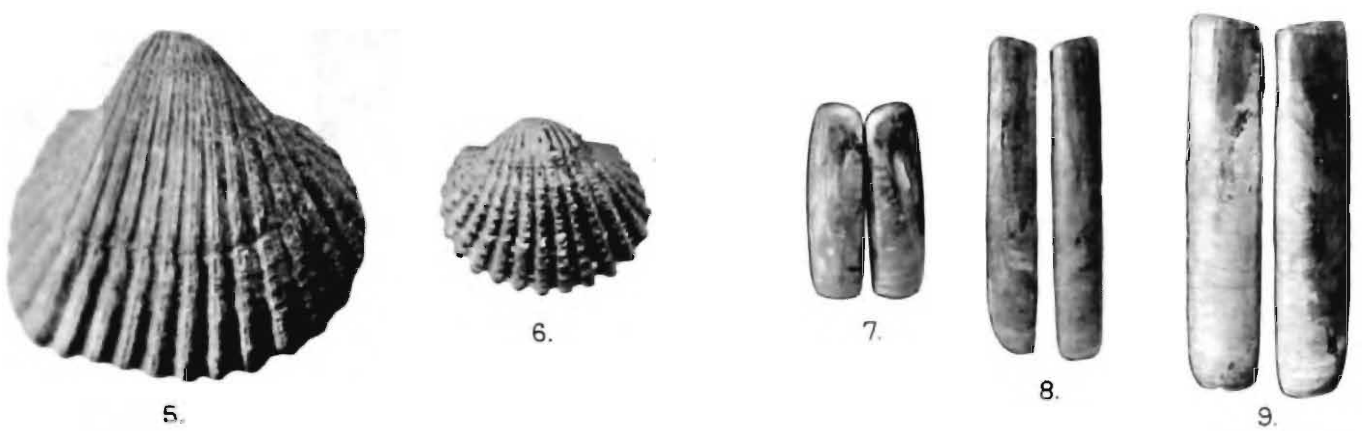
4. 3. 2.



5. 6. 7. 8. 9.

Photo by S C Mondal. Bemrose, Colls., Derby

MOLLUSCA OF THE CHILKA LAKE.

FAUNA OF THE CHILKA LAKE

MOLLUSCA NUDIBRANCHIATA.

By Sir Charles Eliot, *M.A., D.C.L. LL.D., K.C.M.G., C.B.*,
Principal of the University of Hong Kong.

(With 1 text-figure.)

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MOLLUSCA NUDIBRANCHIATA.

By Sir Charles Eliot.

The Nudibranchs collected by Dr. Annandale and Mr. Kemp in the Chilka Lake consist of three specimens, namely two small Aeolids and an *Elysia*. Both species must be treated as new. They may possibly be identical with animals known to us only by the figures and slight descriptions of older naturalists, but they do not correspond exactly with any such figures and descriptions.

Cuthona annandalei, a member of the same genus of Aeolids, has been found in brackish water in the mouths of the Ganges and *Alderia modesta*, a form allied to *Elysia* though not very nearly, is known to inhabit brackish marshes in the British Isles.

Cuthona henrici, sp. nov.

The notes on the living animal are as follows :—

"Two specimens (with drawing from life of one [1]) from off Ganta Sila in the main area of the Chilka Lake, 28-xii-1913.

Colour yellowish-white; cerata dark olive-green with variable black markings at their base.

The specimens were dredged in about five feet of water from among weeds on a muddy bottom just off the rocks of Ganta Sila. When placed in a dish they floated in the surface-film back downwards and moved along rapidly in this position.

They probably feed on the Hydroid *Bimeria fluminalis*, Annandale.

Specific gravity of water (corrected) about 1·006."

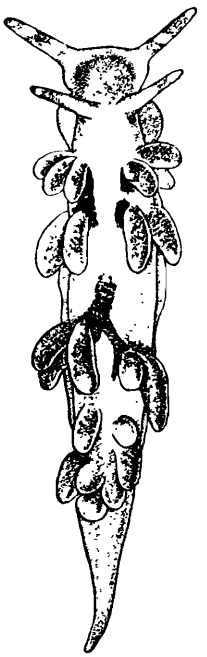

Fig. 1.—*Cuthona henrici*, sp. n. × 15. Drawn from life by Mr. G. H. Henry.

The preserved specimens correspond to the above description, but the bodies appear to have shrunk more than the cerata, making the latter seem relatively larger. The colour has become a dull yellowish-brown. The large specimen is bent, but would be about 10 mm. long if straightened.

The oral tentacles are large and distinct. The rhinophores are of about the same size, cylindrical and smooth,

[1] The drawing was made by Mr. Henry of the Colombo Museum who is alluded to in the specific name.

without a trace of perfoliations. The cerata are rather thick and some are almost ovate. They are set in four groups. The first, second and third groups are divided into two halves, containing two or three cerata on the right and left respectively. The fourth is a clump of seven cerata disposed irregularly across the back. The vent is on the right side about half way down. The shape of the body is elongate and the tail is moderately long. The foot is expanded into a distinct margin all round the body. In front it is rounded and ample, but not produced into horns or other appendages.

The cutting edge of the jaws bears a single row of denticles, blunt and shaped rather irregularly. The radula consists of a single row containing 27 yellowish teeth, of which two are still in process of formation. The teeth are of the horse-shoe shape with a moderately strong central cusp. On either side of it there are usually seven denticles. Of these five are long, pointed and conspicuous. The outermost and that nearest to the central cusp are considerably smaller and sometimes hardly visible.

These specimens cannot be assigned with certainty to any of the tropical species described under the names of *Cuthona* and *Cratena*, and most of these must be regarded as merely provisional. In describing small Aeolids of inconspicuous colouration and without any very salient characteristics, it is particularly desirable to examine a large series of specimens and ascertain what variations occur in the size and markings of the body and in the details of the teeth. But unfortunately there is rarely sufficient material for such an examination and it is consequently difficult to say whether the characters considered as specific really have such importance.

The present species is certainly distinct from *C. annandalei* described by me in the *Records of the Indian Museum* (vol. V, 1910, p. 248) but it is remarkable that both were found in brackish water and feeding on similar hydroids (*Bimeria*). For the name of the genus see my Supplement to Alder and Hancock's Nudibranchs, p. 129. I do not think that the genera *Cuthona* and *Cratena* can be maintained as distinct and *Cuthona* is the older name.

Elysia chilkensis, sp. nov.

The notes on the living animal are as follows:—

"A single specimen taken among weeds in a few inches of water close to the shore at Mahosa in the outer channel of the Chilka Lake, 20-iii-1914.

Form of body elongate and narrow, pointed behind but not produced. Tentacles very slender, tapering, pointed.

Colouration:—Dorsal surface dull moss-green marbled with a darker shade and dotted with white. Front of head between tentacles brownish, the brownish shade gradually diappearing behind head on sides of body. A colourless streak along the mid-dorsal line behind the head; a broad dark brown bar along each side of the head interrupted by a whitish streak containing the orifice of the tentacle.[1] Ventral surface greenish.

Specific gravity of water (corrected to 15°C) 1·0260."

---

[1] If this implies that the tentacle is retractile it is probably a mistake.

The preserved specimen is 17 mm. long and of a uniform brown colour. The shape is as described in the above notes. The rhinophores are very distinct. They would be about 7 mm. long if straightened out, but are curved backwards into a crescent shape and still remain remarkably tapering and pointed. Their surface is smooth and under a lens presents no sign of a fold, but a section seen under the microscope shows a shallow groove. But in life the organs can hardly have been auriform as in most *Elysiae*. The wings are narrow and erect and the veins or ridges on their inner sides are prominent and conspicuous. The pericardial prominence is large and distinct. It it somewhat distorted as preserved, but its natural shape was probably oval. The external orifices appear to be placed as in *E. viridis*, but are not easily seen. The foot is long, distinct and bipartite, the anterior portion being marked off distinctly from the rest.

The radula is of the type usual in the genus and contains 8 teeth in the ascending part, 16 in the descending part and 5 in the heap. The teeth resemble those of *Elysia faustula* as described and figured by Bergh in his Malacogische Untersuchungen (in Semper's *Reisen*, Heft IV, pl. xxii, figs. 15-17. *Cf.* Eliot in *Proc. Zool Soc. London*, 1904, p. 295). They are dagger-shaped, rather elongate and there are no signs of denticulation on the lower edge.

This animal is in most respects a typical *Elysia*, but it has long, tapering tentacles which appear to be only slightly grooved, whereas in most species the tentacles are rather short and distinctly folded or auriculate. *E. lobata*, Gould, from Honolulu, *E.* (*Actaeon*) *australis*, Q. and G. and *E. coodgeensis*, Angas, both from Port Jackson, Australia, and *E. viridissima*, Trinchese, from the Mediterranean are all said to have long tentacles and the present specimen is very likely identical with one of them. But in colour it does not agree with any of them. This is not an important discrepancy for colouration is extremely variable in this genus, coloured borders and spots being present or absent in otherwise similar specimens. Still in the absence of any agreement as to colour it is impossible to identify our specimen with any of those known by the somewhat meagre descriptions of the authors mentioned above and it must be regarded provisionally as a new species, *Elysia chilkensis*.

FAUNA OF THE CHILKA LAKE

STAGES IN THE LIFE HISTORY OF *GOBIUS*, *PETROSCIRTES* AND *HEMIRHAMPHUS*.

By D. R. BHATTACHARYA, *M.Sc., Professor, Muir Central College, Allahabad.*

(Plates XVII—XVIII.)

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STAGES IN THE LIFE HISTORY OF *GOBIUS*, *PETROSCIRTES* AND *HEMIRHAMPHUS*.

By D. R. BHATTACHARYA.

This paper deals with early stages in the life history of *Gobius ostreicola*, Chaudhuri, *Petroscirtes bhattacharyae*, Chaudhuri, and *Hemirhamphus limbatus*, Cuv. and Val. The specimens were all collected in the Chilka Lake by members of the staff of the Indian Museum. I worked on the first two above-mentioned species in the months of May and June, 1915, in the Indian Museum at Calcutta. The specimens of the third were sent to me here at Allahabad, and I worked them out in the Biological laboratory of the Muir Central College, during the month of August, 1915. As it was too hot then for microtome work, many features of the internal anatomy have been neglected, and the paper naturally is not supposed to be exhaustive.

My sincere thanks are due to Dr. Annandale, Superintendent of the Indian Museum, and to Dr. Chaudhuri, Assistant Superintendent, Indian Museum, for kindly allowing me to work in the Museum laboratory, for placing the collections of the Chilka Lake Survey at my disposal, and for assisting me in many other ways, especially in looking up literature on the subject.

Gobius ostreicola, Chaudhuri.

(Plate XVII, figs. 1—7.)

1916. *Gobius ostreicola*, Chaudhuri, *Rec. Ind. Mus.*, XII, p. 105.

The specimens were collected on the oyster-beds of Manikpatna in the outer channel of the Chilka Lake during the first week of December, 1914. The water at that place was then almost fresh owing to the floods at the close of the monsoon, though later on in the dry season the water becomes as saline as in the Bay of Bengal. The specific gravity of the water was found to be 1·01250.

The egg is elongated and oval in shape with a bunch of filaments at the distal extremity which serves as a means of attachment to foreign bodies. In this case the eggs were found attached to the concave side of a dead oyster shell measuring about 3½ inches in length and 2½ inches in breadth. On a rough calculation about 400 eggs were found covering a surface of one sq. cm. The method of attachment of the eggs to the shell is very characteristic There springs from the pedicle of the egg a hyaline structure which spreads out like an umbrella and ends in viscid thread-like filaments which adhere to the shell or to the filaments of the adjacent ova. This hyaline structure is traversed by alternate rows of oval apertures which gradually become bigger in size distally. Three or four such concentric rows of apertures may be made

out under the high power of the microscope. The apertures in the last row (distally) do not keep an exactly oval shape, but are generally slightly curved or bent and much more elongated than broad.

The egg shown in pl. xvii, fig. 1 was the smallest of the lot I came across and measures ·5 mm. in length. It is in one of the early stages of development. Numerous small globules, very likely oil globules, may be seen in the yolk-mass. The egg-membrane is more or less closely attached to the developing egg. The examination of the contents of the egg seems to show, however, that it is really a degenerate egg.

The egg in pl. xvii, fig. 2 measures 1·6 mm. in length. Intermediate stages between figures 1 and 2 could not be found. At this stage the embryo is fairly well developed. In a lateral view the eye, ear and heart may be seen to have begun to develop. The eye has not yet acquired pigments and is consequently colourless. The ear is a simple pit-like depression. The heart is represented by a very minute sac-like dilatation. The yolk-mass lies in a yolk-sac on the ventral surface of the body. Immediately above the yolk-mass we see the beginning of the notochord which gradually tapers towards the tail end, though it has not yet reached its extremity. On the dorsal surface of the embryo from the anterior end to about the middle of the body a thickening like that of the neural plate is observable. It marks the beginning of the development of the nervous system. A continuous fin-fold all over the body, except for a small portion of the head-end of the embryo, forms one of the most characteristic features of the embryo at this stage.

Plate xvii, fig. 3 shows an empty egg-membrane from which the embryo has been extruded. The wavy line at the upper end marks the point of rupture during extrusion.

The specimen in pl. xvii, fig. 4 measures 2 mm. At this stage we find the nervous system fairly well developed. The notochord reaches the extremity of the tail and is slightly curved upwards (heterocercal), and the caudal fin-fold acquires a corresponding shape. The epichordal lobe becomes reduced in size and the hypochordal lobe becomes comparatively enlarged. The continuity of the fin-fold is more or less broken near the middle of the body by its extreme narrowness, and we get anteriorly a dorsal fin-fold, posteriorly a caudal fin-fold, and ventrally a pre-anal fin-fold. The transition from fig. 2 to fig. 5 is rather abrupt. A truly heterocercal stage is not visible and we apparently get a homocercal (fig. 7) from a diphycercal (fig. 2) type. Fig. 5, however, approaches the heterocercal stage to some extent. Black stellate chromatophores lie in streaks both above and below the notochord, but do not reach the caudal extremity. The anus lies near the middle of the body, but the anterior portion of the alimentary canal is either undeveloped or indistinct. The heart acquires a coiled shape.

Plate xvii, fig. 6 shows a slightly more advanced stage. It has a curved tail, which is of course not a characteristic feature of this stage, for many specimens of earlier stages possess coiled or curved tails. This stage marks the development of pectoral fins and of another stucture—probably the gas-bladder which lies just in front of the yolk-mass.

Plate xvii, fig. 7 is the most developed of the specimens which I have seen. It is not yet hatched, but in all likelihood is just ready to be hatched. Of course, hatched specimens leave the colony and lead independent lives and that is why I have not come across them. At this stage the eyes become quite prominent and acquire pigments. The pupil looks yellowish-grey with a brownish spot in the middle, and the bulk of the eye looks brownish-black under the high power of the microscope. The yolk-mass gradually decreases in size. Two streaks of black (in places brownish) resembling stellate chromatophores may be seen lying dorso-laterally, one on either side of the notochord. A big chromatophore lies just in front of the yolk-mass. Embryonic fin-rays may be seen under the high power in the homocercal (not yet true homocercy) caudal fin. The embryonic dorsal fin also becomes well developed. No pigments have been found to occur in the embryonic fins. The pelvic fin has not as yet made its appearance. The pectoral fins are well developed and become fan-shaped. The transparency of the body is lost and every preparation to reach the adult form is more or less begun.

Petroscirtes bhattacharyae, Chaudhuri.

(Plate XVII, figs. 8—11.)

1916. *Petroscirtes bhattacharyae*, Chaudhuri, *Rec. Ind. Mus.*, XII, p. 107.

This species is believed to be a new one and no description of its larval stages seems to exist. Some specimens were obtained off Balugaon on 6-iii-1914, and others near Barkuda I. on 19-xi-1914. The specific gravity of the water (corrected to a standard temperature of 15°C) was about 1·007 on the former occasion and about 1·006 on the latter, showing a low salinity on both.

Only three distinct stages are available. The smallest specimen found measured 3·25 mm. in length and the largest specimen 15·9 mm. (including the middle caudal fin-rays). The following table gives the measurements in mm. of (1) the smallest, (2) the next higher stage—I shall call it medium for the sake of convenience, and (3) the largest specimens available.

Stage.	Total length.	Depth of body.	Length of caudal fin.	Length of pectoral fin	Length of spine.	Length of head.	Length of pelvic fin.
I. Smallest .	3·25	·6	No distinct caudal fin.	·5	·3	·8	Not yet developed.
II. Medium .	13·25	2·25	1·8	2·5	1·25	2·5	1·75
III. Largest .	15·9	2·7	2·1	3·25	1·8	3	2·25

The specimen shown in pl. xvii, fig. 8 measures 3·25 mm. in length (stage I). The muscle segments are fairly well developed and are about 34 in number, out of which about 24 can be distinctly made out, the myocommas of the most anterior and the most posterior segments being rather indistinct. The myotomes have not yet quite acquired the shape of the adult and are slightly wavy in character.

The "concentration" of the body segments has not yet taken place except at the anterior end.

The dorsal, caudal, and anal fin-folds are continuous (a primitive character). Furthermore, the skeletal supports of the fin-folds are either not yet developed or if developed (there are faint indications of the development of the fin-rays towards the caudal end) are not visible even under the high power of the microscope. The pelvic or ventral fins are not yet developed. The pectorals are short and contain 9 fin-rays.

The pigments are a characteristic feature of the larva. There are eleven fairly big black stellate chromatophores in the anal fin-fold from about the middle of the body to the base of the caudal fin-fold. There are also scattered but rare small brown (or in places blue black) pigment spots both in the dorsal and anal fin-folds. The caudal fin-fold is practically free from pigments. At the distal extremity of the pectoral fin beginning from about the middle, pigments of a deep blue black colour are very densely situated.

The posterior region of the alimentary canal and anus are visible. A short opercular spine and a frontal protuberance are developed. The notochord is well developed and extends to the tip of the tail end.

Slightly older stages than these are available. They show a slightly heterocercal tail fin. The caudal fin-rays in these have just begun to develop, but are not yet segmented. In the anal fin-fold the number of chromatophores varies from 12-15 in number.

Plate xvii, fig. 9 (stage II) measures 13·25 mm. in length (including the middle caudal fin-rays). This is a much more advanced stage than fig. 8. The myotomes are well developed, and the myocommas are quite distinct. The longitudinal horizontal septum separates the epiaxial from the hypaxial portion of muscle segments.

The fin-folds have become discontinuous and we get a long dorsal, a caudal, and a long anal fin. The diphycercal and heterocercal stages have been passed through, and we get the homocercal type of fin characteristic of the adult. The caudal fin consists of 22 jointed fin-rays and is practically free from pigments. The ventral fin is short and slender and lies anterior to the pectorals on the ventral side of the body. It consists of 2 fin-rays only. The pectorals are composed of 13 fin-rays, and are deeply pigmented (blue black) towards the distal end. The dorsal and anal fins are composed of spinous rays which will be described in detail in the next stage. On each side of the dorsal and anal fins, and closely attached to them is a membranous fin-fold in which lie a row of pigments or chromatophores (fig. 9 *i*). The stellate chromatophores of fig. 8 are lost at this stage.

The frontal prominence and narial tentacles are developed. The eyes are well developed and acquire deep pigments. Two (only) opercular spines, one on each side of the body, are developed, their extremities having a curiously bent shape. Whether this is their natural condition or is due to injury (which seems more likely), I cannot say, but all the available medium-sized and large specimens (6 only in number) showed this bent condition. The pigments of the brain are visible dorsally through the cartilaginous cranium and the various elements which compose the adult skull are as

yet imperfectly developed. The operculum is fairly well developed and the gills may be easily made out under the microscope. The mouth is armed with sharp pointed teeth.

Plate xvii, fig. 10 (stage III) measures 15·9 mm. in total length (inclusive of the middle caudal rays). The myotomes are well developed. As far as could be made out under the microscope there are about 42 myotomes on each side of the body. The "concentration" of muscle segments must have taken place in the region of the paired fins, and in the most anterior and posterior regions of the body, but throughout its greater length the correspondence between muscle segments, radial muscles, unjointed fins or spines, and the superficially segmented dorso-lateral and ventro-lateral dorsal and anal fin-folds respectively—as I propose to call them—is very remarkable A reference to figures 9, 10 and 11 will show that on each side of the dorsal and anal fins there is a membranous superficially segmented fin-fold containing towards the distal end a number of black pigment spots or chromatophores. These membranous fin-folds are devoid of spines (fig. 11*e*), and their segmented portions or processes are very short, flat and blunt. The dorsal fin consists of the conical muscle processes at the base, from the apex of which (I could not see any close connection between the two) arise unjointed rays or spines (fig. 11). A muscle segment or myotome corresponds with a radial muscle process, a spine, and a segment of the dorso-lateral membranous fin-fold on each side. This correspondence even in the post-larval stage lends support to the theory of segmentation in vertebrates. Certainly later on during development this arrangement undergoes a great deal of modification so essential to keep up the rigidity of the body in order to keep pace with the growingly active movements of the animal. The conical muscle prominences, which in all probability are radial fin muscles, seem to hide from view the corresponding radialia or somactidia, for they are not visible anywhere even under the high power of the microscope. These conical prominences are not yet separated from the myotomes from which they are developed.

A comparison with the *Petroscirtes* species juv. described by Max Weber in *Die Fische der Siboga Expedition*, published in Leiden, 1913, will show certain striking differences. Max Weber describes in his specimens the dorso-lateral folds as being provided with elongated spine-like processes, but in my specimens the processes are very short, flat and blunt. Again he shows only one pigment spot (which is comparatively bigger) in each segment of the anal fin close to the base of the spine, but in my specimens a number of comparatively smaller pigment spots lie more or less in a row not at the base of the anal fin, but at the apex of each dorso-lateral and ventro-lateral fin-fold segment. Again he shows the pigments only in the anal fin, but in my specimens they occur both in the dorso-lateral and ventro-lateral fin-folds in the same positions. He also shows a number of smaller spines in the operculum, which are absent from my specimens. These differences provide ample evidence to prove that my specimens belong to a different species to that described by Max Weber.

The caudal fin is composed of 24 jointed fin-rays. The pectoral and ventral fins are fairly well developed, the former being deeply pigmented towards the distal end. The opercular spine, eyes, and mouth are well developed. A short, blunt and flat

protuberance lies in front of the head above the mouth which I have called the frontal prominence. The mouth is provided with fairly well developed pointed teeth. Later post-larval stages would have shown interesting developments but unfortunately we have not got them.

Hemirhamphus limbatus, Cuv. and Val.

(Plate XVIII, figs. 1—6.)

Young stages of this species were taken in all parts of the Chilka Lake in fresh as well as in brackish water.

Some of the specimens in this collection do not seem to have been well preserved. However, a fairly gradual series of larval stages have been found, and the collection therefore is interesting. I have sorted out the specimens and divided them into 13 distinct stages. Some of the specimens were stained with Borax Carmine, and others with methylene blue. The latter brings certain structures, *e.g.*, cartilaginous skeleton and chromatophores, prominently into view and allows them to be traced for greater distances than the former does. But, on the whole, I found specimens stained with Borax Carmine more suitable for descriptive purposes. The accompanying table shows the length in mm. of body, snout and gas-bladder of the 13 larval stages I am going to describe.

