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FAUNA

OF THE

CHILKA LAKE.

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THE COELENTERATES OF THE LAKE, WITH AN ACCOUNT OF THE ACTINIARIA OF BRACKISH WATER IN THE GANGETIC DELTA.

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

(Plates VI–IX.)

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COELENTERATES.

By N. Annandale.

As will be seen from the list on p. 69, we obtained specimens of sixteen species of coelenterates in the Chilka Lake, *viz.* six Actinozoa, one Scyphomedusa and nine Hydrozoa. Five of the Actinozoa are Actiniaria and one an Alcyonarian; the Scyphomedusa belongs to the order Rhizostomata; one of the Hydrozoa is a Narcomedusa and one a Siphonophoran, while the remainder are true hydroids or hydromedusae, including four Calyptoblastea and three Gymnoblastea. Of the Calyptoblastea it is possible that a hydroid and a medusa actually represent the different generations of a single true species.

Of the Alcyonarian (a species of *Virgularia* probably not yet named) I propose to say no more at present than that it also occurs in the Gangetic estuaries. Our specimens are in the hands of a specialist, who will doubtless describe them in due course.

The Actiniaria are perhaps the most interesting group represented, for not only do they include species of the primitive genera *Edwardsia* and *Halianthus*, neither of which appears to have been found hitherto in the Indian Ocean, but they also include two species of Metridiine Sargatiidae that are here described as the types of new genera. These genera are apparently specialized for different phases of life in conditions such as occur in the Chilka Lake and in the Gangetic delta. Notwithstanding their high degree of apparent secondary specialization, it is possible that the type-species of one of them is in reality no more than a permanent post-larval form of *Metridium schillerianum*, long known from the estuarine tracts of the Ganges. All the species of Actiniaria found in the Chilka Lake occur in its main area, in which it is evident that they are permanent residents. Most of them, if not all, are, however, to some extent affected by the seasonal irruption of fresh water and probably only a few individuals of each survive annually to perpetuate their kind.

The only Scyphomedusa we obtained is also a permanent inhabitant of the main area of the lake, in which we have evidence that it breeds regularly, though it occurs also in the Bay of Bengal. A fortunate accident made it possible to study the direct effect of fresh water on the general physiology and the structure of this species, not only in the Chilka Lake but more particularly in the Ennur backwater near Madras.

The Coelenterata of the lake fall into three classes biologically: (1) casual visitors from the sea; (2) periodic immigrants from the Bay of Bengal; and (3) permanent inhabitants of brackish water or of water subject to great changes in salinity. The first group consists of a few surface or midwater forms of which individuals are

occasionally carried into the outer channel, and of at least one hydroid washed into the main area on drifting weed. To the second category belong several hydroids that are able to establish themselves in the salt-water season in the outer channel but perish in the summer floods; while to the third must be assigned all the Actiniaria, the one Alcyonarian, the one Scyphomedusa and at least two hydroids. The number of species that may be tabulated under each of the three headings is as follows:—

Casual visitors ..	..	4
Periodic immigrants ..	..	3
Permanent inhabitants	..	9
	Total ..	16

The casual visitors include one Narcomedusa, one Siphonophoran and two Calyptoblastic Hydrozoa, one of which is represented by the medusoid generation only; the periodic immigrants consists of one Gymnoblastic and one Calyptoblastic hydroid, with a medusa that may be no more than the fertile generation of the latter; while as permanent residents may be classed five Actiniaria, one Alcyonarian, one Scyphomedusa and two Gymnoblastic hydroids.

ACTINIARIA.

(Plate vi (in part), plates vii, vii*a*).

The Actiniaria of the Chilka Lake belong to three families, five genera and five species. The three families are the Actiniidae, the Sagartiidae and the Edwardsiidae. The first is represented by a single new species of the genus *Gyrostoma*, the second by two species each of which is placed in a new genus, and the last by new species of *Halianthus* and *Edwardsia*. With one exception (that of a Sagartiid previously found in the Gangetic delta) all the species are here described or named for the first time—a fact that is not surprising in view of our present ignorance of the actinian fauna of the Bay of Bengal[1] and of the estuaries and lagoons connected therewith.