Stage.	Length of body including snout and tail fin.	Length of snout.	Length of gas-bladder.	REMARKS.
I	2·5	·0841	?	Specimen not well preserved.
II	2·75	·1069	·1662	
III	3	·1187	·2375	
IV	3·75	·1306	·5770	Fin-fold still continuous, but slightly constricted towards tail.
V	6	·1425	3	More or less distinct tail fin: fin-fold still slightly continuous.
VI	6·75	·1544	3·125	
VII	7·5	·1781	3·5	
VIII	8	·1900	3·75	
IX	8·5	·2109	4	
X	10	·2375	4·5	
XI	10·5	·2612	5	
XII	11	·2850	5·25	
XIII	12	·3444	5·75	A young fish.

STAGE I. This is the smallest specimen I have come across. It measures 2·5 mm. in length. I have not sketched it, as the poor fixation of this specimen makes it difficult to determine the details of internal anatomy with any degree of accuracy. The eye and the gas-bladder is already formed. The lower jaw is prolonged into a slender beak. On the ventral surface a big chromatophore is present (see pl. xviii, fig. 1). The dorsal surface of the gas-bladder is pigmented. The tail is protocercal.

STAGE II. This specimen measures 2·75 mm. in length. The beak or snout becomes slightly more elongated and distinctly pronounced at this stage. The same chromatophore is present on the ventral surface. The tail begins to assume the heterocercal type, and the notochord and myotomes become fairly distinct. The cartilaginous development of the skull and visceral arch has begun. The cartilage cells are quite distinct.

STAGE III (pl. xviii, figs. 1 and 2). The eye is well developed and looks like an opaque black mass. Dorso-ventrally it is longer than laterally. The beak is curiously shaped, being bent in front like that of some birds. The visceral arches are well developed. Under the high power of the microscope, the visceral arches are seen to be lined by more or less parallel rows of cartilage cells. The heart lies just below and behind the basibranchial cartilage, and is in a fairly advanced stage of development. The various chambers are however just formed, and their connections and the various blood vessels which they give rise to are quite indistinct. The gas-bladder has an oval shape and is invested dorsally with pigment bodies. It is continued anteriorly into a hollow tube-like structure which seems to open just at the junction of the pharynx with the oesophagus. The notochord is well developed, and bends sharply upwards at the caudal end to form the beginning of the heterocercal type of tail fin. The myotomes and myocommas are developed, but the body is still more or less transparent. The alimentary canal is formed, but its different regions are rather indistinct. It lies close beneath the gas-bladder. Posteriorly it opens by the anal aperture. The glandular epithelium lining the internal cavity of the stomach is visible under the high power of the microscope, but the cavity of the stomach is very narrow. The spinal cord lies just above the notochord. The brain is also formed, but its various regions are indistinct. The liver is also formed and lies beneath the oesophagus and the anterior region of the stomach. It becomes more distinct in the next stage. The big stellate chromatophore still persists on the ventral side of the body. Except for this one, and those in the gas-bladder, no other chromatophores are to be seen in the body. The dorsal, ventral, and caudal fin-folds are still continuous and quite distinct.

STAGE IV (pl. xviii, fig. 3). The specimen has been sketched exactly as it was found with the mouth wide open. It gives a good idea of the relation of the upper and lower jaws The cartilage cells are very numerous and prominent at this stage. The mandibular, hyoid, and branchial arches are all well developed. The last branchial arch is rather indistinct. Rows of papilla-like outgrowths appear on the first 4 branchial arches, those of the first 3 being quite prominent. These seem to be the rudiments of the branchiae. The opercular membrane also makes its appearance.

The hyoid arch has a curved shape, and the arches of both sides meet ventrally. At their point of junction is to be seen a small cartilaginous piece (probably basihyal) projected forwards,—its hinder portion meeting the anterior prolongation of the basibranchial. The various divisions of the arches are not yet differentiated. The cartilaginous cranium is formed and is still more or less transparent. The heart may be faintly made out, as before, beneath and behind the basibranchial cartilage. The gas-bladder takes an elongated shape, and its dorsal surface is deeply pigmented black. Its anterior prolongation becomes indistinct, but its posterior prolongation is quite distinct, and it seems to open just behind the anus by a distinct slit. The notochord is well developed, and is constricted off into a number of pieces, to form the beginning of the future vertebral column. The skeletogenous layer has started its work, and the skeletogenous cells may be seen in large numbers just at the base and above the notochord. In the latter place they are quite abundant, and may be seen to enclose the spinal cord. The heterocercal tail is fairly well developed, but the fin-rays have not yet made their appearance. The myotomes are well developed, and the transparency of the body is still to a large extent retained. The alimentary canal seems in some places to consist of a solid cord of cells, and the cavity is obliterated, but this may be due to external causes.

The liver may be seen as a thick mass of cells, in front of the stomach. The big stellate chromatophore still persists, though it is now much reduced in size. In addition to it, a number of small chromatophores (about 16) make their appearance on the ventral side of the body. The fin-folds are still continuous, though much norrowed towards the caudal end.

STAGE V (pl. xviii, fig. 4). This stage is much more advanced than stage IV The intermediate stages which would have been very interesting are missing. The snout or beak does not seem to have kept pace with the enormous increase in the length of the body. In fact, I tried to establish a ratio between the length of increase of the body, the gas-bladder and the beak, but failed hopelessly. The above table (p. 388) will show that the increase in the length of the beak has no relation whatsoever with the development of the body.

The operculum is well developed and the branchial arches can only be indistinctly made out. The papilla-like outgrowths have reached a considerable size and are quite a characteristic feature of this stage. The cranium is fairly well developed, and its transparency is lost. The gas-bladder has kept pace with the increase in length of the body and the same is the case with the alimentary canal. The position of the gas-bladder in the body is now denoted only by a long series of deeply pigmented bodies close beneath the notochord. On a careful examination under the high power of the microscope a dense network of capillaries may be seen lining the walls of the gas-bladder. These capillaries probably form the "retia mirabilia" or "red bodies" of the adult. They are arranged in fan-like tufts over almost the whole extent of the inner surface of the gas-bladder. Owing to the opacity of the body the notochord is not distinctly visible, but it is being gradually enveloped by the skeletogenous cells to form the future vertebral column. The condition of the tail is midway between

the heterocercal and homocercal type—a rather nearer approach to the latter. The caudal fin-rays are quite distinct.

The gradual growth of the myotomes has increased the opacity of the body. The chromatophores of the last stage have all disappeared, except of course those of the gas-bladder. In their place we find a paired ventral row of chromatophores, which probably become attached together and form a continuous streak between the anus and the caudal fin. A middle paired row (one on either side of the body) consisting of about 24 chromatophores, occurs on the sides of the body and in a lateral view seems to lie over the notochord. A dorsal paired row lies on the dorsal surface of the body. Each row consists of 16 distinct anteriorly situated chromatophores, and a continuous streak posteriorly consisting of about 9 chromatophores. Pigment spots also make their appearance in the upper jaw. Large irregular pigment bodies are to be seen on the dorsal and lateral sides of the head. They are irregular in their distribution (not shown in the figure). Ventrally in the anterior region of the trunk close behind the head, a line of small black pigment spots make their appearance. The dorsal and ventral fin-folds still exist, though in a much more modified form. The dorsal and anal fins are developed, but their skeletal structures are not yet visible.

STAGE VI (pl. xviii, fig. 5). There is not much difference between this stage and the previous one. The snout in particular shows very little increase, while the general increase in length is ·75 mm. The bony framework of the skull is developing fast and the head region has become quite opaque except on the ventro-lateral edge, where the branchiae are just visible through the operculum. The gas-bladder becomes more densely pigmented. All the 3 paired rows of pigments described in the previous stage are present. The pigments in the head region are repeated again as in the previous stage, except that now the beak also acquires pigments.

The tail acquires true homocercy. The caudal fin-rays are well developed, and faint traces of segmentation are visible in it. The myotomes have considerably grown in thickness and nearly completely hide the notochord from view. There are about 45 myotomes of which 40 are quite distinct. The dorsal and anal fins are fairly well developed and their skeletal structures are also visible. Very faint traces of them were really found in the previous stage. A careful examination under the high power of the microscope reveals the presence of pterygiophores (Parker) or radial elements (Bridge). Corresponding to each fin-ray there is a baseost and an axonost (Cope), the former lying between the heads of two adjacent axonosts as a small round body. The ventral fin-fold still persists, though the dorsal fin-fold disappears. Another striking feature is the appearance of the pectoral fin close behind the operculum.

STAGE VII. The general pigmentation of the body is the same as in the previous stage. The pigments in both the upper and lower jaws and the head are better developed than in stage VI. The fins are pigmented.

STAGES VIII, IX, X, XI, and XII. These stages are marked by the gradual growth of the body beak, and gas-bladder. The pigmentation is practically the same as in stage VII. A gradual growth of the gills, the bones of the skull, and the

skeletal structures of the pectoral, caudal, dorsal, and ventral fins takes place. The ventral fin-fold persists, and the pelvic fin has not yet made its appearance.

STAGE XIII (pl. xviii, fig. 6). The specimen measures 12 mm. in length. The myotomes are fully developed, and more or less completely hide from view the organs inside the body. The prolongation of the lower jaw as snout or beak becomes quite a prominent feature, being just over $\frac{1}{3}$ of a mm. in length. The pelvic fin makes its appearance for the first time. The dorsal and anal fin-rays are well developed. The dorsal fin contains 11 distinct and 2 or 3 indistinct fin-rays. The anal fin contains 14 distinct fin-rays. The ventral fin-fold still persists though faintly, but seems to be interrupted or folded up in the region of the pelvic or ventral fin. The animal is now really a young fish in nearly all respects, and thus marks the termination of the larval stage.

EXPLANATION OF PLATE XVII.

Gobius ostreicola, Chaudhuri.

FIG. 1.—Ovum attached to a dead Oyster shell.

,, 2.—Lateral view of the embryo, inside the egg-membrane.
a=eye; *b*=continuous fin; *c*=notochord; *d*=ear; *e*=beginning of nervous system; *f*=heart; *g*=egg-membrane; *h*=pedicle; *i*=filaments; *j*=yolk.

,, 3.—An empty egg-membrane attached to the shell by means of filaments.

,, 4.—Ventral view of an embryo slightly older than the one seen in fig. 2.

,, 5.—Lateral view of the embryo, showing a heterocercal tail.
a=heart; *b*=two streaks of chromatophores lying above and beneath the notochord; *c*=posterior portion of the notochord; *d*=yolk; *e*=eye; *f*=pre-anal fin; *g*=anus.

,, 6.—Dorsal view of a slightly older embryo.
a=gas-bladder; *b*=pectoral fin; *c*=tail curved; *d*=yolk.

,, 7.—Dorsal view (diagrammatic).
a=pectoral fin (fan-shaped); *b*=two streaks of chromatophores; *c*=caudal fin; *d*=dorsal fin; *e*=chromatophore; *f*=gas-bladder.

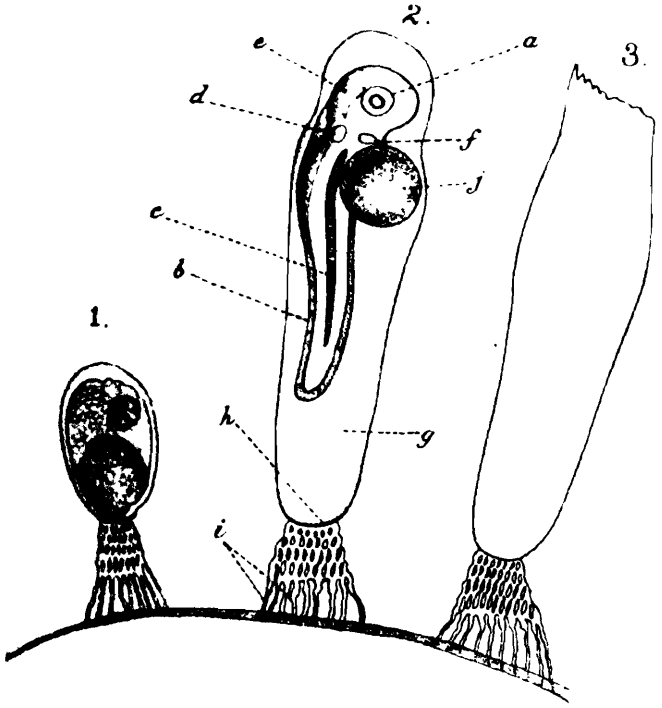
Petroscirtes bhattacharyae, Chaudhuri.

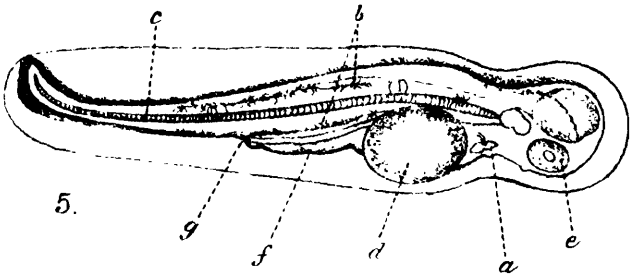
FIG. 8.—Lateral view of the smallest specimen at stage I.
a=opercular spine; *b*=pectoral fin; *c*=anus; *d*=notochord; *e*=dorsal fin-fold; *f*=caudal fin-fold; *g*=ventral fin-fold; *h*=chromatophores.

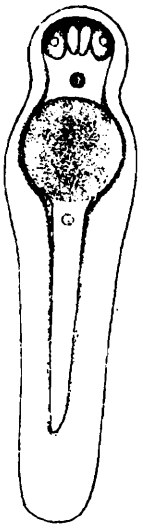
,, 9.—Dorsal view of the medium-sized specimen at stage II.
a=frontal prominence; *b*=narial tentacles; *c*=eye; *d*=operculum; *e*=opercular spine; *f*=pectoral fin; *g*=brain; *h*=dorsal fin; *i*=dorso-lateral (paired) membranous fin-fold.

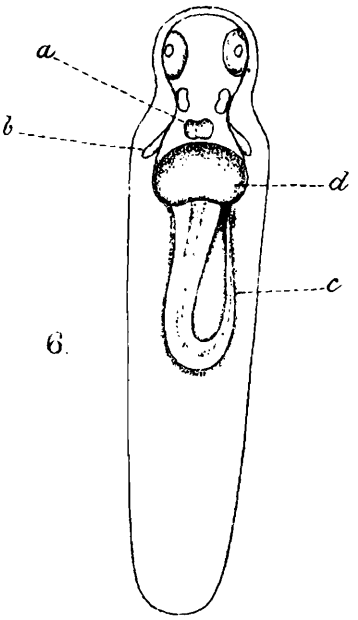
,, 10.—Lateral view of the largest specimen at stage III.
a=eye; *b*=frontal prominence; *c*=mouth; *d*=opercular spine; *e*=operculum; *f*=pectoral fin; *g*=pelvic (ventral) fin; *h*=dorsal fin; *i*=myotome; *j*=longitudinal horizontal septum; *k*=anal fin; *l*=dorso-lateral membranous fin-fold; *m*=caudal fin.

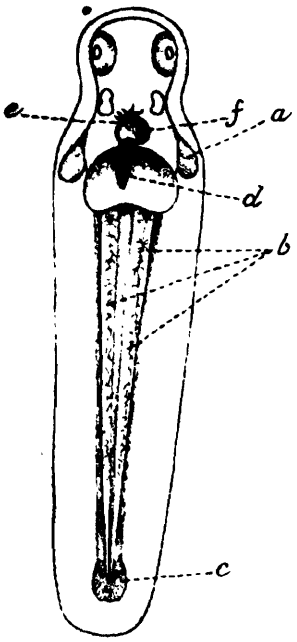
,, 11.—A portion of the dorsal fin with its left membranous fin-fold.
a=myotome; *b*=longitudinal horizontal septum; *c*=conical muscular process; *d*=spine (unsegmented fin-ray); *e*=left membranous fin-fold; *f*=pigments; *g*=epiaxial portions of myotomes; *h*=dorsal fin.

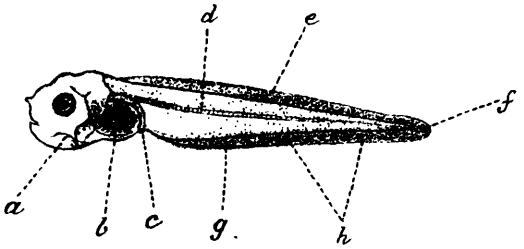


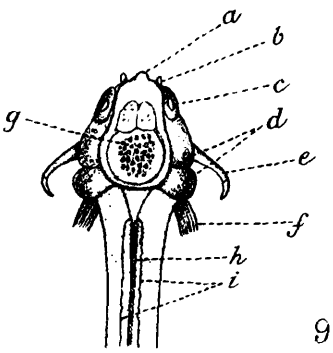


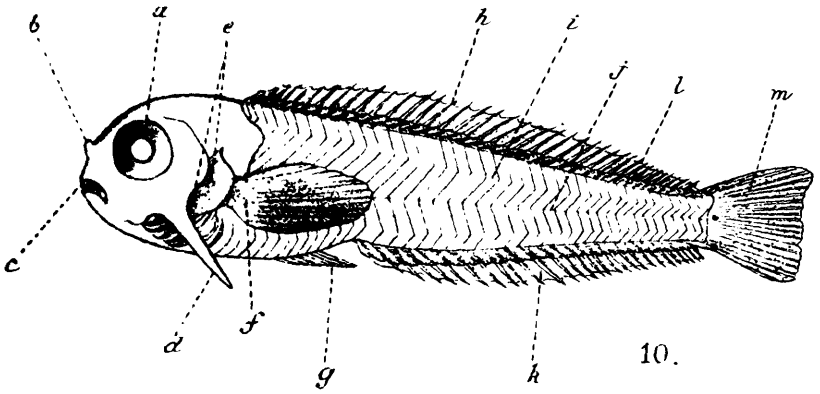


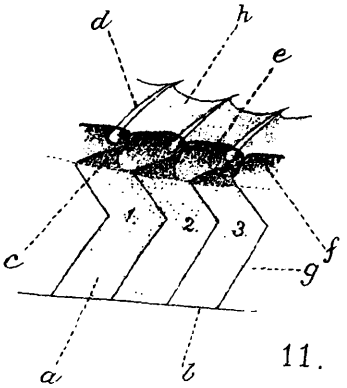












D.R.B. del.

A. Chowdhary, lith.

EXPLANATION OF PLATE XVIII.

Hemiramphus limbatus, Cuv. and Val.

FIG. 1.—An outline of the larva at stage III, × 40.

,, 2.—The head region of the larva showing the development of the visceral arches, × 80.

,, 3.—The larva at stage IV, × 40.

,, 4.—The larva at stage V, × 30.

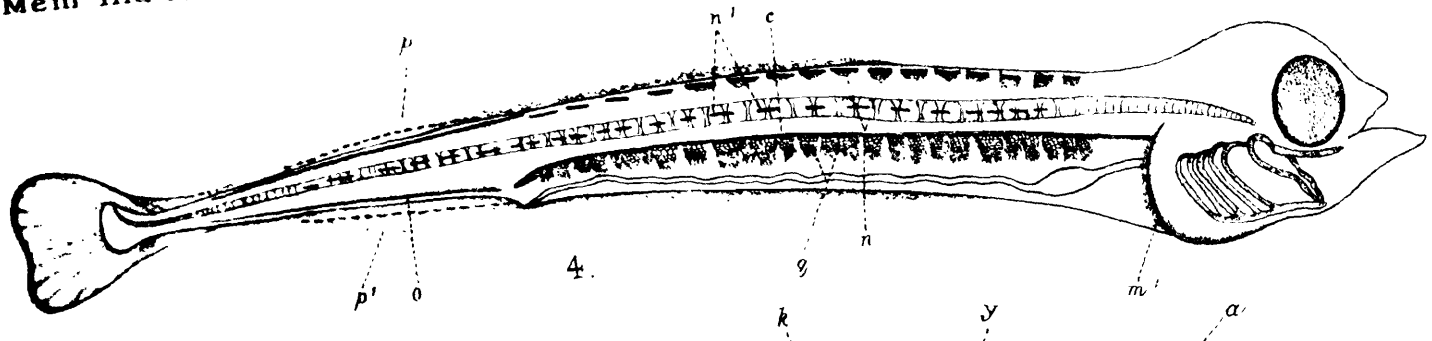
,, 5.—The larva at stage VI, × 30.

,, 6.—A young fish at stage XIII, × 20.

EXPLANATION OF LETTERING.

a = eye; *a'* = beak; *b* = visceral arch; *b'* = heart; *c* = gas-bladder; *c'* = stomach; *d* = oesophagus; *e* = anus; *e'* = notochord; *f* = chromatophore (big); *g* = caudal fin; *g'* = dorsal fin-fold; *h* = ventral fin-fold; *i* = rudiments of branchiae: *j* = liver; *k* = chromatophores in gas-bladder; *k'* = chromatophores (small); *l* = upper jaw; *m* = parallel rows of cartilage cells; *m'* = operculum; *n* = dorsal row of chromatophores; *n'* = middle row of chromatophores; *o* = ventral row of chromatophores; *p* = dorsal fin; *p'* = anal fin; *q* = retia mirabilia; *r* = pectoral fin; *s* = caudal fin: *t* = fin-ray; *u* = baseost; *v* = myotomes; *w* = pelvic or ventral fin; *x* = axonost; *y* = brain and spinal cord.

Mem Ind Mus., Vol. V, 1916.



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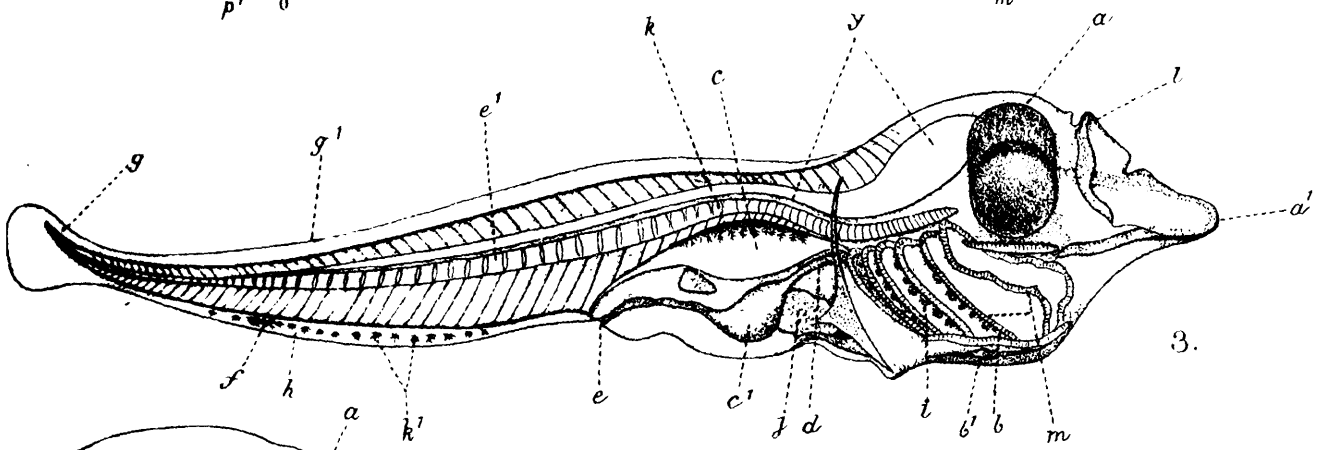

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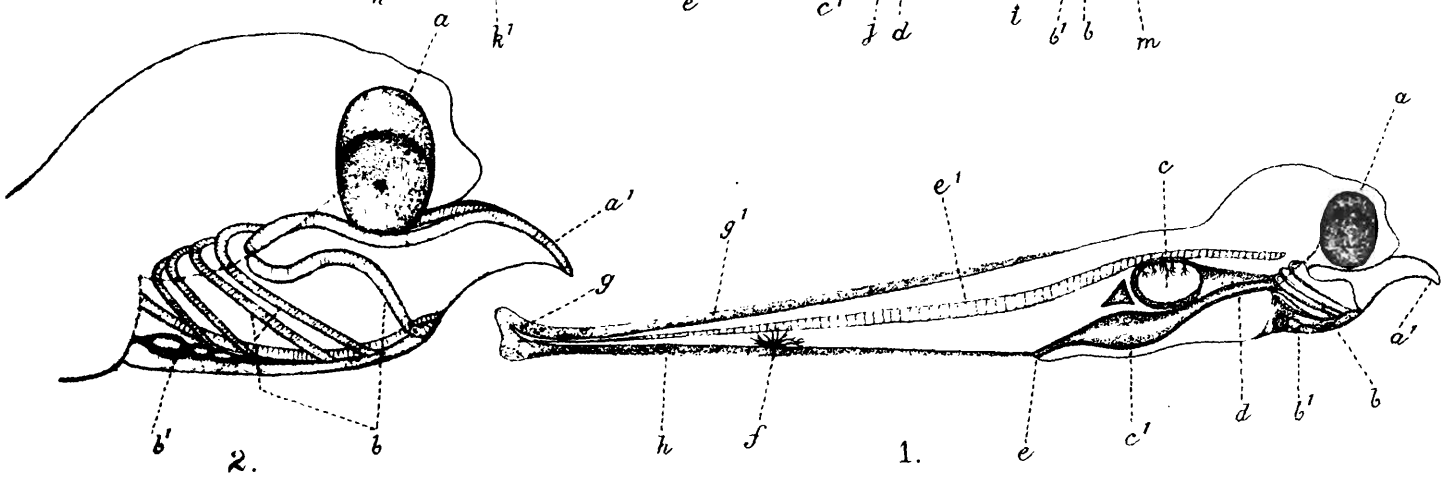

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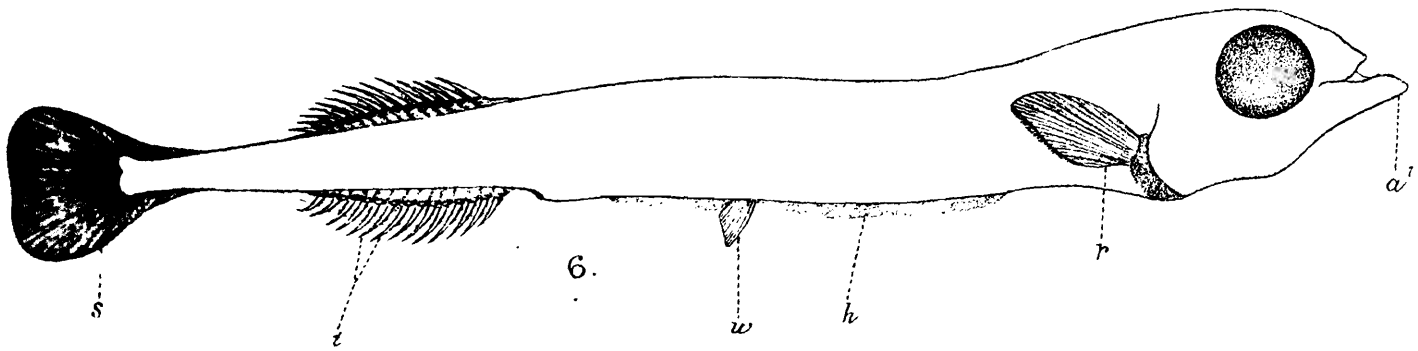

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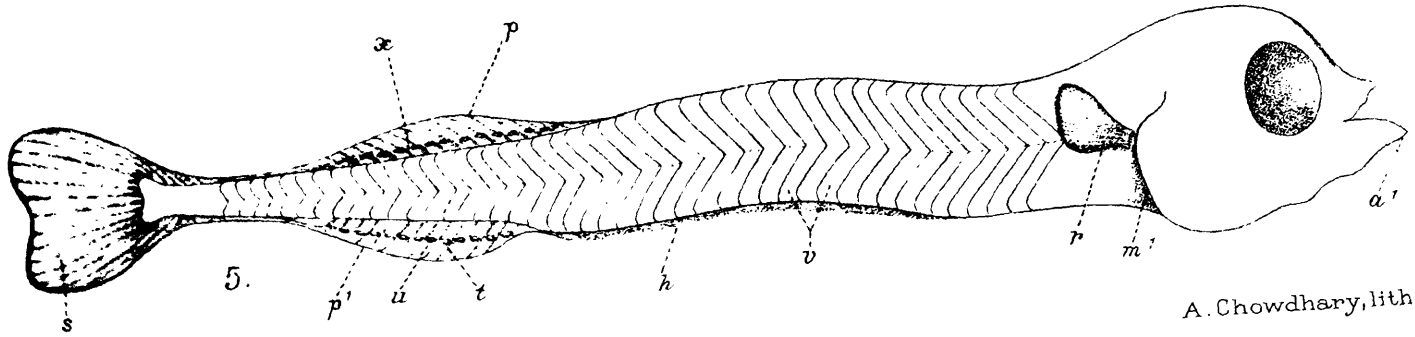

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A. Chowdhary, lith.

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FAUNA OF THE CHILKA LAKE

CUMACEA.

By STANLEY KEMP, *B.A.*

(With 5 text-figures.)

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CUMACEA.

By STANLEY KEMP.

The Cumacea found in the Chilka Lake belong to two species both of which appear to be undescribed. They belong respectively to the genus *Iphinöe* of the family Bodotriidae and to *Paradiastylis* of the family Diastylidae. No species of either of these genera has hitherto been recorded from brackish water and the group as a whole is essentially marine in habitat.

The *Iphinöe* was found only in the main area of the lake. It occurred rarely in March in water of specific gravity 1·008, but was taken in abundance later in the year in water that was almost or quite fresh. Only females of this species were discovered.

The *Paradiastylis* was common in the main area of the lake at all times of the year and, in the freshwater season, was found in the outer channel. The species is evidently able to thrive in water varying in specific gravity from 1·000 to 1·015.

Family BODOTRIIDAE.

Genus **IPHINÖE**, Bate.

Iphinöe sanguinea, sp. nov.

Of this species females only were obtained.

The carapace, including the pseudorostral lobes, is about two-sevenths the total length, excluding uropods. The depth of the carapace is a little more than half its length. The pseudorostral lobes are scarcely upturned; they are apically pointed and the margin of each, below the apex, is obliquely truncate—slightly concave anteriorly and a little convex in advance of the exceedingly shallow antennal notch. The convexity bears a series of about five small forwardly-directed teeth and further back, behind the insertion of the antennae, there is a series of some twenty similar teeth on the anterior half of the lower margin of the carapace (text-fig. 2*a*). There is no antennal tooth. The carapace is feebly carinate in the median line for a short distance behind the eye, the carina bearing five (more rarely four) small forwardly-directed teeth. The teeth are situated well in advance of the middle point of the carapace, differing conspicuously in position from those found in the Atlantic *I. trispinosa*. The carapace is otherwise devoid of sculpture, but is closely covered with a very fine reticulation, only visible under high powers of the microscope.

The first pedigerous somite is well exposed both dorsally and laterally and is not, as in *I. trispinosa*, covered at the sides by a forward prolongation of the second somite. The second somite, measured dorsally, is about one and a half times the length

of the first; the third and fourth are about equal, intermediate in length between the first and second. Except for the first, the somites are a little puckered laterally, but are otherwise without sculpture. On either side of the last three somites, near the anterior margin, is a large forwardly-directed bristle which does not seem to occur in any other species of the genus (text-figs. 1 *a*, *b*).

The abdominal segments are without carinae. In lateral view each is strongly convex ventrally in its anterior half.

In the peduncle of the first antennae (text-fig. 2 *b*) the third segment is longer than the second. At the distal end of the third segment are a few simple hairs, while in a similar situation on the first and second segments are others of a more complex nature which are illustrated in detail in text-figs. 2 *c*, *d*. The inner flagel-

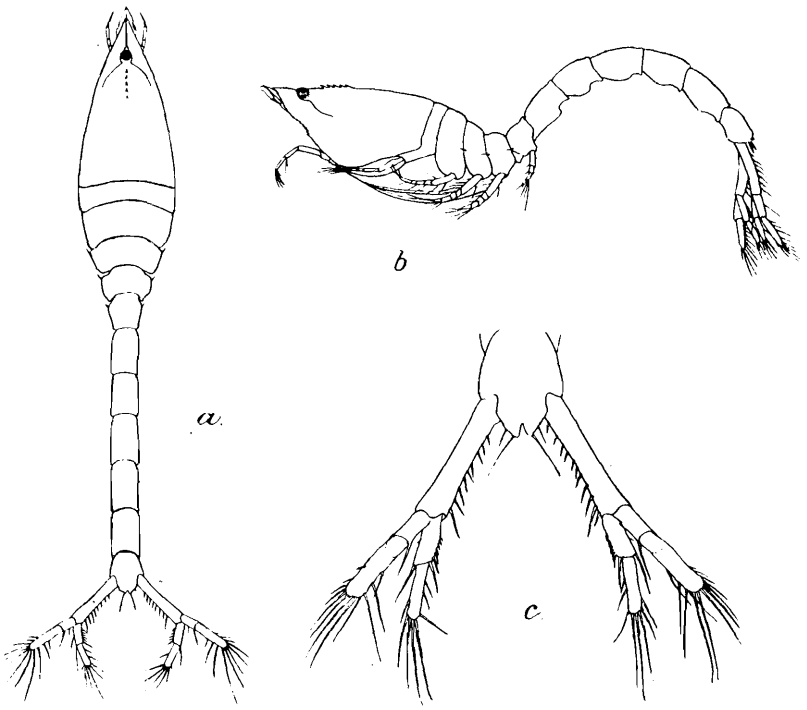

Fig. 1.—*Iphinöe sanguinea*, sp. nov. ♀

a. Female in dorsal view. *b*. Female in lateral view. *c*. Last abdominal segment and uropods.

lum is extremely small, but is two-segmented. The outer is also two-segmented and carries two long annulated filaments.

The second antennae (text-fig. 2 *b*) are very inconspicuous in the female and consist of two segments, the basal one subtriangular and the distal very slender and articulated with it at an acute angle. The distal segment bears a single long seta at its apex.

The form of the second maxillipedes is shown in text-fig. 2 *e*. In the third maxillipedes (text-fig. 2 *f*) the second segment is not much longer than the combined length of the segments distal to it. Externally the distal end of the second segment reaches a little beyond the articulation between the third and fourth; on its anterior margin is a series of six setae, the two outermost being of great length. The produced

end of the fourth segment reaches to the middle of the fifth and bears three setae externally.

In the first peraeopods (text-fig. 2 *g*) the second segment is a little shorter than the rest of the limb; its external margin is serrated near the base. The fifth segment is considerably longer than the sixth or seventh. The second peraeopods (text-fig. 2 *h*)

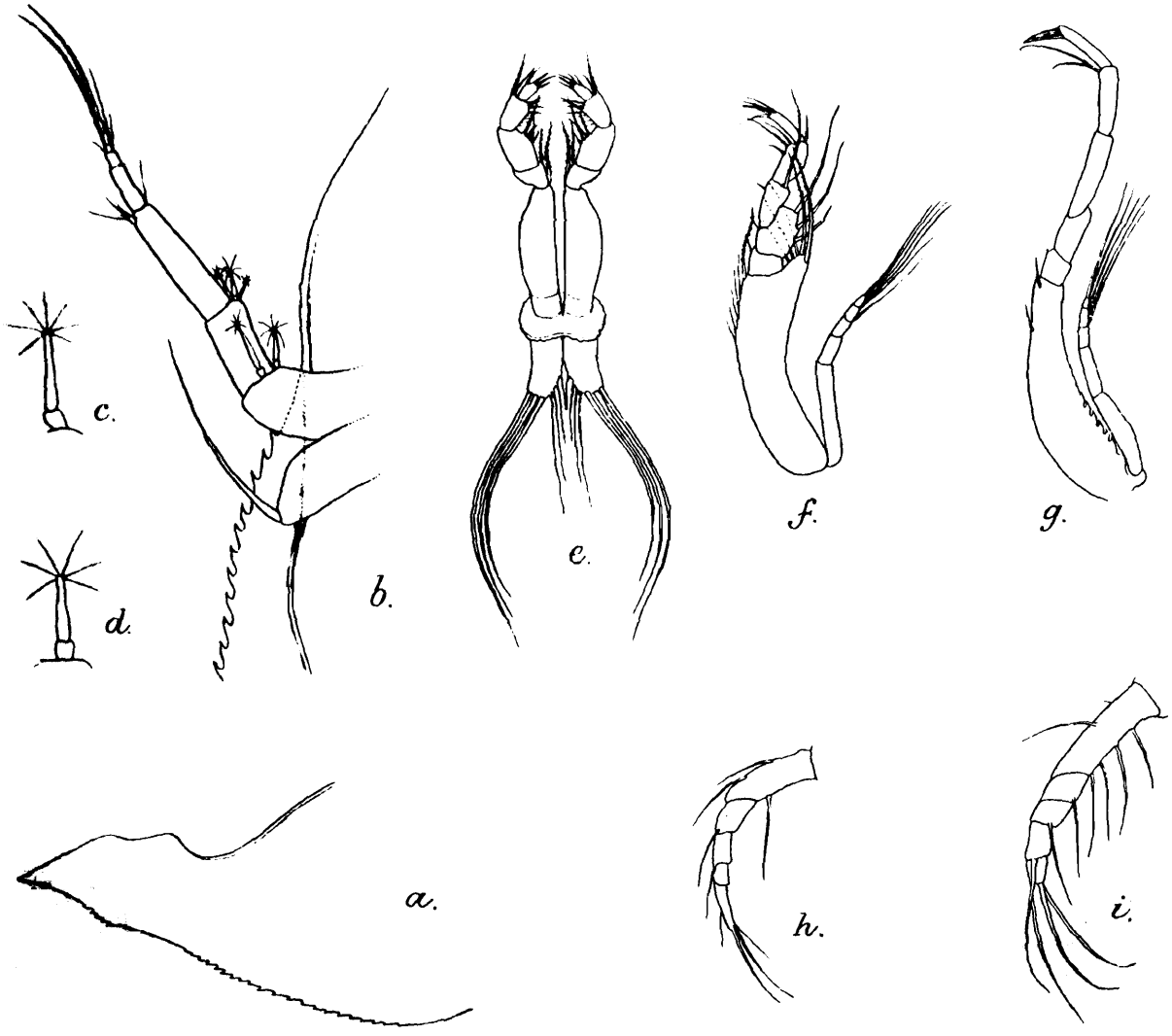

FIG. 2.—*Iphinöe sanguinea*, sp. nov. ♀.

a. Left pseudorostral lobe and adjacent part of carapace.
b. Antennule and antenna.
c, *d*. Hairs from peduncle of antennule.
e. Second maxillipedes.
f. Third maxillipede.
g. First peraeopod.
h. Second peraeopod.
i. Third peraepod.

are a little shorter than the third (text fig. 2 *i*); the ultimate segment of the former is slender and about as long as the two preceding combined.

The peduncle of the uropods (text-fig. 1 *c*) is about one quarter longer than the exopod or endopod, the two latter being subequal. On the inner margin of the peduncle there is a series of from 8 to 11 long spines. The exopod is composed of two segments. In dorsal view the ultimate is about twice the length of the penulti-

mate; the latter, however, is much produced inferiorly at its distal end and the two segments when seen from below are almost equal in length. The basal segment bears one or two setae internally and the distal some 11 or 12 distributed round its apex. Of the two segments that compose the endopod, the first is a little shorter than the second and is provided internally with a series of six or seven spines which are closely set and increase in size distally. There is also a single slender spine at the end of the outer margin. The ultimate segment bears five or six slender spines at its apex and one or two on the inner edge.

Large specimens reach a length of about 5 mm.

Stebbing in his monograph of the Cumacea[1] recognises eight species of *Iphinöe*. Of these the species from Lake Chilka is evidently most nearly allied to *I trispinosa* (Goodsir), a species found in the N. E. Atlantic from an area ranging from the Bay of Biscay to the Shetland Is. and Norway. So far as females are concerned *I. sanguinea* is easily distinguished from this species by the number and disposition of the teeth in the mid-dorsal line of the carapace, by the teeth on the lower margin of the carapace, by the form of the second pedigerous somite which does not overlap the first, by the bristles on the last three of these somites and by a great number of details in the appendages.

Iphinöe sanguinea is, when living, of a deep blood-red colour, a feature to which allusion is made in the specific name. The species was only found twice in the Chilka Lake, firstly in March, when a few specimens were obtained in the vicinity of Kalidai in water of specific gravity 1·008 (corrected), and secondly in September, much further to the north, in water that was practically fresh. On the latter occasion large numbers of specimens were collected, all of them, however, females.

The absence of males is doubtless to be attributed to differences in habits between the two sexes. The examples obtained were all caught in nets fished on soft mud at depths of between 6 and 8 ft. The males are perhaps to be found at some distance above the bottom, but I have searched our townet gatherings for them without success. There can be little doubt that the species is a permanent inhabitant of the main area of the lake: there are embryos in the brood-pouches of some of the females caught in September.

The species of *Iphinöe* hitherto described are recorded from the Mediterranean and N. E. Atlantic, from the Gulf of Guinea and from S. Africa. One species is also known from the Gulf of Manaar.

Family DIASTYLIDAE.

Genus **PARADIASTYLIS**, Calman.

Paradiastylis culicoides, sp. nov.

This species is remarkable for the great differences that exist between the sexes in the form of the apex of the telson. In the female there are two minute terminal

[1] *Das Tierreich: Cumacea*, p. 42 (1913).

spines, whereas in the male the apex is drawn out to a long, sharp, spine-like process, in this respect disagreeing with the diagnosis of the Diastylidae in Stebbing's synopsis of the families of Cumacea.[1] The peculiar structure of the telson of the male may also be proper to some other species of the genus, for the sex is unknown in two out of the three species that have been described.

Female.—The carapace (text-figs. 3 *a*, *b*) is considerably inflated and its breadth is little less than one-third the total length, uropods excluded. The surface is rather

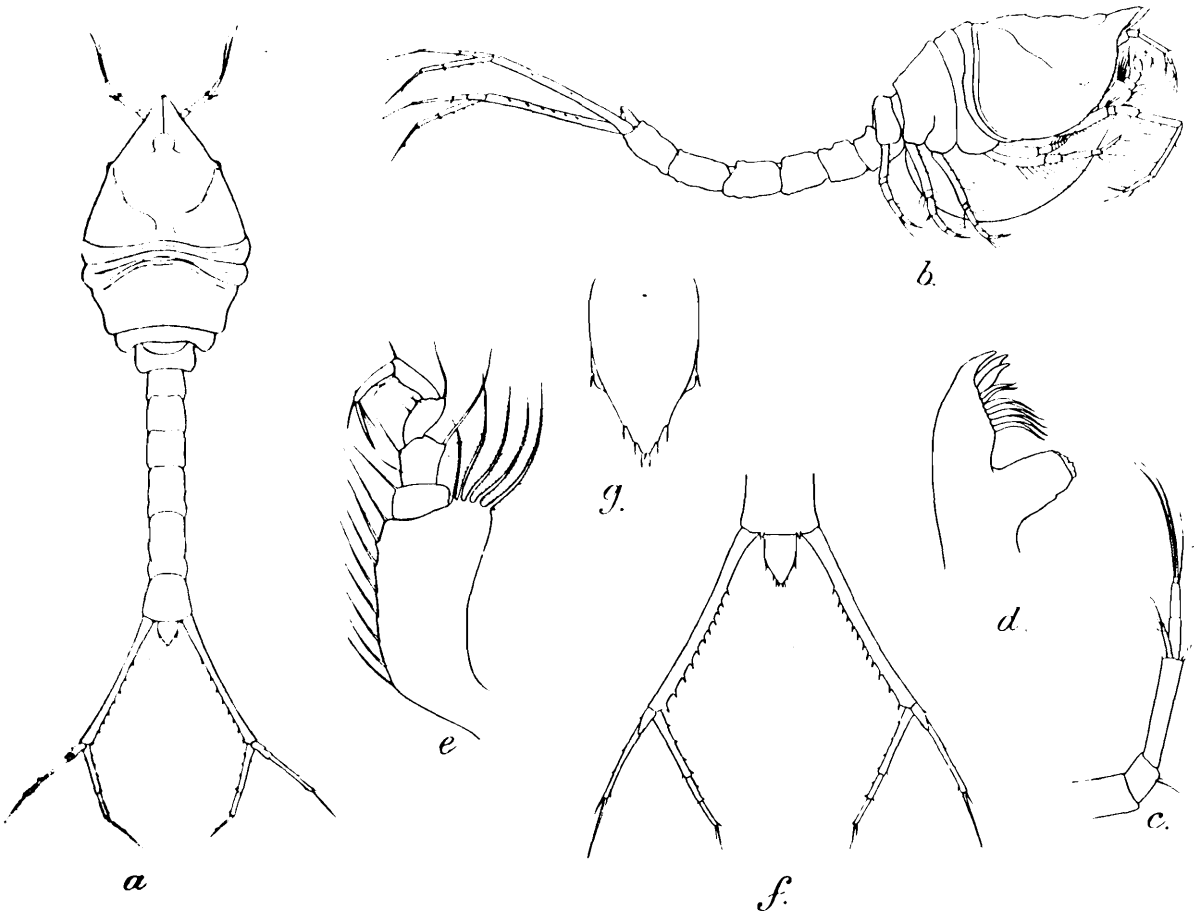

FIG. 3.—*Paradiastylis culicoides*, sp. nov. ♀.

a. Female in dorsal view.
b. Female in lateral view.
c. First antenna.
d. Mandible.
e. Third maxillipede.
f. Telson and uropods.
g. Telson further enlarged.

coarsely reticulate and bears only one oblique lateral ridge in place of the three or four which exist in other known species of the genus. The single ridge, which corresponds to the foremost of those found in allied forms, is very strong anteriorly with its edge microscopically spinulose. Posteriorly each ridge approaches, but does not reach, the median line of the carapace; it is then continued backwards and outwards, becoming very indistinct in this part of its course. Anteriorly the carapace

[1] *Das Tierreich: Cumacea*, p. 7 (1913).

is slightly elevated in the median line and the dorsal margin is rather uneven in lateral view; on either side of this elevation there is an obscure longitudinal ridge. The pseudorostral lobes are not upturned. Close to the apex the inferior margin of each is serrated and the lower margin of the carapace, behind the exceedingly shallow antennal notch, is armed with a series of coarse teeth, some twenty-five in number.