From a geographical point of view the most interesting feature of the Chilka species is the occurrence among them of *Edwardsia* and *Halianthus*, genera known from both northern and southern regions but apparently represented but poorly in the Tropics.

Biologically the most important forms are those here accepted as the types of new genera of Sagartiidae. Their significance is discussed at some length on pp. 72-76, *postea*. The apparent effect of the irruption of fresh water into the lake on the species of *Halianthus* is another interesting feature of the fauna (see p. 91), and may

[1] The only papers on the sea-anemones of the Bay of Bengal that I can trace are those by Alcock in the *Journal of the Asiatic Society of Bengal* (vol. LXII, part 2, pp. 151 and 169: 1893), and by Haddon in the *Journal of the Linnean Society* (Zool., vol. XXI, p. 247: 1888). These papers deal with a few species only.

COELENTERATES OF THE CHILKA LAKE.

m.a. = main area : o.ch. = outer channel : sp. gr. = specific gravity of water in the lake.
Species whose names are marked with a star have been found only in the Chilka Lake.

	Chilka Lake.		Further Distribution.	Sp gr.
	m.a.	*o.ch.*		
ANTHOZOA.				
Actiniaria.				
Actiniidae.				
*Gyrostoma glaucum** ..	x	x		1·0075—1·02575
Sagartiidae.				
*Phytocoetes chilkaeus** ..	x	x		1·0105—1 0265
Pelocoetes exul ..	x		Gangetic delta (*brackish water*).	1·005—1·010
Edwardsiidae.				
*Halianthus limnicola** ..	x	x		1·000—1·0257
*Edwardsia tinctrix** ..	x	x		1·000—1·0257
Alcyonaria.				
Virgulariidae.				
Virgularia sp. ..	x		Gangetic delta (? *salinity*).	
SCYPHOMEDUSAE.				
Rhizostomata.				
Rhizostomata Triptera.				
Acromitus rabanchatu ..	x	x	Bay of Bengal (*marine*).	1·000—1·02575
HYDROZOA.				
Narcomedusae.				
Aeginidae.				
Solmundella bitentaculata ..		x	Practically cosmopolitan (*marine*).	1·02575
Siphonophora.				
Diphyidae.				
Diphyes bojani ..		x	Indian and Pacific Oceans (*marine*).	1·02575
Calyptoblastea.				
Campanulinidae.				
Campanulina ceylonensis ..		x	Bay of Bengal; G. of Manaar; Gangetic delta (*salt and brackish water*).	1·02575
Campanulariidae.				
Obelia spinulosa ...	x		N. S. Wales; Java: Andamans (*marine*).	1·02575
Clytia serrulata ..		x	N. S. Wales (*marine*).	*ca.* 1·006
*Phialidium cruciferum** ..		x	Perhaps the medusa of *C. serrulata*.	1·02575
Gymnoblastea.				
Bougainvilliidae.				
Bimeria fluminalis .	x	x	Gangetic delta (*brackish water*).	1·000—1·02575
Corynidae.				
Dicyclocoryne filamentata ..	x		Gangetic delta (*brackish water*).	*ca.* 1·0150
Hydractiniidae.				
Clavactinia gallensis ..		x	G. of Manaar (*marine*).	1·02575

be compared with that noted in greater detail in the case of the medusa *Acromitus rabanchatu* (see p. 101); generally speaking, this change in environment seems in both cases to induce a period of physiological quiescence accompanied by a shrinkage of the mesogloea and is probably fatal to a large number of individuals, though not to the species as a whole.

With my account of the Chilka species I have included a description of a new Gangetic anemone co-generic with one of the former, and also some notes on another Gangetic species that has long been known but is of particular interest in reference to the question of the origin of the fauna of brackish water. These Gangetic species are *Phytocoetes gangeticus*, sp. nov. and *Metridium schillerianum* (Stoliczka).

Family ACTINIIDAE.

Genus **Gyrostoma**, Kwietniewski.

1900. *Gyrostoma*, Carlgren, *Mitt. Naturh. Mus. Hamburg*, XVII, p. 55.
1905. ,, McMurrich, *Zool. Jahrb.*, Suppl. VI (111), p. 226.