The third and fourth leg-bearing somites appear to be fused dorsally, as in Calman's *P. longipes*.

The abdominal somites are without lateral serrations. The sixth somite bears a pair of small spinules distally, one on either side of the telson.

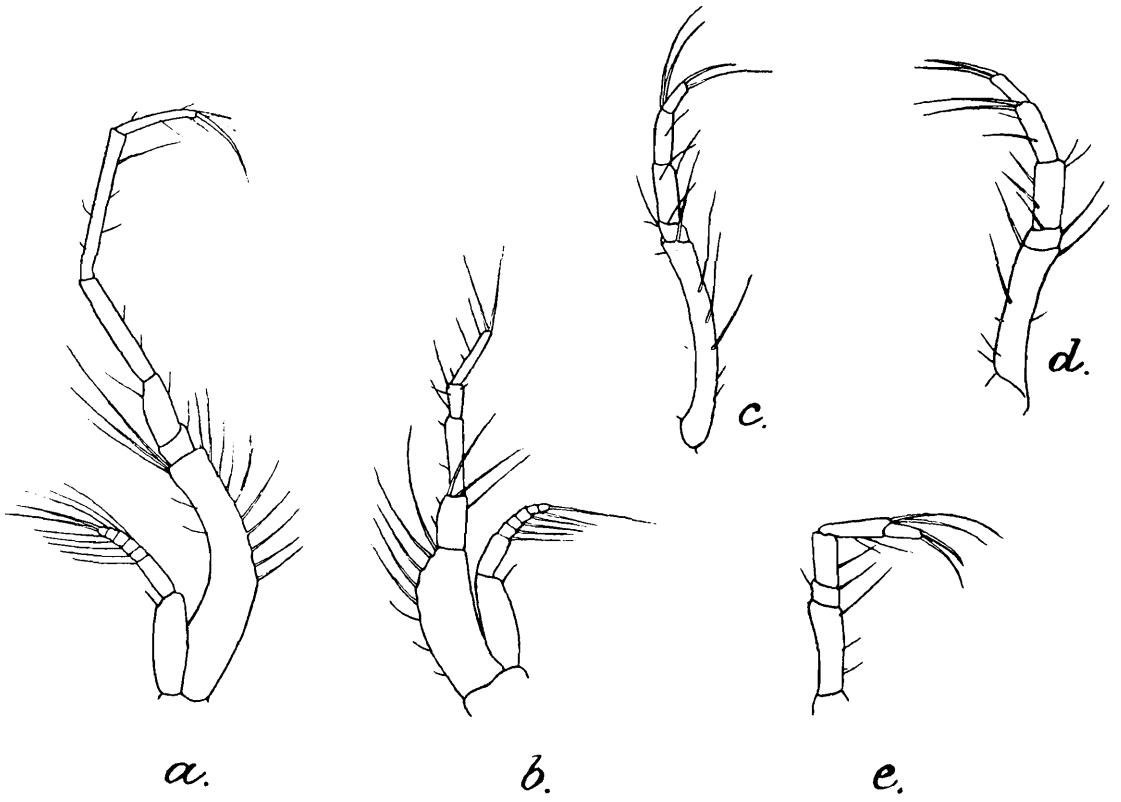

FIG. 4.—*Paradiastylis culicoides*, sp. nov. ♀

a. First leg.
b. Second leg.
c. Third leg.
d. Fourth leg.
e. Fifth leg.

The telson (text-fig. 3 *g*) is smaller than that of the allied species, being little more than half the length of the last abdominal segment. The apex bears a pair of small spinules flanked on either side by two setae.

The form of the mandible is shown in text-fig. 3 *d*.

The antennules (text-fig. 3 *c*) are apparently much as in *P. longipes*, the third segment of the peduncle being slender and about as long as the first two taken together. The larger flagellum terminates in two annulated filaments.

The third maxillipedes (text-fig. 3 *e*) are without exopods; the basis is exceptionally broad.

The first and second pairs of peraeopods (text-figs. 4 *a*, *b*) bear exopods. The former reach beyond the tip of the pseudorostrum by about half their length, the exopod, though longer than in *P. longipes*, being shorter than the basis. In their proportional lengths the segments of the endopod in this limb agree closely with Calman's figure of *P. longipes*. The remaining peraeopods (text-figs. 4 *c–e*) are slender.

The uropods (text-fig. 3 *f*) are long and slender ; the peduncle is very nearly three times the length of the sixth somite and bears from 8 to 12 spines on its inner margin. The exopod (excluding the terminal seta) is as long as the first two segments of the endopod and is half the length of the peduncle. Of the three segments composing the endopod the first is longer than the two following combined. The first segment bears four short spines on its inner margin and the second two.

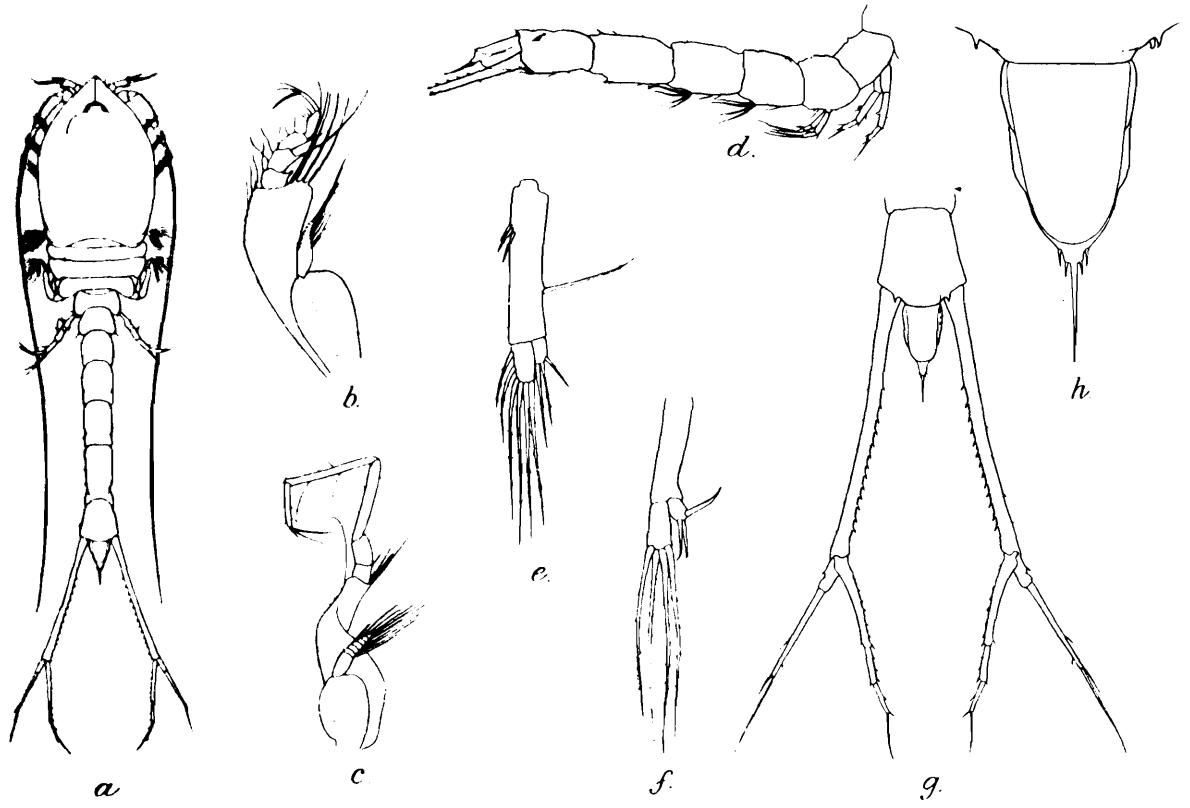

FIG. 5.— *Paradiastylis culicoides*, sp. nov. ♂.

a. Male in dorsal view.
b. Third maxillipede.
c. First leg.
d. Abdominal segments and telson in lateral view.
e. First pleopod.
f. Second pleopod.
g. Telson and uropods.
h. Telson further enlarged.

Male.—The male (text-fig. 5 *a*) is more slender than the female and shows merely the faintest trace[1] of the oblique ridge on the carapace. The pseudorostrum is also noticeably shorter and there are fewer teeth (only about ten) on the margin of the carapace behind the insertion of the antennae. The ocular lobe appears to be pro-

[1] Not shown in text-fig. 5 *a*.

vided with four corneal lenses, one on each side and a pair, partially fused in the middle. The third and fourth leg-bearing somites are quite distinct and there may be a pair of spines on the last abdominal somite on either side of the telson.

The telson (text-fig. 5*h*) is longer than in the female and is totally different in form. The upper surface is flattened and U-shaped in outline and posteriorly slopes sharply downwards to a long drawn-out apex resembling a large spine. There are two setae on either side at the base of this spine, but there is no trace of the pair of terminal spinules found in the female.

The ultimate peduncular segment of the antennule is enlarged and bears sensory setae. As in *P. longipes* both inner and outer flagella are composed of four segments. The terminal segment of the antennal peduncle is provided with eleven transverse rows of setae.

The third maxillipedes (text-fig. 5*b*) have a well-formed exopod and the basal segments of the first four legs are greatly expanded and their exopods very strongly developed.

The pleopods on the first and second abdominal segments are illustrated in text-figs. 5*e*, *f*. On the third and fourth segments (text-fig. 5*d*) they are replaced by two pairs of long setae, on the fifth by a pair of backwardly directed teeth, each bearing a small setae behind the apex. On the sixth there is a single pair of setae.

The uropods (text-fig. 5*g*) are more slender than those of the female, but do not differ markedly in structure.

Large females of *P. culicoides* reach a total length of about 4 mm.; males are a trifle smaller, rarely exceeding $3\frac{1}{2}$ mm.

The species differs conspicuously from all others of the same genus in the presence of only a single oblique ridge on the carapace.

Living females in their form and movements bore a curious resemblance to pupae of mosquitoes. Both sexes were of a pale brown colour.

We obtained females in abundance in all parts of the main area of the lake in nets drawn over the surface of the mud at depths of from 6 to 12 ft. Males were found in company with the females, but were much scarcer. A few females were found at the inner end of the outer channel in September in water that was almost or quite fresh. Earlier in the year, when the water in this locality was as salt as that of the sea in the vicinity of the lake, we failed to find any specimens. The species is evidently a permanent inhabitant of the main area of the lake, living in water that varies in specific gravity from 1·000 to 1·015.

The three species of the genus hitherto known are recorded from Japan, the Gulf of Manaar, the Sulu Archipelago and the Gulf of Siam.

FAUNA OF THE CHILKA LAKE

FISH.

PART I.

By B. L. CHAUDHURI, *D.Sc.* (*Edin.*), *F.R.S.E.*, *F.L.S.*

(With 11 text-figures.)

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FISH. (*PART I.*)

By B. L. CHAUDHURI.

This part contains a systematic treatment of the Sub-orders Selachii and Batoidei of the Order Plagiostomi and of two Sub-orders (Malacopterygii and Ostariophysi) of the Order Teleostei. The total number of specimens examined and recorded in this part is 823, which are found to belong to forty-two species. Of these four are new to science. These forty-two species fall into twenty-five genera belonging to nine different families. The geographical and biological results of my study of the fish fauna of the lake will be discussed on the completion of the systematic notice of the entire collection.

Order PLAGIOSTOMI.

Suborder *SELACHII.*

Family CARCHARINIDAE.

Genus **PHYSODON**, Müller and Henle.

Physodon mulleri, Müller and Henle.

1841. *Carcharias (Physodon) mulleri*, Müller and Henle, *Plagiost.*, p. 30, pl. xix, fig. 1.
1878. *Carcharias mulleri*, Day, *Fish. Ind.*, p. 713.
1889. *Carcharias mulleri*, Day, *Faun. Brit. Ind., Fish.*, I, p. 11.
1913. *Physodon mulleri*, Garman, *Mem. Mus. Comp. Zool.* (Harvard), XXXVI, p. 108.

One young specimen (female), 355 mm. in total length, was collected at Rambha in March 1914.

The teeth are not serrated; their cusps are long with broad and somewhat swollen bases, bent towards the angle of the mouth; on the upper jaw there is a small median tooth and there are two small teeth on the symphysis of the lower jaw. The head is broader than deep; the snout is pointed and is about one-third of the distance from the tip of the snout to the fifth gill-cleft; the nostrils are very close to the mouth, their distance from it being only one-fifth of the distance from the tip of the snout to the mouth; the mouth is greatly arched; the eyes, which are lateral, are small and are provided with a nictitating membrane at least on the anterior side; the gill-clefts are wider than the eyes. The second dorsal fin is very small and extends a little further back than the anal fin; there is a distinct pit anterior to the root of the caudal fin. The denticles are very small and numerous.

To judge from the part of the lake in which it was obtained, it is probable that the species is a permanent inhabitant in the main area.

Distribution:—Bengal and China.

Genus **CARCHARINUS**, Blainville.

Carcharinus gangeticus (Müller and Henle).

1841. *Carcharias (Prinodon) gangeticus*, Müller and Henle, *Plagiost.*, p. 39, pl. xiii.
1878. *Carcharias gangeticus*. Day, *Fish. Ind.*, p. 715, pl. clxxxvii, fig 1.
1889. *Carcharias gangeticus*, Day, *Faun. Brit. Ind., Fish.*, I, p. 13.
1913. *Carcharinus gangeticus*, Garman, *Mem. Mus. Comp. Zool.* (Harvard), XXXI, p. 139.

A specimen was obtained at Satpara in March 1914, the total length of which is 747 mm. The jaw of a young fish was also secured at Rambha in February of the same year. The length and the breadth of this jaw are 68 mm. and 43 mm. respectively. There are 27 rows of teeth in the upper jaw with five teeth in each row and 25 rows in the lower jaw with 6 teeth in each row. There is only one tooth in the middle of each jaw and it is very small. The rest of the teeth are fairly large, generally with long cusps and broad bases, and their margins are serrated; in the end rows, however, the cusps are very short and bent inwards with the bases somewhat swollen.

The species is found in the main area and is probably a permanent inhabitant of the lake.

Distribution:—The species is met with in the seas and estuaries of India, in Japan, the Fiji Islands and at Baghdad. Individuals are known to ascend rivers above tidal influence.

Carcharinus melanopterus (Quoy and Gaimard).

1824. *Carcharias melanopterus*, Quoy and Gaimard, *Voy. Uran. Poiss.*, p. 194, pl. xliii, figs. 1 and 2.
1878. *Carcharias melanopterus*, Day, *Fish. Ind.*, p. 715, pl. clxxxv, fig. 3.
1889. *Carcharias melanopterus*, Day, *Faun. Brit. Ind., Fish.*, I, p. 14.
1913. *Carcharinus melanopterus*, Garman, *Mem. Mus. Comp. Zool.* (Harvard), XXXVI, p. 134.

There is no specimen of this species in the collection. Dr. Jenkins, however, reported (*Rec. Ind. Mus.*, V, p. 135) that he obtained the species at Satpara in December, 1908. Probably it is an occasional visitor to the outer channel when the water becomes brackish.

Distribution:—This species is found in the seas of India and of the Malay Archipelago.

Suborder *BATOIDEI.*

Family PRISTIDAE.

Genus **PRISTIS**, Klein.

Pristis pectinatus, Latham.

1794. *Pristis pectinatus*, Latham, *Trans. Linn. Soc.*, II, p. 278, pl. xxvi, fig. 2.
1822. *Squalus pectinatus*, Hamilton Buchanan, *Fish. Gang.*, pp. 5, 361.
1841. *Pristis pectinatus*, Müller and Henle, *Plagiost.*, p. 109.
1878. *Pristis pectinatus*, Day, *Fish. Ind.*, p. 811.
1889. *Pristis pectinatus*, Day, *Faun. Brit. Ind., Fish.*, I, p. 39.
1909. *Pristis pectinatus*, Annandale, *Mem. Ind. Mus.*, II, p. 7.
1913. *Pristis pectinatus*, Garman, *Mem. Mus. Comp. Zool.* (Havard), XXXVI, p. 262.

In the collection there is only one skull with the rostrum, collected in December, 1914 at Nalbano Island. This is the only record we possess of a sawfish in the lake.

The rostrum from the eye to the tip measures 26·5 mm. There are 26 teeth on the right and 23 on the left. The teeth on the left side nearer the head are most irregular. The width of the rostrum in the middle portion is nearly uniform, being 30 mm. At the tip it is only 17 mm. and at the base 50 mm.

This species appears to be only an occasional visitor to the lake.

Distribution:—Tropical and temperate seas, the Red Sea, the Indian Ocean and beyond.

Family TRYGONIDAE.

Genus **TRYGON**, Cuvier.

Trygon uarnak (Forskål).

1775. *Raia uarnak*, Forskål, *Descript. Anim.*, pp. viii, ix.
1878. *Trygon uarnak*, Day, *Fish. Ind.*, p. 737 (in part).
1889. *Trygon uarnak*, Day, *Faun. Brit. Ind., Fish.*, I, p. 53 (in part).
1909. *Trygon uarnak*, Annandale, *Mem. Ind. Mus.*, II, p. 22, pl. i, figs. 1 and 2; pl. ii. figs. 1 and 1*a*; pl. iii, fig. 2*c*.
1910. *Trygon uarnak*, Gunther, *Sudsee Fische*, III, p. 492.
1913. *Dasybatus uarnak*, Garman, *Mem. Mus. Comp. Zool.* (Harvard), XXXVI, p. 376.

There is only one young specimen (female) in the collection; it was purchased from a fisherman at Satpara. The dorsal surface is covered with round and black spots on a greyish white ground. The measurements of the specimen are given below:—

Breadth across disk	290 mm.
Tip of snout to root of tail	264 „
Mouth to vent	177 „
Length of tail	720 „
Breadth of the mouth	25 „
Interorbital space	49 „
Length of snout	71 „

The species is a permanent inhabitant of the lake, in the shallower parts of which it is common.

Distribution:—Indian Ocean, Red Sea, Gulf of Siam, East Indies.

Trygon pareh, Bleeker.

1851. *Trygon pareh*, Bleeker, *Verhand. Batav. Genoots.*, p. 71, t. xxiv.
1860. *Trygon ellioti*, Blyth, *Journ. Asiat. Soc. Bengal*, xxix, p. 41.
1865. *Trygon pareh*, Duméril, *Hist. Nat. Poiss.*, I, p. 590.
1909. *Trygon alcockii*, Annandale, *Mem. Ind. Mus.*, II, p. 27, text-fig. 3.

This is a medium-sized *Trygon*, the disk of which is slightly broader than long, with the pectoral angles rounded. The snout is pointed and forms nearly a right angle at its extremity. The interorbital distance is contained about one and half times in the length of the snout and four and a half times in the length of the disk, which is moderately flat. Of the four specimens collected a young one has a smooth central dorsal tubercle and another behind it, surrounding which there is a group of

small tubercles indefinitely scattered. In this species the denticles do not form as definite a pattern as in *Trygon gerrardi*. The tail is provided with a single serrated spine, and its dorsal and lateral surfaces are uniformly covered with denticles. The cross-section of the tail anterior to the spine is distinctly flattened, which character marks it off from allied species, in all of which the cross-section in that position is circular. In a young male specimen the tail is more than three and a half times the length of the disk, but in an adult female its length (perhaps mutilated) is only one and a half times that of the disk.

Colour:—The dorsal surface of the disk is dark olive-brown and the dorsal and lateral surfaces of the tail are also brown without markings; the ventral surface (including the base of the tail) is white suffused with pink. The measurements of the four specimens in the collection are given below:—

	Adult ♂, Nalbano, Nov. 1914.	Adult ♀, Balugaon, 2-i-15.	Adult ♀ Balugaon, 4-i-15.	Young ♂, Balugaon, 5-i-15.
	mm.	mm.	mm.	mm.
Breadth of disk	530	582	546	198
Length of disk	512	582	538	190
Distance between the eyes	68	71	66	38
Snout	106	127	117	43
From the broadest part of the disk to the end of the snout.	215	242	221	68
Breadth of mouth	43	51	49	17
Distance between mouth and vent ..	317	381	320	144
Tail	912	Mutilated	762	594

The adult female from Balugaon collected on the 2nd of February, 1915 is slightly peculiar in the shape of the disk, the angle at the snout being somewhat obtuse; its caudal spine is wanting but perhaps it was lost during life; the tail, which is very short, must have been mutilated, and is, moreover, less flat than in the rest of the specimens.

This species is a permanent inhabitant of the main area, probably breeding in the lake.

Distribution:—R. Hughli, Bay of Bengal, Malay Archipelago.

Trygon imbricata (Schneider).

1801. *Raia imbricata*, Schneider, Bloch's *Ichthyol.*, p. 366.
1841. *Trygon imbricata*, Müller and Henle, *Plagiost.*, p. 164.
1841. *Trygon walga*, Müller and Henle, *ibid.*, p. 159, pl. li, fig 1.
1878. *Trygon imbricata*, Day, *Fish. Ind.*, p. 739.

1889. *Trygon imbricata*, Day, *Faun. Brit. Ind., Fish.*, I, p. 52.
1909. *Trygon imbricata*, Annandale, *Mem. Ind. Mus.*, II, p. 32, text-fig. 6, pl. iii, fig. 5.
1913. *Dasybatus imbricatus*, Garman, *Mem. Mus. Comp. Zool.* (Harvard), XXXVI, p. 379.

This small *Trygon* is very common all over the lake-system at all times of the year and breeds in the lake. There are three adult specimens in the collection; one was obtained off Samal Island (22-ix-13), one at Rambha (February, 1914) and the other at Balugaon (5-i-15). Besides these, there are four embryos two of which are small males and the other two still smaller females. The female embryos are slightly longer than broad, whereas in the males the disk is almost as broad as long. The length of the tail in the male embryos is nearly double the length of the disk, whereas in the female embryos the tail is only slightly longer than that of the disk. As the tails in these cases cannot have been mutilated, these proportions are of interest. The localities with the measurements of the embryos are given below. The two younger embryos have the numerous trophonematous filaments still present on all the gill-slits.

Locality and date of collection.		Length of disk in mm.	Breadth of disk in mm.	Length of tail in mm.	Length of umbilical cord in mm.
Barkul, Sept. 1914	♂	60	60	105	U. C. broken, no filaments.
Patsahanipur, 8-iii-14	♂	46	45	60	U. C. 15 mm. with a bulbular yolk sac at the end, no filaments.
Outer Channel, Satpara, 21-iii-14	♀	33	30	40	U. C. 17 mm. with y. s. at the end, numerous filaments entering gill slits.
Ditto	♀	27	24	30	U. C. 13 mm. with y. s. at the end, numerous filaments entering gill slits.

The food of this species consists chiefly of Amphipods and other small Crustacea and of burrowing Molluscs such as *Solen*.

The alimentary canal is remarkably free from parasites.

***Distribution*:**—East Indies.

Genus **HYPOLOPHUS**, Müller and Henle.

Hypolophus sephen (Forskål).

1775. *Raia sephen*, Forskål, *Descript. Anim.*, p. 17, no. 16.
1822. *Raia sancur*, Hamilton-Buchanan, *Fish. Gang.*, pp. 2, 361.
1841. *Hypolophus sephen*, Müller and Henle, *Plagiost.*, p. 170.
1878. *Trygon sephen*, Day, *Fish. Ind.*, p. 740, pl. cxcv, fig. 2.
1889. *Trygon sephen*, Day, *Faun. Brit. Ind., Fish.*, I, p. 50, fig. 21.
1909. *Hypolophus sephen*, Annandale, *Mem. Ind. Mus.*, II, p. 35, pl. v, fig. 1.
1913. *Dasybatus sephen*, Garman, *Mem. Mus. Comp. Zool.* (Harvard), XXXVI, p. 384.

This large species of fringe-tailed sting-ray is found everywhere in the lake-system and always in very large numbers in the main area. It breeds in the lake. Together with *Trygon fluviatilis* (H.B.), it has long been known to produce its young in fresh water in India (*Journ. Asiat. Soc. Bengal* (n.s.), VI, p. 497).

The measurements of two embryos are given below; one, a male, is very young, while the other—a female—is almost fully formed. The disk of the younger embryo is much longer than broad, in the advanced embryo it is as broad as long, while in the normal adult it is rather broader than long.

	Embryo ♀. Barkul, September 1914.	Embryo ♂. Patshanipur, March 1914.
	mm.	mm.
Length of disk	120	22
Breadth of disk	120	17
Interorbital distance	30	6
Snout ..	30	6
Mouth to vent	100	17
Tail ..	320	33
Umbilical cord	35	12
Yolk sac.	5 × 2	10 × 3
Filament ..	None.	Numerous entering gill-slits.

The food of this species consists chiefly of fish and prawns. In one instance the stomach was found full of weed, which had probably been swallowed for the sake of young molluscs (*Modiola undulata*) attached to it.

The following Cestodes[1] were found in the alimentary canal of specimens taken in the lake:—

Phyllobothrium pammicrum, Shipley and Hornell.

Parataenia medusia, Linton.

Calliobothrium eschrichtii, Van Ben.

The Trematode *Anaporrhutum largum*, Lühe, was found in the body cavity in two cases (Southwell, *op. cit.*, p. 335).

The Ray appears to have no fixed breeding-season.

In fine weather individuals often lie just below the surface of the water gently undulating their pectoral fins.

Distribution:—Indian Ocean, Red Sea, East Indies.

[1] *See* Southwell, *Rec. Ind. Mus.*, XI, p. 331.

Family MYLIOBATIDAE.

Genus **AETOBATIS**, Blainville.

Aetobatis flagellum (Schneider).

1801. *Raia flagellum*, Schneider, Bloch's *Ichthyol.*, p. 361, pl. lxxiii.
1841. *Aetobatis flagellum*, Müller and Henle, *Plagiost.*, p. 180.
1870. *Aetobatis narinari*, Gunther, *Cat. Fish. Brit. Mus.*, VIII, p. 402.
1878. *Aetobatis narinari*, Day, *Fish. Ind.*, 743, pl. cxciv, fig 4.
1889. *Aetobatis narinari*, Day, *Faun. Brit. Ind., Fish.*, I. 59.
1909. *Aetobatis flagellum*, Annandale, *Mem. Ind. Mus.*, II, p. 54, text-fig. 10, pl. iv, fig. 5.
1913. *Aetobatus flagellum*, Garman, *Mem. Mus. Comp. Zool.* (Harvard), XXXVI, p. 440.
1914. *Aetobatus flagellum*, Gudger, *Pub. Carn. Inst.* (Washington), CLXXXIII, p. 312.

There is one female specimen in the collection secured by purchase at Barkul. A large number of dead *Aetobatis flagellum* were seen lying on the Island of Nalbano by Dr. Annandale in the month of March, 1914. A severed head of the species was brought by Dr. Jenkins from the mouth of the Chilka Lake in December, 1909. In the specimen from Barkul the snout is very long and tapers to a sharp point and is much longer than broad. The eyes are lateral; their dorso-ventral axis is vertical and forms a right angle with the upper surface of the head. The distance from the mouth to vent is contained three times in the width of the disk. The teeth of the lower jaw are strongly curved and the pointed end of the band is seen projecting forward from the mouth. The skin is smooth and of a dark colour and there are no spots.

The measurements of the Barkul specimen are given below:—

Breadth of disk	494 mm.
Mouth to vent	165 ,,
Length of snout	76 ,,
Rostral fin	63 × 2 ,,
Diameter of eye	12·6 ,,
Interorbital space	63 ,,
Length of spiracle	25 ,,
Ventral fin	76 × 28 ,,
Tail	851 ,,

The conclusions Dr. Annandale arrived at about this species in 1909 (*Mem. Ind. Mus.*, II, pp. 54-58) have been now widely accepted.

Distribution:—Tropical and semitropical waters of the world.

Aetobatis guttata (Bloch and Schneider).

1801. *Raia guttata*, Bloch and Schneider, *Syst. Ichthy.*, pp. 361-364.
1803. *Raja* No. viii [*Eel tenkee*], Russell, *Vizag. Fish.*, I, p. 5, pl. viii.
1804. *Raia guttata*, Shaw, *Zool.*, V, p. 285.
1839. *Aetobatis indica*, Swainson, *Fish.*, II, p. 3.
1849. *Stoadson narinari*, Cantor, *Cat. Mal. Fish.*, p. 1416.
1865. *Aetobatis narinari*, Day, *Fish. Malab.*, p. 280.
1870. *Aetobatis narinari*, Gunther, *Cat. Fish. Brit. Mus.*, VIII, p. 493.

1878. *Aetobatis narinari*, Day, *Fish. Ind.*, p. 743.
1889. *Aetobatis narinari*, Day, *Faun. Brit. Ind., Fish.*, I, p. 59.
1909. *Aetobatis guttata*, Annandale, *Mem. Ind. Mus.*, II, pp. 55-56, text-fig. 10.
1913. *Aetobatis ocellatus*, Garman, *Mem. Mus. Comp. Zool.* (Harvard), XXXVI, p. 442.
1914. *Aetobatis guttata*, Gudger, *Pub. Carn. Inst.* (Washington), CLXXXIII, p. 313.

Gudger, in his paper on the *History of the Spotted Eagle Ray* on page 313, has shown that the specific name *guttata* was first employed by Bloch and Schneider in 1801. It would therefore have priority over "*ocellata*" of Russell (1803). In any case, however, the latter is inadmissible as it is merely used by Russell in a descriptive sense; the same term (*ocellata*) had been used by him exactly similarly for his *Raja* No. I and *Raja* No. II, as well as for his No. viii, the present species also referred to by him by the local name *Eel tenkee*. He refrained from giving specific names to any of the species of rays he described or figured [see Russell, *Fish. Vizag.*, I, p. v. (Preface)]. Thus the specific name newly proposed by Garman lapses owing to want of priority.

There are three young male specimens in the collection. The snout in all these specimens is comparatively short, conical, bluntly pointed and distinctly retroverted and agrees with Dr. Annandale's figure of 1909 (*op. cit.*, fig. 10 B, p. 55). The dorso-ventral axis of the eye is inclined downwards and inwards and the pupil is visible from below. The distance between the mouth and the vent is contained $2\frac{1}{2}$ times or a little more in the breadth of the disk, and the length of the tail is more than twice the breadth of the disk. The teeth are in a single series, those of the lower jaw meeting at an obtuse angle and slightly projecting out of the mouth. The skin is smooth with slight roughness; there are no denticles. The dorsal surface is of a uniform dark slate-gray colour without any trace of spots.

The measurements of the three specimens are given below.

	Barkul, ♂ (2-i-15).	Barkul, ♂ (3-i-15).	Balugaon, ♂ (4-i-15).
	mm.	mm.	mm.
Breadth of disk ..	398	317	496
Mouth to vent	165	114	190
Length of snout	43	35	51
Rostral fin ..	43 × 40	33 × 35	46 × 46
Diameter of eye ..	9	8	10
Interorbital space ..	56	45	56
Length of spiracle	17	16	17
Ventral fin	67 × 28	51 × 24	72 × 28
Tail	1012	797	1063

This species appears to breed freely in the main area of the lake as young specimens are numerous.

Distribution:—Tropical parts of the Indian Ocean.

Genus **AETOMYLAEUS**, Garman.

Aetomylaeus nichofii (Schneider).

1801. *Raia nichofii*, Schneider, Bloch's *Ichthyol.*, p. 364.
1878. *Myliobatis nieuhofii*, Day, *Fish. Ind.*, p. 742.
1889. *Myliobatis nieuhofii*, Day, *Faun. Brit. Ind., Fish.*, I, p. 58.
1909. *Myliobatis nieuhofii*, Annandale, *Mem. Ind. Mus.*, II, p. 51.
1913. *Aetomylaeus nichofii*, Garman, *Mem. Mus. Comp. Zool.* (Harvard), XXXVI, p. 436.

No specimen of this species appears to have been collected but many were observed in the course of the survey. Dr. Annandale tells me that the species is very common in February in the shallows near the outer shore of the south end of the main area of the lake, where it moves about in shoals, occasionally leaping out of the water. The back is brown and is banded with five or six narrow bands of lighter colour which are conspicuous in life and can be seen when the fish is several inches below the surface of the water.

The species is a permanent inhabitant in the main area of the lake.

Distribution:—Seas of India, East Indies and Japan.

Order TELEOSTEI.

Suborder *MALACOPTERYGII.*

Family ELOPSIDAE.

Genus **ELOPS**, Linnaeus.

Elops indicus, Swainson.

(Text-figures 1, 2.)

1803. *Elops saurus* (*nec* Linné), Russel, *Vizag. Fish.*, II, p. 63, pl. clxxix.
1839. *Elops* (*saurus*) *indicus*, Swainson, *Nat. Hist Fish. Amph. Rep.*, II, p. 292.
1846. *Elops saurus*, Cuvier and Valenciennes, *Hist. Nat. Poiss.*, XIX, p. 358.
1868. *Elops saurus*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 470.
1878. *Elops saurus*, Day, *Fish. Ind.*, p. 649, pl. clxvi, fig. 1.
1889. *Elops saurus*, Day, *Faun. Brit. Ind., Fish.*, I, p. 401, fig. 125.

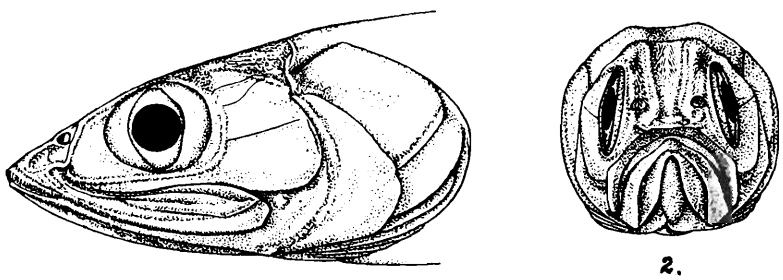
There are altogether nine specimens in the collection; one is from the main area of the lake off Balugaon (6-iii-1914), while the other eight were bought from a fisherman at Rambha on January 1st, 1915.

All these specimens have the lower jaw within the upper jaw and the teeth on the tip of the former entirely exposed (text-figs. 1 and 2): thus the entire collection falls into the '*saurus* group', and not into the '*machnata* group' of the genus.

In his revision of the fishes of the genus *Elops* (*Ann. Mag. Nat. Hist.*, (8), III, p. 37) Tate Regan has divided all the species into two main groups:—one, which may be designated the '*saurus* group, consists of five species. All have "included" lower jaws and the whole of the praemaxillary band of teeth exposed when the mouth is closed. The other group, which may be termed the "*machnata* group," consists of two species in both of which the lower jaw is projecting and covers the anterior part of the praemaxillary band of teeth when the mouth is closed.

Tate Regan when reviewing the genus had only one specimen from India before him. It was said to have come from Madras. This specimen he referred to *Elops machnata* (Forskål). Some have been led to suppose, therefore, that all the Indian *Elops* belong to this species, which in reality is a species of the Red Sea (see Jordon and Richardson on the *Fishes of Formosa* in *Mem. Carnagie Mus.*, IV, p. 165).

There is a very valuable specimen in spirit (Registered No. 2641) in the collection of the Indian Museum, purchased from Day; it was the original of figure no. 1 of plate



1. 2.

FIG. 1.—*Elops indicus*, Swainson.
Side view of the head, with the mouth closed and the lower jaw included

FIG. 2.—*Elops indicus*, Swainson.
Anterior part of the head seen from the front, slightly below the horizontal line, with the mouth closed; lower jaw is seen included and the anterior part of the intermaxillary teeth exposed.

clxvi in his *Fishes of India*. This specimen was caught by Mr. H. S. Thomas in a brackish-water enclosure at South Canara, and Mr. Thomas alluded to it in his *Rod in India* (Second Edition, p. 214). In this fish as well as in another specimen of *Elops*, also preserved in spirit, that was bought in the Calcutta market by the Curator of the Museum of the Asiatic Society of Bengal in the early sixties, the lower jaw is included inside the upper, so that the whole of the praemaxillary band of teeth is exposed in both the specimens when the mouth is closed. Neither of these specimens, therefore, can belong to *E. machnata* (Forskål), which I have reason to suspect is not an Indian species at all. Professor Weber and Dr. Beaufort in their *Fishes of the Indo-Australian Archipelago* (Vol. II, p. 4) in describing this species (*i.e.*, *E. machnata*) remarked "not seen by us." Their note a few lines below to the effect that Bean and Weed confirmed the occurrence of *E. machnata* in the Indian Archipelago is not corroborated in the original paper by the latter authors. In this paper, which is on the Fishes of Java (*Proc. U. S. Nat. Mus.*, LXII, p. 589), Bean and Weed stated that they had examined

altogether thirty-five specimens belonging to the genus *Elops*, (*viz.*, seven from Java, three from Ashantee, five from the west coast of America, three from Australia, six from the east coast of America, five from the Philippine Islands, five from Hawaii and one from Hong Kong, China). This series indicated to them that it would not bear out the conclusions reached by Tate Regan. In fact, they thought that their Java specimens represented the species described by Bleeker under the name *Elops saurus* (*nec* Linné) and not *E. machnata* (Forskål).

The Chilka series of the genus *Elops* closely agrees with the Indian species represented by Thomas' specimen from South Canara, as well as with Russel's description and figure (*Vizag. Fish.*, II, p. 63, pl. clxxix). The following extract from Russel's description "the jaws are nearly of equal length, long extractile, the under carinate. .the teeth are marginal, small, not close except in the forepart of the lower jaw" clearly shows that in species examined by him the lower jaw was included and the teeth on the praemaxillary exposed. Russel's description of his species is very minute and his figure is excellent. Moreover his vernacular name leaves no doubt about its identity. All these facts make it very clear that Russel's species cannot be *E. machnata* (Forskål). Russel called it *E. saurus*, with the description of which his species agreed very closely. Swainson, however, was first to realize the necessity of the addition of a new name to distinguish the Indian species from the North American one, and therefore named the former *indicus* in his classification of fishes (*Nat. Hist. Fish. Amph. Rep.*, II, p. 292). There was no necessity for Swainson to supply any description, as Russel's description, which he adopted, was very minute and exhaustive. Günther also corroborated Russel's description by saying "the lower jaw scarcely projecting beyond the upper" (*Cat. Fish. Brit. Mus*, VII, p. 470). Day has made this important distinction still more clear with reference to the Indian species by saying that "*the under jaw slightly shorter than the upper*" (***Fish. Ind.***, II, p. 650). Thus one is compelled to believe that Russel's species of ***Elops*** as well as Thomas' specimen, drawn and described by Day, belong to one and the same species as the Chilka form, for all of which Swainson's name *indicus* should stand on the grounds of priority. *Elops machnata* (Forskål), which is said to be a species of the Red Sea by Jordan and Richardson (*op. cit.*), is very different from the Chilka specimens because in *E. machmata* the lower jaw is not only decidedly longer than the upper jaw but it completely covers the teeth on the praemaxillary bone when the mouth is shut. Of course in dried and stuffed specimens the lower jaw may get artificially fixed to look longer, hence the necessity of an examination of spirit specimens in which the natural position of the jaws is not at all interfered with. No specific locality for Tate Regan's Madras specimen is given; it is therefore difficult to say whether it is a Red Sea specimen forwarded through Madras, or whether it is an imperfectly mounted stuffed specimen in which the lower jaw was artificially fixed further forward than was natural in the species.

The Chilka form, as has been already shown, falls under the "*saurus* group in which Tate Regan has proposed as many as five species; with the validity of such a large number of species, founded on slight differences under the *saurus* group of the

genus we are not at present concerned, as the Chilka species differs from all of the new species in proportions, etc. It should, however, be mentioned that Bean and Weed (*op.cit.*), after examining a large number of specimens belonging to the genus from different localities, felt that all these new species proposed by Regan were only closely allied forms. The Chilka species differs considerably from *E. hawaiensis* and the other new species proposed and described by Tate Regan. It comes nearest on the whole to *E. saurus*, Linn., re-described by Regan in his revision, except in the number of vertebrae. Bean and Weed (*op.cit.*) ascertained the number of vertebrae in different groups according to localities. These figures are interesting and are quoted below :—

East Coast of America (Skeleton)		$75\frac{1}{2}$
West Coast of America (Radiograph)		$79\frac{1}{2}$
Ashanti, West Africa	Do.	$69\frac{1}{2}$
Hawaii ..	Do.	$68\frac{1}{2}$
Hong Kong, China	Do.	$65\frac{1}{2}$
Philippine Islands	Do. ..	$65\frac{1}{2}$
Java	Do.	$65\frac{1}{2}$

In the Chilka forms the number of vertebrae is sixty-six, following Tate Regan's method of counting the upwardly directed hypural portion as representing three vertebrae.

For comparison the proportions of measurements of the Chilka specimens are given below. The total length of those collected is from 280 mm. to 340 mm., but the fish is said to grow considerably bigger.

The depth of the body is contained nearly six and a half times in the total length (without caudal), the length of the head four and a half times. The length of the snout is equal to the diameter of the eye as well as to the inter-orbital width, which is contained four and a half times in the length of the head. The maxillary bone extends considerably beyond the eye ; the lower jaw is included inside the upper when the mouth is closed. The length of the gular plate is two-thirds of the length of the lower jaw, which is again four-seventh times the length of the head. The number of branchiostegal rays is twenty-eight. The number of the scales in the longitudinal series in the lateral line is one hundred and two, in the transverse series above the lateral line there are fourteen rows of scales, fifteen rows below the lateral line, and there are twelve rows of scales between the lateral line and the ventral fins. The dorsal fin contains twenty-four rays of which eighteen are branched. The anal fin has thirteen branched rays out of a total of sixteen. The length of the pectoral fin is slightly greater than half the length of the head. The depth of the caudal peduncle is a little less than three-eighths of the length of the head. The number of vertebrae is 66.

The fish is found in large numbers during the winter months in the main area of the lake, but probably does not breed in it as there is not a single young specimen in the collection.

Distribution :—The Bay of Bengal and the Arabian Sea, entering the estuaries.

Genus **MEGALOPS**, Lacépède.

Megalops cyprinoides (Broussonet).

1782. *Clupea cyprinoides*, Broussonet, *Ichthyol.*, Dec. I, tab. ix.
1803. *Clupea cyprinoides*, Russel, *Vizag. Fish.*, II, p. 81, pl. cciii.
1803. *Megalops filamentosus*, Lacépède, *Hist. Nat. Poiss.*, V, p. 289.
1822. *Cyprinodon cundinga*, Hamilton Buchanan, *Fish. Gang.*, p. 154.
1839. *Megalops cyprinoides*, Swainson, *Nat. Hist. Fish. Amph. Rep.*, II, p. 293.
1846. *Megalops indicus*, Cuvier and Valenciennes, *Hist. Nat. Poiss.*, XIX, p. 388, pl. 576.
1878. *Megalops cyprinoides*, Day, *Fish. Ind.*, p. 650, pl. clix, fig. 3.
1889. *Megalops cyprinoides*, Day, *Faun. Brit. Ind., Fish.*, I, p. 402, fig. 126.

There are two specimens in the collection; the larger one, 250 mm. in length (without caudal), was collected at Rambha at the end of the year 1914 and the smaller one (190 mm. in length) was caught near Barkul in September, 1914.

The mouth is superior, and the lower jaw, which is very prominent, goes to form a part of the upper profile of the snout. The Chilka specimens do not show any noticeable peculiarity.

This fish occurs in the main area of the lake after the rains and continues there during the winter months.

Distribution:—The Indian and the Pacific Oceans and their estuaries. The fish is often found in brackish waters and is occasionally met with in freshwater ponds.

Family CHANIDAE.

Genus **CHANOS**, Lacépède.

Chanos chanos (Forskål).

1775. *Mugil chanos*, Forskål, *Descript. Anim.*, p. 74.
1801. *Mugil salmoneus*, Bloch and Schneider, *Syst. Ichthy.*, p. 121.
1803. *Chanos arabicus*, Lacépède, *Hist. Nat. Poiss.*, V, p. 396.
1871. *Chanos chanos*, Klunz, *Fisch. R.M.*, p. 605.
1878. *Chanos salmoneus*, Day, *Fish. Ind.*, p. 651, pl. clxvi, fig. 2.
1889. *Chanos salmoneus*, Day, *Faun. Brit. Ind., Fish.*, I, p. 403, fig. 127.

There is no specimen in the collection. The fish is, however, reported to be caught occasionally in the main area during the rains. Its ripe roe, dried and smoked, is sold by the fishermen of Barkul and other villages bordering on the lake.

Distribution:—The Indian and the Pacific Oceans and their estuaries; the Red Sea, the east coast of Africa and Madagascar.

Family CLUPEIDAE.

Subfamily *DOROSOMATINAE*.

Genus **DOROSOMA**, Rafinesque.

Dorosoma nasus (Bloch).

1795. *Clupea nasus*, Bloch, *Aus. Fische*, IX, p. 116.
1803. *Clupea thrissa* (L.), Russel, *Vizag. Fish.*, II, p. 76, pl. cxcvi.
1803. *Clupea* sp. (*Pedda Kome*), *ibid.*, p. 77, pl. cxcvii.
1830. *Chatoessus altus*, Gray and Hardwicke, *Ill. Ind. Zool.*, pl. xci, fig. 2.

1848. *Chatoessus nasus*, Cuv. and Valenciennes, *Hist. Nat. Poiss.*, XXI, p. 164.
1878. *Chatoessus nasus*, Day, *Fish. Ind.*, p. 634, pl. clx, fig. 4.
1889. *Chatoessus nasus*, Day, *Faun. Brit. Ind., Fish.*, I, p. 387, fig. 120.

Russel made out two species in this mud-eating fish in which the last ray of the dorsal fin is greatly elongated. In so doing he simply followed the Telegu fishermen who distinguished two different kinds of fish among them by two different names, *viz.* *Kome* and *Pedda Kome* (*Pedda* = big). Russel has two figures, plate 196 representing *Kome* and plate 197 representing *Pedda Kome*, but neither of these figures show the conspicuous bluish black blotch behind the opercles characteristic of the species (at least in the adult stage). There are sixteen specimens in the Chilka collection, of these seven possess the blotch about three scales deep behind the opercle, measuring in larger specimens 15 mm. × 6 mm. In full-grown specimens the elongated ray almost reaches the root of the caudal fin, falling short by the breadth of two scales. Among the smaller specimens none have any blotch behind the opercle, and the elongated ray is proportionately shorter. Probably the want of the coloured blotch and the comparative shortness of the elongated ray in the young led the coast fishermen to use two different names for the same fish. Russel noticed a difference in the distance between the nostrils in his two species, but no such difference is noticed in any of the specimens of this collection. The Chilka fishermen have only one name, *Bolangi* (both for the fish with a blotch and for the fish without it. The lengths of the specimens in the collection, together with the lengths of the respective elongated ray, and the presence or absence of the coloured blotch are stated below.

Locality and date.	Number of specimens.	Total length in mm.	Length of the elongated ray in mm.	Presence or absence of a bluish black blotch.
Barkul, Sept. 14	1	171	66	Present. Three scales behind the opercle, 15 × 6.
Parikud, 28-xi-14	1	169	61	Present.
Patsahanipur, 3-ii-14	2	125	Damaged.	Present.
Off north side of Samal Island, 24-ii-14	1	102	41	Five scales behind opercle, 7 × 3 mm.
Barkul, 4-i-15	2	96	36	Present.
Off Nalbano, 18-ix-14	1	63	18	Absent.
Barkul, 4-i-15	1	53	9	Do.
Satpara, March 14	1	52	8	Do.
Rambha Bay, 22-vii-14	1	45	9	Do.
Do.	1	44	5	Do.
Do.	2	43	5	Do.
Do.	2	42	4	Do.

The last six specimens have a longitudinal silvery band about half way down.

The fish is found all over the lake throughout the year, probably breeding in it.

Distribution :—Seas of India to the Malay Archipelago, Philippines, Formosa, China, South Arabia and Sokotra.

Dorosoma indicus (Russel).

1803. *Harengus minor indicus*, Russel, *Vizag. Fish.*, II, p. 70, pl. clxxxvi, fig. 1.
1822. *Clupanodon chakunda*, Hamilton Buchanan, *Fish. Gang.*, p. 246.
1833. *Clupia mauritiana*, Bennet, *Proc. Zool. Soc.*, p. 32.
1848. *Chatoessus chacunda*, Cuv. et Val., *Hist. Nat. Poissons*, XXI, p. 111.
1866. *Dorosoma chakunda*, Bleeker, *Atl. Ichth.*, VI, p. 143, t. 261, figs. 5 & 6.
1878. *Chatoessus chakunda*, Day, *Fish. Ind.*, p. 632, pl. clx, fig. 3.
1889. *Chatoessus chakunda*, Day, *Faun. Brit. Ind., Fish.*, I, p. 386.

Of the three specimens in the survey collection two are without the black spot behind the opercle said to be characteristic of the species One of these is a young specimen measuring 47 mm. from Rambha Bay (22-vii-14), which is without any spot. The specimen from Gopkuda collected on 15-viii-07 measuring 60 mm. is also without the spot. The black spot behind the opercle is very conspicuous in the specimen from Barkul caught about 18-ix-15. Russel's figure (plate clxxxvi, fig. 1 of vol. ii) does not show the spot nor does his description (p. 70) make any mention of it. Russel considered, probably correctly, his fish to be identical with Willoughby's figure 2, tab. i of his *Ichthyological Appendix*—but as he did not describe the fish and Russel was first to supply the description under Willoughby's name—Russel is the real author of the species for which Willoughby supplied the name and a figure. Russel is not quite sure about the local name of the fish and he gives two alternative names "*Kowal* or *Kowarloo*." Day gives *Muddecru* as its Telugu name. Russel's local names appear to be of the nature of a generic name for small Clupeioids.

The fish occurs throughout the main area after the freshets. There are altogether four specimens in the collection with the Gopkuda one of 1907.

Distribution :—Seas and estuaries of India, Burma, Siam, Malay Archipelago and Philippines.

Subfamily *ENGRAULINAE*.

Genus ENGRAULIS, Cuvier.

Engraulis annandalei, sp. nov.

(Text-figure 3.)

The dorsal profile is almost straight and the ventral profile is convex from the end of the snout to the origin of the anal fin, from which it is nearly straight to the root of the caudal fin. The shape of the fish is oblong and the body is compressed. The abdominal keel possesses altogether twenty-five scutes beginning from the throat, fifteen of which are preventral and ten behind the root of the ventral fin.

The height (the greatest depth) of the body is 27 %,[1] the length of the head 18·5 % ;

[1] Measurements are in hundredths of the length without the caudal fin.

the least depth of the caudal peduncle 10 %; the length of the maxillary 25·7 %; the length of the pectoral fin 17 %; the length of the ventral fin 9·4 %; the length of the base of the anal fin 38·5 %; the diameter of the eye 5 % and the length of the snout is 3·5 % of the total length.

The snout is prominent, the maxilla is dilated above the mandibulary joint and its posterior tapering portion extends further than the anterior root of the pectoral fin.

The dorsal fin with its two spines and ten rays has an isolated scaly spine anterior to it; there are twenty-five flat scales in front of the dorsal fin, the height of the fin is 17 % of the total length; the origin of the fin is nearer to the end of the snout than to the base of the caudal fin.

The pectoral fin with fourteen rays has a broad appendage attached to the inner side of the root of the fin and is about half its length when it lies flat against the body; the pectoral fin does not reach the root of the ventral fin, and is slightly shorter than the length of the head.

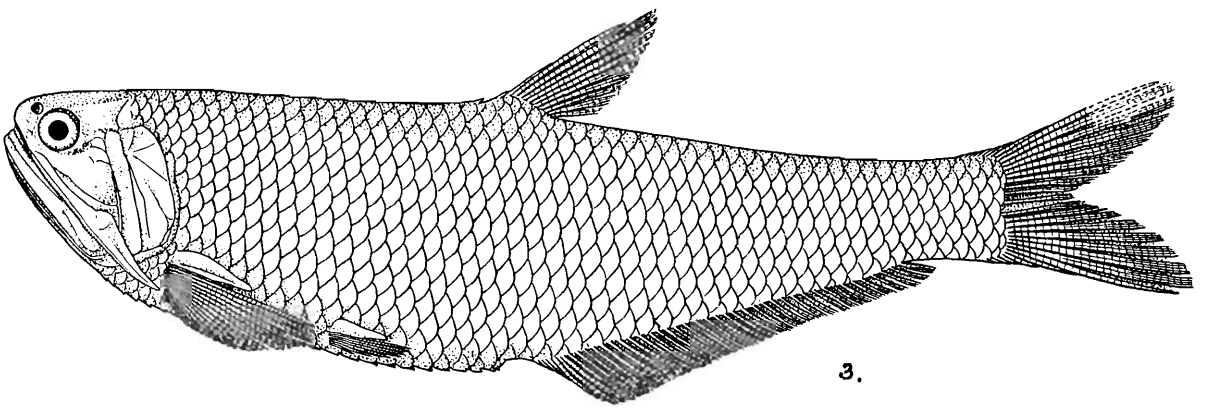


Fig. 3.—*Engraulis annandalei*, Chaudhuri, nat. size.

The ventral fin with its eight rays has also an appendage in its axil which is three-fourths of the length of the fin; the root of the ventral fin is nearer to the origin of the anal fin than the mandibulary joint in the proportion of six to seven.

The anal opening is nearer to the base of the caudal fin than the end of the snout in the proportion of seven to eight, and is not reached by the tips of the ventral fins.

The anal fin has forty-three rays with one or two short compact spines. It commences below the posterior rays of the dorsal fin: the length of the base of the fin is contained $2\frac{5}{9}$ times in the total length (without caudal fin).

The scales are thin but not readily deciduous; the number of scales in the lateral line is fifty and across the body in the line of its greatest breadth thirteen. The colour of the body is silvery with the back slightly dark and the fins hyaline.

This new species is closely related to *E. purava* (H.B.) and *E. mystax* (Bl. and Schn.) but in a good many particulars it differs from both. From *E. purava* (H.B.) it differs in being broader—(the height in *E. purava* being about four whereas in the new

species it is only $3\frac{2}{3}$), and in having a slightly shorter head and larger eye. In *E. purava* the origin of the dorsal fin is midway between the snout and the base of the caudal fin or a little nearer to the base of the caudal, but in the new species the origin of the dorsal fin is nearer to the snout than the root of the caudal fin. The maxillary is slightly longer in the new species than it is in *E. purava*. From *E. mystax* (Bl. and Schn.) the new species differs in having a shorter anal fin, a shorter head, a more prominent snout and in having the origin of the dorsal fin nearer to the snout than to the caudal fin. In *E. mystax* the pectoral fin when laid against the body reaches the root of the ventral fin, whereas in the new species there is some distance between the tip of the pectoral fin and the root of the ventral fin. In *E. mystax* the root of the ventral fin is midway between the mandibulary joint and the anterior root of the anal fin, but in the new species it is nearer to the anterior root of the anal fin. The new species resembles *Engraulis spinifer*, Cuv. et Val., in having the origin of the dorsal fin nearer to the end of the snout than to the base of the caudal fin, but it differs from it in possessing a larger number of scutes, a longer maxillary and in many other important particulars. It resembles *E. valenciennesi* (Blkr.) in having a longer anal fin and in having the origin of that fin a little before the end of the dorsal fin and also in the maxillary reaching slightly beyond the anterior root of the pectoral fin, but differs from it in not having the dorsal profile convex and in not having the origin of the dorsal fin nearer to the base of the caudal than to the snout, in having the pectoral fins not reaching the root of the ventrals and in having a larger number of scutes.

Type.—A specimen 140 mm. long dredged in shallow water on 18-ix-14 off Nalbano Island. It is numbered $F^{\frac{S}{1}\frac{781}{1}}$ in the Indian Museum register.

Engraulis kempi, sp. nov.

(Text-figure 4.)

The dorsal profile is almost straight as far as the dorsal fin, behind which it is convex; the ventral profile is convex to the anal opening, posterior to which it is somewhat concave. The body is compressed, and the shape is lanceolate. The anterior abdominal edge is provided with twenty-three scutes beginning from the throat, eight of these scutes are post-ventral.

The height of the body is 28 % of the total length, the length of the head 20·5 %, the least depth of the caudal peduncle 10 %, the length of the maxillary 20·5 %, the length of the pectoral fin 19 %, the length of the ventral fin 10 %, the length of the base of the anal fin 32 %, the diameter of the eye 6 % and the length of the snout 5 % in the total length without the caudal fin.

The snout is prominent with a rostro-frontal projection which is rounded. The maxillary is dilated above the mandibulary joint and its posterior tapering portion does not extend beyond the gill-opening.

The dorsal fin has two spines and ten rays with an isolated spine in front and twenty flat scales. The point of origin of the fin is slightly nearer to the snout than to the root of the caudal and its height is 19 % of the total length.

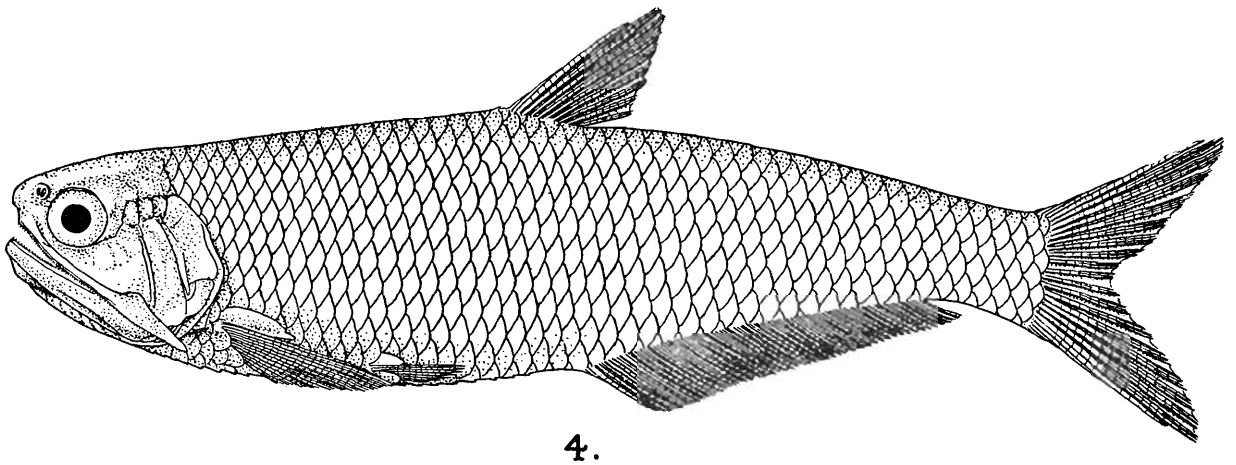
The pectoral fin, which has fourteen rays, reaches beyond the root of the ventral fin, covering almost one-fourth of the length of that fin; there is a broad appendage at the axil of the fin.

The ventral fin, which is also provided with a broad appendage, has eight rays and reaches half the distance that lies between its root and the anal opening. The anal fin has forty rays.

The number of scales in the lateral line is forty-five and there are twelve scales along the line of the greatest breadth.

Colour.—The dorsal side is dark, the middle portion of the body together with the anterior portion of the abdomen silvery, the rest of the body is somewhat pale yellow. The fins are hyaline.

This species differs from *E. annandalei* in having a shorter maxillary which reaches only to the gill-opening, a longer pectoral fin reaching beyond the root of the ventral



4.

FIG. 4.—*Engraulis kempi*, Chaudhuri, × 2.

fin, having a lesser number of scutes, a shorter anal fin, in its shape and both in the dorsal and ventral profile. It resembles *E. valenciennesi* (Blkr.) in having twenty-three scutes and in the pectoral fin reaching the ventrals, but it differs from that species in the dorsal and the ventral profiles, in having longer ventral fins, a shorter maxillary, in having the dorsal fin nearer to the snout and also in proportions.

The *type* specimen, which is 68 mm. in length (without the caudal fin), was caught on 1-iii-14 off Barkul in the main area of the lake and is numbered F $\frac{8}{1}\frac{7}{}\frac{8}{}\frac{2}{}$ in the Indian Museum register.

There are fifteen co-types of which two were secured on 10-iii-14, eight miles N. E. of Patsahanipur, measuring 64 mm. and 61 mm., thirteen at the same place on 6-iii-14 of which three (measuring 59 to 61 mm.) are pale yellow and the rest (measuring from 46 mm. to 56 mm.) reddish-brown.

The species appears to be a permanent inhabitant of the lake, probably breeding in it.

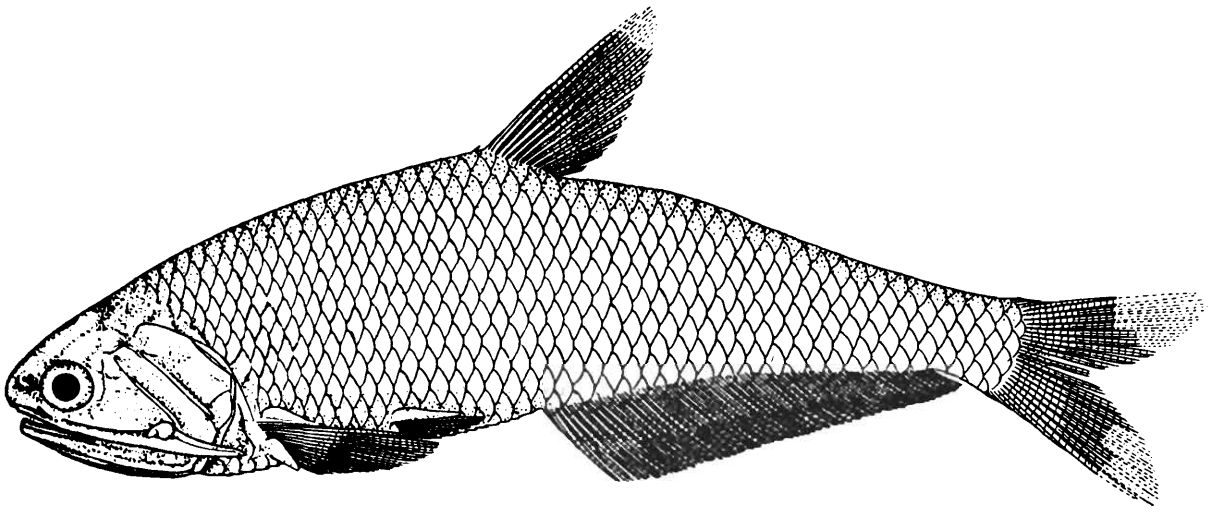
Engraulis rambhae, sp. nov.

(Text-figure 5.)

The dorsal profile is highly convex and the ventral profile is almost straight. The body is compressed. The anterior abdominal edge is provided with twenty-two scutes beginning from the throat, seven of which are post-ventral.

The height of the body is 26% of the total length, the length of the head 24%, the least depth of the caudal peduncle 8%, the length of the maxillary 23%, the length of the pectoral fin 18%, the length of the ventral fin 9%, the length of the base of the anal fin 39%, the diameter of the eye 6% and the length of the snout 4% in the total length without the caudal fin.

The snout is prominent, the maxillary is dilated above the mandibulary joint and



5.

FIG. 5.—*Engraulis rambhae*, Chaudhuri, × 1⅓.

its posterior tapering portion extends slightly beyond the gill opening, but does not reach the root of the pectoral fin.

The dorsal fin has one spine and ten rays with an isolated spine just in front, the origin of the fin is nearer to the snout than to the base of the caudal fin.

The pectoral fin has thirteen rays and reaches much beyond the root of the ventral fin, covering nearly three-fourths of that fin. The appendage is small and thin.

The ventral fins have seven rays each, the tips of which are at three scales in front of the anal opening. The appendages at their axil are thin and small.

The anal fin has forty rays, the number of scales in the lateral line is forty-six and in the line of the greatest breadth twelve.

Colour.—The dorsal edge is black; the body is silvery with the upper portion yellowish-brown, the lower half of the posterior part is brown and the fins are hyaline.

The highly convex dorsal profile at once distinguishes this species from the rest of the species in the genus most of which have a more or less straight dorsal profile.

It differs also in the number of scutes and in some of its proportions from the other species.

A specimen measuring 100 mm. was caught in Rambha Bay in March, 1914. It is the *type* of the new species and is entered under number F $\frac{8783}{1}$ in the register of the Indian Museum. There are two co-types, one from the same locality as the type measuring 95 mm., and the other (measuring 53 mm.) from off Nalbano, collected on 6-iii-14.

The species is in all probability a permanent inhabitant in the main area and breeds in the lake.

Engraulis purava (H.B.)

1803. *Clupea* sp. (*Pedda Poorawah*), Russel, *Vizag. Fish.*, II, p. 73, pl. cxc.
1822. *Clupea purava*, Hamilton Buchanan, *Fish. Gang.*, pp. 238, 382.
1848. *Engraulis purava*, Cuvier and Valenciennes, *Hist. Nat. Poiss.*, XXI, p. 65.
1878. *Engraulis purava*, Day, *Fish. Ind.*, p. 628, pl. clvii, fig. 2.
1889. *Engraulis purava*, Day, *Faun. Brit. Ind., Fish.*, I, p. 393.

Hamilton Buchanan derived the name of the species from the generic vernacular name quoted by Russel: *Peddah Poorawah*—the great purava. A pair of pear-shaped black markings behind the occiput appears not to have been noticed by Hamilton Buchanan who consequently remarked "No spotting."

There are altogether thirty-four specimens of the species in the collection. This appears to be the prevailing species of the genus in the lake, occurring in all sizes, all over the lake throughout the year. Probably the species breeds in the lake during the rains. The statement below gives the sizes, dates and the different localities in the lake from which specimens were collected.

1	specimen	Off Barnikuda Island ..	6-ix-14,	measuring	85 mm.
3	specimens	Barkul Bay	21-ix-14,	,,	72 mm. to 112 mm.
2	,,	Off Breakfast Island ..	17-ii-14,	,,	63 mm. and 65 mm.
1	specimen	Chiriya Island towards Samal	8-ii-14,	,,	80 mm.
22	specimens	Kalupara ghat	16-ix-14,	,,	from 33 mm. to 65 mm.
2	,,	Kalidai	8-iii-14,	,,	62 mm and 67 mm.
1	specimen	Nalbano	25-xi-15,	,,	60 mm.
1	,,	Patsahanipur	7-iii-14,	,,	49 mm.
1	,,	Off Samal Island	22-ix-13,	,,	34 mm.

Distribution:—In the seas and the estuaries of Sind and both sides of India, Rangoon, Penang and the Malay Archipelago.

Engraulis mystax (Bl. and Schn.)

1801. *Clupea mystax*, Bloch and Schneider, *Sys. Ichthyol.*, p. 426.
1849. *Thryssa porova*, Bleeker, *Verh. Bat. Genoots.*, XXII, p. 14.
1867. *Engraulis mystacoides*, Günther, *Cat. Fish. Brit. Mus.*, VII, 396.
1878. *Engraulis mystax*, Day, *Fish. Ind.*, p. 625, pl. clvii, fig. 3.
1889. *Engraulis mystax*, Day, *Faun. Brit. Ind., Fish.*, I, p. 390.
1897. *Trichosoma porava*, Rutter, *Proc. Acad. Nat. Sc. Philadelphia*, p. 65.

Bleeker described a species under the impossible name *E. porova* (*Ich. Madura*, p. 14)—a name very similar to *E. purava* (H. B.). Bleeker's name had been adopted

by Rutter—by whom *E. mystax* was sunk as a synonym of *E. porova*, Blkr., without any justification. Günther rightly concluded that *E. mystax*, *E. porova* and *E. mystacoides*, Blkr., were names for the same species; he, however, selected *E. mystacoides*, sinking the rest of the names believing *E. mystax* (Bl and Schn.) to be a different species.

There are four specimens in the collection from Rambha Bay, one 80 mm. in length was collected in March 1914, and the rest measuring 66 mm. to 77 mm. were collected on 22-VII-14.

Probably the species is an occasional visitor not breeding in the lake.

Distribution:—Seas and estuaries of India, China, North Celebes, Singapore, Borneo, Sumatra and Java.

Genus STOLEPHORUS, Lacépède.

Stolephorus indicus (V. Hasselt).

1803. *Clupea atherinoides*, Russel, *Vizag. Fish.*, II, p. 71, pl. clxxxvii.
1823. *Engraulis indicus*, Van Hasselt, *Algem. Konst-Letterbode*, p. 229, fig. 2.
1872. *Stolephorus indicus*. Bleeker, *Atl. Ich.*, VI, p. 127, t. cclix, fig. 2.
1878. *Engraulis indicus*, Day, *Fish. Ind.*, p. 629, pl. clviii, fig. 3.
1889. *Engraulis indicus*, Day, *Faun. Brit. Ind., Fish.*, I, p. 394.
1914. *Anchovia indica*. Alvin Seale, *Philip. Journ. Sc.*, IX D, p. 59.

This is the most common species of the family in the lake. It is gregarious in habit, planctonic, of small size and translucent when alive. There are altogether five hundred and two specimens in the collection, some of which are young. There are two prevailing colours irrespective of age, size and locality, *viz.*,—reddish-brown and pale yellow.

The following table gives the localities, dates of capture, and the sizes. The species occurs throughout the lake and it appears to be a permanent inhabitant breeding in winter (January and February).

7	specimens	Balugaon	21-vii-13,	measuring from 18 mm. to 23 mm. Colour pale yellow.
1	specimen	Off Barnikuda Island ..	17-ii-14,	.. 60 mm. Col. brown.
13	specimens	S.E. of Barkul bungalow ..	1-iii-14,	,, 25 mm. to 35 mm. Col. pale yellow.
288	,,	From prawn traps and nets at Barkul	21-ix-14.	.. 26 mm. to 56 mm. Col. yellow.
14	,,	Breakfast Island	17-ii-14.	,, 35 mm. to 40 mm. Col. pale yellow.
1	specimen	Chiriya Island	23-ii-14,	,. 38 mm. Col. pale yellow.
3	specimens	S.W. of Kalidai	23-ii-14.	,. 36 mm. to 42 mm. Col. pale yellow.
122	,,	N.E. of Kalidai	5-iii-14.	,, 28 mm. to 47 mm. Col. pale yellow.
10	,,	Do. Do.	Do.	.. 36 mm. to 47 mm. Col. reddish-brown.
4	,,	Do. Do.	Do.	,. 12 mm. to 18 mm. Col. yellow.
7	,,	Off Nalbano Island	6-iii-14.	,, 25 mm. to 42 mm. Col. pale yellow.
1	specimen	S.E. of Patsahanipur ..	28-ii-14,	,, 38 mm. Col. pale yellow.

12	specimens	N.E. of Patsahanipur		3-iii-14,	measuring	28 mm. to 45 mm. pale yellow.	Col.
5		Do.	Do.	6-iii 14,	,,	30 mm. to 35 mm. pale yellow.	Col.
7	,,	S.E.	Do.	8-iii-14,	,,	32 mm. to 36 mm. reddish-brown.	Col.
3	,,	Rambha Bay		February, 1914,	,,	68, 75 and 86 mm. brown.	Col.
2	,,	Do.	..	March, 1914,	,,	50 mm. and 53 mm. brown.	Col.
1	specimen	Off Samal Island		22-ix-13,	,,	35 mm.	Col. yellow.
1	,,	Satpara			,,	14 mm.	Col. brown.

Distribution:—In seas (ascending rivers) of India, the Malay Archipelago, Philippines, Formosa, Japan, Samoa and Tahiti.

Stolephorus commersonii, Lacépède.

1803. *Stolephorus commersonii*, Lacépède, *Hist. Nat. Poiss.*, V, p. 382, t. xii, fig. 1.
1848. *Engraulis brownii*, Cuvier and Valenciennes, *Hist. Nat. Poiss.*, XXI, p. 41.
1878. *Engraulis commersonii*, Day, *Fish. Ind.*, p. 629, pl. clviii, fig. 1.
1889. *Engraulis commersonii*, Day, *Faun. Brit. Ind., Fish.*, I, p. 394.

There are altogether eight specimens in the collection, all of adult size, obtained during the months of February and March, in the main area of the lake. Probably the species is only an occasional visitor during the period of maximum salinity of the water of the lake. It does not appear to have bred in the lake.

1	specimen	Off Barkul Bay	1-iii-14,	measuring	37 mm.
1	,,	Kalidai	21-ii-14,	,,	42 mm.
2	specimens	South of Kalidai	2-iii-14,	,,	32 and 37 mm.
2	,,	S. W. Do.	March 1914,	,,	36 and 42 mm.
2	,,	S. E. of Patsahanipur	9-iv-15,	,,	35 and 40 mm.

Distribution:—Seas of India, of the Malay Archipelago, Philippines and also of Madagascar.

Stolephorus tri, Bleeker.

1852. *Engraulis tri*, Bleeker, *Verh. Bat. Genoots.*, XXIV, p. 40.
1872. *Stolephorus tri*, Bleeker, *Atl. Ich.*, VI, p. 128, t. cclxii, fig. 1.
1878. *Engraulis tri*, Day, *Fish. Ind.*, p. 630, pl. clviii, fig. 6.
1889. *Engraulis tri*, Day, *Faun. Brit. Ind., Fish.*, I, p. 395.

Only one specimen is in the collection; it is of adult size and was obtained from Rambha Bay in the month of February, 1914. The colour of the body is reddish-brown with a longitudinal silvery band in the middle. Probably an occasional visitor to the lake.

Distribution:—The seas and estuaries (ascending rivers) of India, Malay Archipelago and Philippines.

Subfamily *CLUPEINAE*.

Genus CLUPEOIDES, Bleeker.

Clupeoides lile (Cuvier and Valenciennes).

1847. *Meletta lile*, Cuvier and Valenciennes, *Hist. Nat. Poiss.*, XX, p. 378.
1850. *Alausa champil*, Cantor, *Journ. As. Soc. Bengal*, XVIII, p. 1284.

1878. *Clupea lile*, Day, *Fish. Ind.*, p. 638, pl. clxii, fig. 1.
1889. *Clupea lile*, Day, *Faun. Brit. Ind., Fish.*, I, p. 374.

There are altogether twenty-six specimens in the collection of which only one was obtained in the month of July near Samal Island ; the rest were caught in the main area during the months of February and March, in which period the water of the lake becomes as salt as that of the Bay outside. Probably the species is a seasonal visitor during the season of maximum salinity. It does not breed in the lake, from which it has been previously reported. The following statement will show the different localities from which the specimens were collected and their number and sizes :—

1	specimen	Off Barkul Bungalow	1-iii-14,	measuring	46 mm.
1	,,	Do.	3-iii-14,	,,	50 mm.
1	,,	Do.	?	,,	53 mm.
4	specimens	N.W. of Breakfast Island	17-ii-14,	,,	48 mm. to 54 mm.
1	specimen	Between Domkuda and Samal I.	18-vii-14,	,,	58 mm.
2	specimens	N.E. of Kalidai	5-iii-14,	,,	45 mm.
1	specimen	N.E. of Patsahanipur	3-iii-14,	,,	53 mm.
1	,,	S.E. Do.	6-iii-14,	,,	50 mm.
1	,,	N.E. Do.	7-iii-14,	,,	53 mm.
1	,,	Two miles S.E. of Patsahanipur	8-iii-14,	,,	54 mm.
4	specimens	Eight miles N.E. Do.	10-iii-14,	,,	42-50 mm.
7	,,	Rambha Bay	2-ii-14,	,,	42-62 mm.
1	specimen	Do.	14-ii-14,	,,	54 mm.

Distribution:—In the sea, along the West Coast of India, Ceylon, Burma, Siam, and the Malay Archipelago.

Genus **CLUPEA**, Linnaeus.

Clupea ilisha (Hamilton Buchanan).

1803. *Clupea* sp. (*Palashah*), Russel, *Vizag. Fish.*, II, p. 77, pl. cxcviii.
1822. ***Clupanodon ilisha***, Hamilton Buchanan, *Fish. Gang.*, pp. 243, 382, pl. xix, fig. 93.
1878. ***Clupea ilisha***, Day, *Fish. Ind.*, p. 640, pl. clxii, fig. 3.
1889. ***Clupea ilisha***, Day, *Faun. Brit. Ind., Fish.*, I, p. 376, fig. 115.

There is a specimen in the collection, caught at Barkul in the month of September, 1914, which is 322 mm. in length. Another specimen, 360 mm. in length, which was obtained by netting near Kalidai on the 14th January, 1907, was kept alive for over six hours in an earthen pot. Hence the general belief that *C. ilisha* always dies immediately on capture is not true—at least of the Chilka race.[1] Probably the high salinity of the water in January might have had something to do with the prolongation of life after capture. The occurrence of *C. ilisha* in the lake throughout the year and the fact of its not dying off immediately after capture, as well as the comparative freshness of the water of the lake soon after freshets, should prove to be sufficient inducement to practical pisciculturists to attempt 'stripping' *C. ilisha* in the lake, though it must remain doubtful if the species breeds there.

Distribution :—The coasts of India, including Sind and Burma, passing up the

[1] *Journal Bengal Fisheries* (1907), p. 94, para. 329.

large rivers to breed, the Persian Gulf ascending the Tigris, and the coast of Siam entering lakes.

Suborder *OSTARIOPHYSI.*

Family SILURIDAE.

Subfamily *CLARIINAE.*

Genus **PLOTOSUS,** Lacépède.

Plotosus canius, Hamilton Buchanan.

1803. *Platystacus anguillaris*, Russel, *Vizag. Fish.*, II, p. 51.
1822. *Plotosus canius*, Hamilton Buchanan, *Fish. Gang.*, pp. 142, 374, pl. xv, fig. 44.
1878. *Plotosus canius*, Day, *Fish. Ind.*, p. 482, pl. cxii, fig. 3.
1889. *Plotosus canius*, Day, *Faun. Brit. Ind., Fish.*, I, p. 113, fig. 47.

Russel mentions two specimens, one of which was caught in a river, measuring two feet and seven inches in length, and the other, which was obviously caught in the open sea and was the original for Russel's plate no. clxvi, measuring seven inches in length. The latter was undoubtedly a specimen of *Plotosus anguillaris* (Bloch) which is a marine species, but the former from its size as well as from its estuarine character must have been a specimen of *Plotosus canius*, H.B., which Russel described under the name *P. anguillaris*, Bloch.

There are altogether twenty-eight specimens in the collection from different parts of the lake, obtained throughout the year. Young specimens were mainly obtained after the rains in the outer channel. The following list indicates roughly the distribution of the species in the lake.

2	specimens	Channel north of Arupátná (south side of Satpara)	10-ix-14,	measuring	60 mm. and 28 mm.
2	,,	Barkul Point	21-ix-14,	,,	256 mm. and 250 mm.
1	specimen	Off Mahosa	12-ix-13,	,,	27 mm.
4	specimens	Between Samal Island and Mainland	10-ix-14,	,,	76 mm. to 80 mm.
2	,,	Satpara	March 1914,	,,	283 mm. to 316 mm.
2	,,	Off Satpara ..	17-ix-13,	,,	42 mm. and 120 mm.
13	,,	Serua Nadi (depth 5ft. to 9ft.)	18-ix-14,	,,	33 mm. to 68 mm.
2	,,	South-eastern corner of the lake	?	,,	485 mm. and 496 mm.

In every specimen there is an anal papilla, which is tubular and elongated, immediately behind the vent. It is enclosed from behind by a large spongy and arborescent (dendritic) organ. In very young specimens this arborescent organ appears to look like a gill-book-form of respiratory organ. The whole of it is covered over by the ventral fins, which extend beyond it over-lapping a portion of the anal fin. The ventral fins thus probably protect the organ from mud, on which the fish usually rests, being a bottom fish. The arborescent organ would be soon choked with mud if not thus protected. The function of the organ is evidently respiratory and not sexual as it is found fully formed even in very young specimens.

Distribution:—In the sea, brackish waters and rivers of India, Ceylon, Andaman Islands, the Malay Archipelago and Celebes.

Subfamily *SILURINAE*.

Genus **WALLAGO**, Bleeker.

Wallago attu (Bloch and Schneider).

1801. *Silurus attu*, Bloch and Schneider, *Syst. Ichthyol.*, p. 378.
1803. *Silurus* sp. (*wallago*), Russel, *Vizag. Fish.*, II, p. 50, pl. clxv.
1822. *Silurus boalis*, Hamilton Buchanan, *Fish. Gang.*, pp. 154 and 375, pl. xxix, fig. 49.
1862. *Wallago attu*, Bleeker, *Atl. Ichth.*, II, p. 79, tab. lxxxvi, fig. 1.
1878. *Wallago attu*, Day, *Fish. Ind.*, p. 479, pl. cxi, fig. 4.
1889. *Wallago attu*, Day, *Faun. Brit. Ind., Fish.*, I, p. 126, fig. 54.

Only one specimen, comparatively young, measuring 253 mm., was collected, at Barkul in September, 1914. The fleshy and triangular anal papilla lies horizontally in a groove behind the anal opening and the ventral fins extend to the first few rays of the anal fin entirely covering the papilla.

This fish appears to be an occasional visitor to the main area after freshets.

Distribution:—Fresh waters throughout India, Ceylon, Siam and the Malay Archipelago. The fish is occasionally found within tidal influence.

Genus **CALLICHROUS**, Hamilton Buchanan.

Callichrous bimaculatus (Bloch).

1794. *Silurus bimaculatus*, Bloch, *Ausl. Fisch.*, VIII, p. 24.
1822. *Silurus* (*Callichrous*) *canio*, Hamilton Buchanan, *Fish. Gang.*, pp. 151, 375.
1842. *Silurus indicus*, McClelland, *Cal. Journ. Nat. Hist.*, II, p. 583.
1841. *Schilbe pabo*, Sykes, *Trans. Zool. Soc.*, II, p. 367.
1878. *Callichrous bimaculatus*, Day, *Fish. Ind.*, p. 476, pl. cx, figs. 4 and 5.
1889. *Callichrous bimaculatus*, Day, *Faun. Brit. Ind., Fish.*, I, p. 131, fig. 57.

One specimen, measuring 231 mm., was obtained at Barkul in the month of September, 1914. Evidently it entered the lake from some river during the floods.

Distribution:—Fresh waters of India, Ceylon, Siam and the Malay Archipelago. The fish has been also found within tidal influence in Burma.

Genus **PANGASIUS**, Cuvier and Valenciennes.

Pangasius pangasius (Cuvier and Valenciennes).

1822. *Pimelodus pangasius*, Hamilton Buchanan, *Fish. Gang.*, pp. 163 and 376, pl. xxxiii, fig. 52.
1840. *Pangasius buchanani*, Cuvier and Valenciennes, *Hist. Nat. Poiss.*, XV, p. 45.
1878. *Pangasius buchanani*, Day, *Fish. Ind.*, p. 470, pl. cviii, fig. 5.
1889. *Pangasius buchanani*, Day, *Faun. Brit. Ind., Fish.*, I, p. 142, fig. 61.

Two young specimens, measuring 104 mm. and 85 mm. respectively, were collected about eight miles south-east of Kalupara Ghat on the 16th September, 1914. They evidently came to the lake along with the freshets. There is a thick anal papilla

lying alongside the body behind the anal opening. The tips of the ventral fins reach the anterior edge of the anal opening in both specimens.

The species is a flood-time visitor to the lake when the water is almost fresh.

Distribution:—Large rivers and estuaries of India and the Malay Archipelago.

Genus **OSTEOGENEIOSUS**, Bleeker.

Osteogeneiosus militaris (L.)

1758. *Silurus militaris*, Linnaeus, *Syst. Nat.*, Edit. X, p. 305.
1850. *Arius militaris*, Cantor, *Journ. Asiat. Soc. Bengal*, XVIII, p. 1241.
1858. *Osteogeniosus cantoris*, Blyth, *Proc. Asiat. Soc. Bengal*, p. 286.
1878. *Osteogeniosus militaris*, Day, *Fish. Ind.*, p. 469, pl. cviii, fig. 4.
1889. *Osteogeniosus militaris*, Day, *Faun. Brit. Ind., Fish.*, I, p. 190, fig. 69.

Two adult specimens of the species are in the collection, one measuring 260 mm., from Parikudh, collected on 29-xi-14 and the other measuring 240 mm. from Barkul, obtained on 28-xi-14.

This fish probably is not a permanent inhabitant of the lake, nor does it appear to breed in it. It is a visitor to the main area during the winter months when the water is fairly saltish.

Distribution:—The seas, estuaries and tidal rivers of India and the Malay Archipelago.

Subfamily *BAGRINAE*.

Genus **ARIUS**, Cuvier and Valenciennes.

Arius satparanus, sp. nov.

(Text-figures 6—8.)

The body is elongated and round but compressed in the region of the caudal peduncle.

The measurements in hundredths of the length without the caudal fin are as follows: the length of the head 28·6 %, the greatest depth of the body 20 %, the length of the snout 12 %, the diameter of the eye 4·76 %, the length of the pectoral fin 19 %, and the length of the ventral fin 14·3 %.

The head is somewhat depressed, and is broader than high. The median fontanel is rather narrow and short, beginning from behind the nostrils to the occipital process, which is granular and rugose. The occipital process continues to the basal bone of the dorsal spine (text-fig. 7). The dorsal profile, from the dorsal spine to the slightly prominent snout, slopes down in a somewhat convex line.

The eye is oval, the vertical diameter being 80 % of the length of the horizontal diameter; the orbital margin is not entirely free, being continuous with the skin of the forehead in one-fourth of its upper margin in the middle.[1] The longer diameter of the

[1] "Eyes with free orbital margins" is stated to be one of the generic characters of *Arius*. In the specimen under description one-fourth of the upper margin about the middle of the eye is not free, but is continuous with the skin of the forehead. Instead of founding a new genus or subgenus on this difference, the description for the genus should be modified to allow this species to be included.

eye is contained two and a half times in the length of the snout and three and a half times in the length of the interorbital distance.

The barbels are rather short ; the maxillary barbels are three-fourths of the length of the head, the mandibular pair is as long as the interorbital distance and the mental pair is as long as the snout.

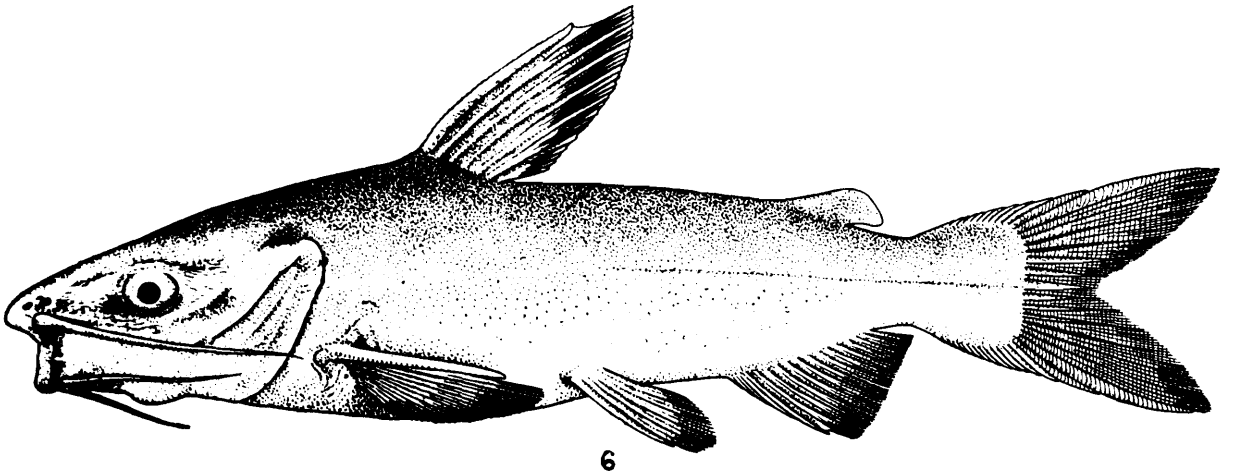


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FIG. 6.—*Arius satparanus*, Chaudhuri, × $\frac{2}{3}$.

The dorsal fin has one spine and six rays, the spine is feebly serrated behind and granulated in front. The height of the fin is equal to the length of the maxillary barbels and the length of the spine is about 80 % of the height of the fin. The base of the adipose dorsal fin is two-thirds of its length and is contained ten and a half times in the distance between the two dorsal fins.

The pectoral fin contains one spine and ten rays and does not reach the ventral fin. The spine is somewhat flattened and is serrated both ways. The ventral fin has six rays, the outer one of which is articulated. It is three-fourths the length of the pectoral, and the vent is just above the middle of the fin when it lies horizontally along the body. The anal fin has nineteen rays, a few of the anterior rays are in front of the vertical line from the origin of the adipose dorsal. The caudal fin is deeply forked with rounded lobes, the upper being slightly longer than the lower portion.

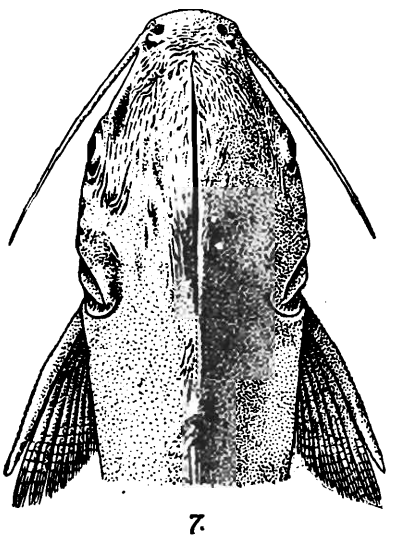

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FIG. 7.—*Arius satparanus*, Chaudhuri, × $\frac{2}{3}$.
Dorsal view of the head.

The teeth in the jaws are villiform, in the upper jaw the space covered with these teeth is divided into two equal ellipsoidal areas with a separating line in the middle. In the lower jaw the space is divided into two short and narrow arcuate areas with a broad toothless space in the middle. The palatine teeth are granular and occur in two

somewhat oval patches far backward on the roof of the mouth (text-fig. 8). There are fifteen gill-rakers which are short and stiff.

The colour of the fish (in spirit) in the upper part is dark brown tinged with blue; the lower part of the sides and the abdomen are dull white. The margins of the dorsal and caudal fins are black.

The new species resembles *Arius arius* (Ham. Buch.) and also *A. maculatus* (Thunberg) in general appearance, but differs from both in the character of the teeth, the length of the barbels and fins, as well as in the structure of the orbital margin; this margin is not free, but is continuous in the middle with the skin of the forehead above.

Type.—A specimen 210 mm. long, dredged in six and a half feet of water in the channel between Satpara and Barnikuda, on 4-ix-14. It is entered in the Indian Museum register under No. F $\frac{8784}{1}$.

Arius arius (Hamilton Buchanan).

(Text-figure 9.)

1822. *Pimelodus arius*, Hamilton Buchanan, *Fish. Gang.*, pp. 170 and 376.
1878. *Arius buchanani*, Day, *Fish. Ind.*, p. 463, pl. cv, fig. 6.
1889. *Arius buchanani*, Day, *Faun. Brit. Ind., Fish.*, I, p. 181.

One young specimen, measuring 185 mm., obtained on 2-ix-14 in the channel off Satpara, is in the collection. The horizontal diameter of the eye is 22 % in the length of the head, while in the adult it is 18 % to 13 %. The anal papilla has a wide lumen with a thin fimbriated edge. The species is quite distinct from *A. maculata* (Thunberg), which has longer barbels, different proportions, colouration and dentition (text-fig. 9).

Probably this species is a permanent inhabitant of the outer channel.

Distribution:—The estuaries of Bengal, Orissa and Burma.

Arius caelatus, Cuvier and Valenciennes.

(Text-figure 10.)

1840. *Arius caelatus*, Cuvier and Valenciennes, *Hist. Nat. Poiss.*, XV, p. 66.
1878. *Arius caelatus*, Day, *Fish. Ind.*, p. 459. pl. cv, fig. 5.
1889. *Arius caelatus*, Day, *Faun. Brit. Ind., Fish.*, I, p. 174.

There are two specimens in the collection. One is a young fish measuring 125 mm. caught north of Patsahanipur on 3-iii-14, the other is an adult fish measuring 245 mm. secured off Barkul Point on 27-xi-14. The ventral fins are situated far backwards in both specimens, almost reaching the anal fin, the anal opening being above the middle of the ventral fin. The anal papilla is rather inconspicuous. In the upper jaw the villiform teeth are in a broad arcuate band of almost uniform breadth, occupying only the middle half of the whole jaw and without any dividing line or empty space in the middle. They are very unlike the villiform teeth of the lower jaw—which are situated in two divided horn-shaped areas with a smooth space in the middle of the jaw, with their broad ends towards the middle. The teeth on the palate are also villiform. They occur in two triangular patches not very far from

the upper jaw, the bases of these triangular areas being turned towards the upper jaw, with the apices towards the centre of the upper palate (text-fig. 10).

The species appears to be a permanent inhabitant in the main area of the lake, probably breeding in it.

Distribution:—In seas, rivers, and brackish waters of Bombay, Madras, Orissa, Bengal, Burma, Siam and the Malay Archipelago.

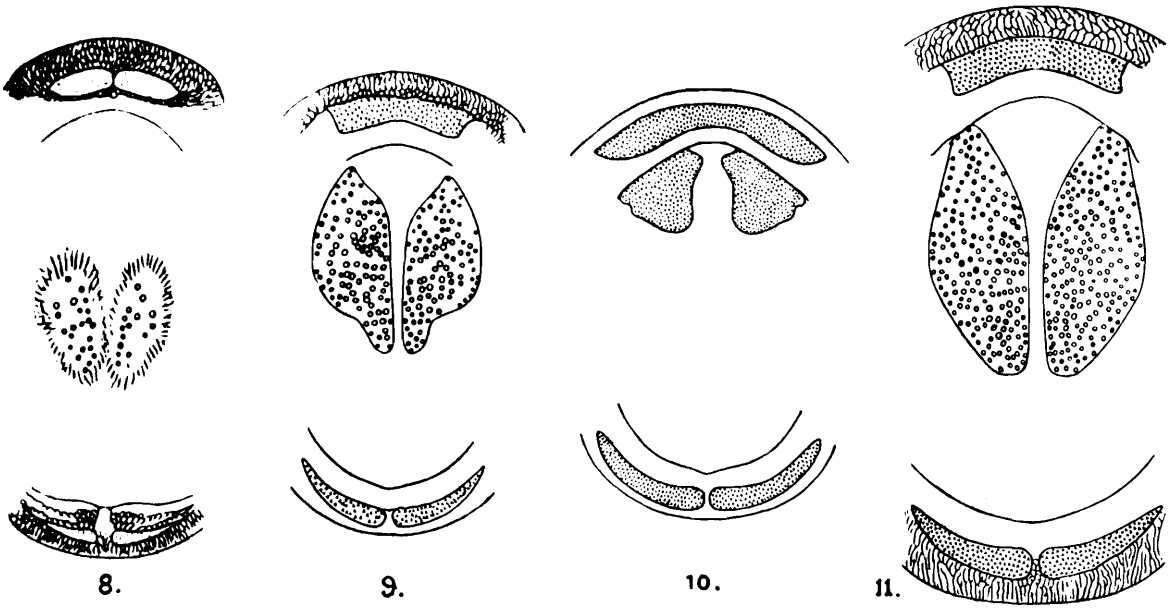

FIG. 8.—*Arius satparanus*, Chaudhuri.
Teeth of upper jaw, palate and lower jaw.

FIG. 9.—*Arius arius* (Hamilton Buchanan).
Teeth of upper jaw, palate and lower jaw.

FIG. 10.—*Arius cælatus*, Cuvier and Valenciennes.
Teeth of upper jaw, palate and lower jaw.

FIG. 11.—*Arius falcariu*, Richardson.
Teeth of upper jaw, palate and lower jaw.

Arius falcarius, Richardson.

(Text-figure 11.)

1844. *Arius falcarius*, Richardson, *Zool. Voy. Sulph. Fish*, p. 134, pl. 62, figs. 7-9.
1846. *Arius falcarius*, Richardson, *Rep. Ichthy. Sea. Chin. Jap.*, p. 284.
1866. *Arius falcarius*, Günther and Playfare, *Fish. Zanzib.*, p. 114.
1878. *Arius falcarius*, Day, *Fish. Ind.*, p. 463, pl. cvi, fig. 5.
1889. *Arius falcarius*, Day, *Faun. Brit. Ind., Fish.*, I, p. 182.

There is one adult specimen in the collection measuring 384 mm., captured near Barkuda Island inside the lake on 6-ix-14, in five and a half feet of water.

The villiform band of teeth in the upper jaw is equally wide throughout and does not reach the angles of the jaw, nor is there a dividing line in the middle. The palatine teeth are in two elongated patches, close and running parallel to the middle line—the anterior teeth are granular and the posterior globular. The villiform teeth in the lower jaw are divided by a smooth mesial line into two elongated arcuate

bands, broad towards the mesial line and tapering to a point towards the angle of the jaw, the two taken together being much longer than the band of teeth in the upper jaw (text-fig. 11).

Probably a casual visitor to the lake.

Distribution:—Seas of India and China, and East Africa. A variety of this species occurs in Africa.

Genus **MACRONES**, Duméril.

Macrones cavasius (Hamilton Buchanan).

1822. *Pimelodus cavasius*, Hamilton Buchanan, *Fish. Gang.*, pp. 203 and 379, pl. xi, fig. 67.
1841. *Pimelodus seengtee*, Sykes, *Trans. Zool. Soc.*, II, p. 374, t. lxvi, fig. 2.
1865. *Hypselobagras cavasius*, Day, *Fish. Malab.*, p. 188.
1878. *Macrones cavasius*, Day, *Fish. Ind.*, p. 447, pl. c, fig. 1.
1889. *Macrones cavasius*, Day, *Faun. Brit. Ind., Fish.*, I, p. 155.

One specimen from Barkul secured in September, 1914, measuring 85 mm., is in the collection. It evidently entered the lake from neighbouring fresh waters during the floods and is only a chance visitor when the water is entirely fresh.

Distribution: --In fresh waters of Sind, Southern India, Bengal, Assam and Burma.

Macrones gulio (Hamilton Buchanan).

1822. *Pimelodus gulio*, Hamilton Buchanan, *Fish. Gang.*, pp. 201 and 379, pl. xxiii, fig. 66.
1849. *Bagrus abbreviatus*, Cantor, *Journ. Asiat. Soc. Bengal*, XVIII, p. 1236.
1878. *Macrones gulio*, Day, *Fish. Ind.*, p. 445, pl. xcix, fig. 2.
1889. *Macrones gulio*, Day, *Faun. Brit. Ind., Fish.*, I, p. 151, fig. 64.

There are altogether forty-five specimens of this species in the collection, from different parts of the lake; they are of all sizes as shown in the list given below. In all the specimens no anal papilla proper is found, but in its place, that is at a distance of one diameter of the eye behind the vent, there is a pore edged with a thick fimbriated muscular margin. The ventral fins almost reach the anal fin. The colouration of the pectoral, ventral, anal and caudal fins is very variable, in some they are black all over, in others the superior sides of the paired fins are quite white, in still others only the tips of some of these fins are black and the rest white; sometimes the tips of the anal or the ends of the caudal fins only are black.

The fish is a permanent inhabitant of the lake and breeds freely in it. It is more numerous in the outer channel and probably is replaced by *Macrones vittatus* (Bloch.) in the north-east corner of the main area where freshwater channels enter the lake.

The following list of the catch will roughly show the distribution of the species in the lake:—

1	specimen	Off mouth of Barkul Bay	18-ix-14,	measuring	45 mm.
1	,,	Nalbano Island	25-xi-14,	,,	58 mm.
1	,,	Parikudh	28-ix-14,	,,	81 mm.

8	specimens	Rambha	.. ..	.. 19-xi-14,	measuring 87 to 123 mm.
2	,,	Rambha Bay	..	February, 1914,	,, 79 mm. and 85 mm.
23	,,	Satpara	.. ..	March, 1914,	,, 44 mm. to 85 mm.
3	,,	Do.	.. ..	September, 1913,	,, 22 mm., 24 mm. and 26 mm.
1	specimen	South-eastern corner of the lake	..		,, 170 mm.
2	specimens	South end of the lake	..	21-31-vii-13,	,, 89 mm. and 111 mm.

Distribution:—Seas, estuaries and tidal waters of Sind, Bombay, Madras, Orissa, Bengal, Assam and Burma; also of Ceylon and the Malay Archipelago.

Macrones vittatus (Bloch).

1785. *Silurus vittatus*, Bloch, *Ausl. Fisch.*, t. cccIxxi, fig. 2.
1801. *Silurus vittatus*, Bloch and Schneider, *Syst. Ichthy.*, p. 387.
1822. *Pimelodus carcio*, Hamilton Buchanan, *Fish. Gang.*, pp. 181 and 377.
1842. *Pimelodus indicus*, McClelland, *Cal. Journ. Nat. Hist.*, II, p. 584.
1849. *Bagrus affinis*, Jerdon, *Mad. Journ. Lit. Sc.*, XV, p. 338.
1878. *Macrones vittatus*, Day, *Fish. Ind.*, p. 448, pl. xcviii, fig. 3, and pl. xcix, fig. 4.
1889. *Macrones vittatus*, Day, *Faun. Brit. Ind., Fish.*, I, p. 157.

There are altogether thirty-five specimens of this species in the collection all from the main area of the lake. The species appears to be restricted more to the western edge and the north-western corner of the lake as the distribution list given below will show:—

7	specimens	Off Barnikuda	.. .. ..	6-ix-14,	measuring 40 mm to 60 mm.
11	,,	Near Barnikuda (inside lake)	.. ..	6-ix-14,	,, 55 mm. to 70 mm.
5	,,	Barkul (Prawn traps)	.. ..	21-ix-14,	,, 44 mm. to 80 mm.
3	,,	Off Kalupara ghat (1½ miles)	.. ..	15-ix-14,	,, 37 mm. to 57 mm.
9	,,	About eight miles south-east of Kalupara ghat		16-ix-14,	,, 38 mm. to 58 mm.

This freshwater *Macrones* in all probability breeds in the lake after the rains. It is not a casual visitor like the other freshwater *Macrones, i.e., Macrones cavasius* (H.B.), of which there is only one specimen in the collection.

In the specimens of *M. vittatus* the ventral fin reaches the anal fin and the anal papilla is more often present than not. The tips of the caudal fin are black and the rest of the fin white. It is a much smaller fish than *Macrones gulio* (H.B.) which is the most numerous *Macrones* in the lake.

Distribution:—Throughout the fresh waters of India, Ceylon, Siam and Tranquebar.

Family CYPRINIDAE.

Subfamily *CYPRININAE*.

Genus **CIRRHINA**, Cuvier.

Cirrhina latia (Hamilton Buchanan).

1822. *Cyprinus latius*, Hamilton Buchanan, *Fish. Gang.*, pp. 345 and 393.
1822. *Cyprinus gohama*, *id.*, *ibid.*, pp. 346 and 393.
1838. *Barbus diplochilus*, Heckle, *Fische aus Kasmir*, p. 53, t. x, fig. 1.

1839. *Gonorhynchus fimbriatus*, McClelland, *Asiat. Researches*, XIX, pp. 282 and 375, pl. xliii, fig. 3 B.
1839. *Gonorhynchus macrosomus*, *id.*, *ibid.*, pp. 282 and 372, pl. xliii, fig. 7 B.
1839. *Gonorhynchus gohama*, *id.*, *ibid.*, p. 283, pl. xliii, fig. 6 B.
1839. *Gonorhynchus brevis*, *id.*, *ibid.*, p. 373.
1841. *Chondrostoma wattanah*, Sykes, *Trans. Zool. Soc.*, II, p. 360, pl. lxii, fig. 4.
1872. *Crossocheilus barbatulus*, Beavan, *Proc. Zool. Soc.*, p. 152, fig. 2.
1878. *Cirrhina latia*, Day, *Fish. Ind.*, p. 548, pl. cxxx, fig. 4.
1889. *Cirrhina latia*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 279.

There is only one specimen, secured on 4-i-15 at Barkul and measuring 89 mm. The maxillary barbels are wanting. This is a strictly freshwater species. Its occurrence in the lake, especially in the beginning of January (when the water is very salt) is most extraordinary. This must have been one of those rare occasions on which a freshwater fish had entered the lake through one of the numerous streams or flood overflows and had survived at the edge of the lake at a place where the inflow drainage water had enabled it to shift for a time.

Distribution:—Fresh waters along the foot of the Himalayas, and of the United Provinces, Punjab, Sind, Deccan, Orissa, Bengal and Assam.

Genus **BARBUS**, Cuvier.

Barbus sophore (Hamilton Buchanan).

1822. *Cyprinus sophore*, Hamilton Buchanan, *Fish. Gang.*, pp. 310 and 389, pl. xix, fig. 86.
1839. *Cyprinus sophore*, McClelland, *Asiat. Researches*, XIX, pp. 285 and 382.
1842. *Cyprinus sophore*, Cuvier and Valenciennes, *Hist. Nat. Poiss.*, XVI, p. 388.
1844. *Leuciscus stigma*, *id.*, *ibid.*, XVII, p. 93, pl. ccccIxxxix.
1844. *Leuciscus duvaucelii*, *id.*, *ibid.*, XVII, p. 95, pl. ccccxci.
1844. *Leuciscus sulphureus*, *id.*, *ibid.*, XVII, p. 96.
1849. *Systomus sophore*, Jerdon, *Madr. Journ. Lit. Sc.*, XV, p. 316.
1867. *Puntius modestus*, Kner, *Novara Fische*, p. 348, t. xv, fig. 3.
1868. *Puntius stigma*, Day, *Proc. Zool. Soc.*, p. 198.
1868. *Barbus sophore*, Gunther, *Cat. Fish. Brit. Mus.*, VII, p. 152.
1869. *Barbus* (*Puntius*) *stigma*, Day, *Proc. Zool. Soc.*, p. 375.
1878. *Barbus stigma*, Day, *Fish. Ind.*, p. 579, pl. cxli, fig. 5.
1889. *Barbus stigma*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 329.

There are altogether forty-six specimens of various sizes in the collection obtained at different times of the year in the main area of the lake. The largest number was obtained after the floods.

Hamilton Buchanan gave the name "*Cyprinus sophore*" to this fish, the specific name being derived, as he says, from its Sanskrit equivalent; he found this fish to be a "beautiful little fish," "very common in ponds" in Bengal. He definitely stated in the text that the fish so named by him was represented by figure 86 of plate xix of his illustrations that were published along with the text of his work on the *Fishes of the Ganges*.

In the introductory remarks in English there were two or more 'printer's mistakes. In the first para. of his introductory remark he stated that there were only

two black spots, "one at the end of the tail (caudal peduncle) and another at the root of the dorsal fin"—a few lines below in the second para. he says "besides the five spots mentioned in the specific character" (p. 310). This *five* is obviously a misprint for *two*. In the third para. he makes another obvious mistake by stating "there are four tendrils, so very minute, as often to be scarcely perceptible" (p. 311). The figure in the illustration which he specially refers to in the text does not show any trace of barbels whatever, nor in his *Index Methodicus* (synoptical table, 42) which follows the introductory remarks in English, and which contains brief scientific descriptions in Latin of all the species,—do the barbels find any place (p. 389). Therefore the statement as to four minute barbels must also be regarded as a mistake or oversight. McClelland, Cuvier, Valenciennes, and Günther all took up this position and decided that the species *C. sophore* described by Hamilton Buchanan was the little *Barbus* without barbels so common in the ponds of Bengal. Day, however, disputed this point, and he thought that by the name *C. sophore* Hamilton Buchanan described a *Barbus* with four barbels and the name should be restricted to some fish which must have four barbels even if it had no resemblance to the figure nor any reference to other portions of his description. In going over the collection of fish in the Museum of the Asiatic Society of Bengal, Day came across one "bleached" specimen of a small *Barbus* with four barbels, but without any name or label for locality or donor. This Day at once concluded to be a typical specimen of *C. sophore* in spite of its long barbels and colourless condition,[1] and when twelve other small *Barbus* (some of which were undoubtedly young—their lengths without the caudal fin varying from 24 mm. to 58 mm.) similar to the bleached specimen came to the Museum from the Khasia Hills, forwarded by Mr. R. Bevan,[2] Day at once concluded that the bleached fish without a label must have come from the Khasia Hills! He also concluded that this was the *Cyprinus sophore* of Hamilton Buchanan. In arriving at this conclusion Day entirely disregarded the fact that Hamilton Buchanan's *C. sophore* was "very common in ponds" in Bengal. The Khasia species has rather long barbels and the colouration and proportions are different; it is a comparatively rare species and even according to Day is to be found only in "Assam and Khasia Hills" (*Faun. Brit. Ind.*, *Fish.*, I, p. 309). Thus disregarding the conclusions of Cuvier, McClelland, Günther and others, Day wanted to apply the name *sophore* to a very rare species of *Barbus* from Assam, a species with four long barbels and of a very different colouration from that given by Hamilton Buchanan for his *sophore*.

There is another specimen in the collection of the Indian Museum[3] purchased from Day on the 8th September, 1879, which is labelled "*Barbus sophore* (H.B.)" in Day's own handwriting. The locality of this specimen is given by Day as Basein, Burma. It has only two maxillary barbels and is without any dark

[1] This specimen is in the collection of the Indian Museum numbered No. F $\frac{5}{1}$ in the register of the Museum. Its total length without the caudal fin is 86 mm.

[2] These specimens are numbered F $\frac{5}{1}$ to F $\frac{5}{1}$ in the register of the Indian Museum.

[3] This specimen is numbered 2734 in the register of the Indian Museum.

spots and measures 117 mm. in length without the caudal fin. This specimen also cannot be said to have anything to do with "the beautiful little fish very common in ponds" to which Hamilton Buchanan gave the name. Thus Day used the name "*sophore*" of Hamilton Buchanan for two very different fishes—one from the Khasia Hills and the other from Burma. Hamilton Buchanan in his work *The Fishes of the Ganges* described only those he came across, in his statistical survey of the Bengal Districts, in the Ganges and its tributary streams, except "a few he observed in the rivers of the south of India" (see his Introduction, p. vii); the names of these, however, have no number prefixed to them in the synoptical table. There is no record that Hamilton Buchanan received any collection from the Khasia Hills or Burma. Day, moreover, had adopted for the Bengal fish the name *Barbus stigma*. This name was invented by Cuvier and Valenciennes for a small *Barbus* from Mysore which is a local race of *Barbus sophore* of Hamilton Buchanan, as defined by him in Latin in the synoptical table No. 42 (p. 389) supported by figure 86 of plate xix of his *Illustrations*, as well as by the detailed description in English in which unfortunately two obvious mistakes occur. These mistakes were duly corrected by McClelland and Günther long before Day thought it necessary to take advantage of one of them to change the prior name of a very common species of fish occurring everywhere in ponds in Bengal and to adopt a much later name invented for the local race of the same fish found in Mysore.

The following list gives the distribution of the fish in the lake:—

6	specimens	Barkul	13-xi-12,	measuring	19 mm. to 56 mm.
2	,,	,,	1-ii-13,	,,	40 mm. and 41 mm.
32	,,	,,	21-ix-14,	,,	39 mm. to 51 mm.
2	,,	Off Barkul	25-i-14,	,,	40 mm. and 48 mm.
1	specimen	Off Nalbano	18-ix-14.	,,	37 mm.
2	specimens	Nalbano	25-xi-14,	,,	33 mm. and 42 mm.
1	specimen	Rambha Bay	February, 1914,	,,	43 mm.

The specimens collected during the dry months have the black spots very conspicuous and bright, but do not show any trace of longitudinal coloured bands, nor are their fins tinted pink. On the other hand the specimens collected after the floods are found to have one or other of the two black spots indistinct or wanting, and most of them show coloured longitudinal bands and the ends of the ventral fins are pink. In some, however, no coloured bands are visible—and in these the upper half of the body is dark brown and the lower half dull silvery.

Distribution:—Fresh waters of India and also in tidal rivers from Sind to Burma including Assam.

Barbus ticto (Hamilton Buchanan).

1822. *Cyprinus ticto*, Hamilton Buchanan. *Fish. Gang.*, pp. 314 and 389, pl. viii, fig. 87.
1839. *Systomus ticto*, McClelland, *Asiat. Researches*, XIX, p. 382.
1841. *Rohtee ticto*, Sykes, *Trans. Zool. Soc.*, p. 365.
1849. *Systomus ticto*, Jerdon, *Madr. Journ. Lit. Sc.*, XV, p. 318.
1849. *Systomus tripunctatus, id., ibid.*, XV, p. 316.

1878. *Barbus ticto*, Day, *Fish. Ind.*, p. 576, pl. cxliv, fig. 7.
1889. *Barbus ticto*, Day, *Faun. Brit. Ind., Fish.*, I, p. 325.

There are three specimens of this species in the collection obtained from different parts of the main area at different periods of the year as stated below :—

1 specimen	Off Barkul	..	25-i-14,	measuring 27 mm.
1 ,,	Rambha Bay	..	March, 1914,	,, 31 mm.
1 ,,	Between Samalkuda and Barkuda		15-xi-14,	,, 19 mm.

In the first two specimens the anterior black blotch is less conspicuous and the third specimen is dark brown all over.

The species is a permanent inhabitant of the main area throughout the year and breeds in it.

Distribution :—Fresh waters of India and Ceylon, extending to brackish waters.

Barbus vittatus, Day.

1865. *Puntius vittatus*, Day, *Proc. Zool. Soc.*, p. 303.
1865. *Puntius vittatus*, Day, *Fish. Malab.*, p. 215, pl. xiii.
1867. *Puntius sophore*, Kner, *Novara Fische*, p. 347.
1878. *Barbus vittatus*, Day, *Fish. Ind.*, p. 582, pl. cxliv, fig. 2.
1889. *Barbus vittatus*, Day, *Faun. Brit. Ind., Fish.*, I, p. 333.

There are three specimens in the collection measuring from 20 mm. to 22 mm. ; they were obtained at Satpara on 17-iii-14. In all these specimens the anterior black spot is altogether wanting. The inferior black spot is anterior to the anal fin and is not at its base.

The species appears to be confined to the outer channel. The specimens were collected in the middle of March in water as salt as that of the Bay outside.

Distribution :—Madras, Malabar, Cutch and Ceylon.