The only representatives of the Actiniidae found in the Chilka Lake belongs to the genus *Gyrostoma* as redefined by the authors cited. The genus is represented in all the warmer seas and species have been described from East Africa, South Australia, Torres Straits and the West Indies.

Gyrostoma glaucum, sp. nov.

(Plate vii*a*, fig. 1.)

In life the animal is of an almost uniform glaucous green colour, but in some individuals there are darker V-shaped cross-bars on the upper surface of the tentacles. The column is slender and more or less vase-shaped, much longer than broad when fully extended. The external surface is smooth to the naked eye, except when the circular muscle is strongly contracted, but is covered with scattered microscopic prominences provided with nematocysts. The contracted muscles are visible as distinct annuli which, in preserved specimens, are more opaque than the expanded parts of the column.

The oral disk is rather narrow, circular in outline, flat but ridged and grooved radially. The mouth, which is provided with not very prominent lips, is almost linear and occupies about two-thirds of the circle in its longer axis. The tentacles are moderately long and slender; when fully expanded they are pointed, but even a slight contraction produces a faint ovoid swelling of the tips due to a greater thickness of the wall (mainly the ectoderm) in this region. The outer circle consists of about 24 tentacles distinctly longer and stouter than any of the others Within this circle there are four others, but neither the number nor the arrangement is at all regular. Some of the tentacles of the innermost circle, though smaller than the outermost ones, are larger than the majority. These are often thrust into the mouth.

The basal disk, though small and not extending beyond the margin of the column,

is thick and muscular. It is capable to some extent of retraction, the margin of the retracted portion being angular in vertical section. There is a minute central aboral pore.

There are twelve complete and thirty-six incomplete mesenteries, the latter being situated in the intermesenterial spaces only, six in each. The two central incomplete mesenteries in each space are fertile. The longitudinal muscles are very feebly developed and in strictly horizontal sections the width of the mesenteries is almost uniform throughout, the folds at the base on both sides in particular being diffuse and poorly developed. The two pairs of directive mesenteries are very short.

The stomodaeum is ample and extends much more than half way down the column in a state of expansion.

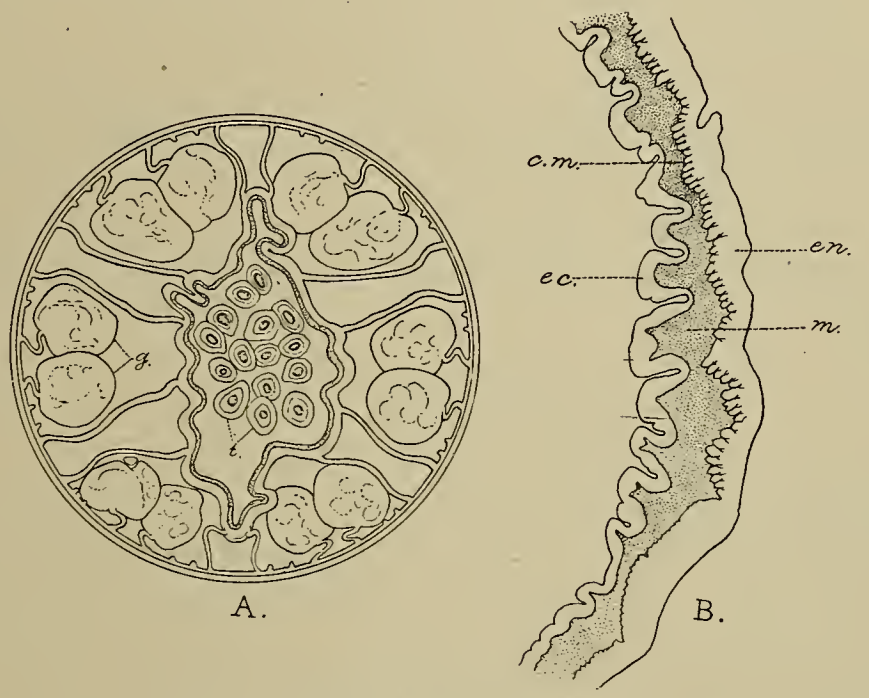

FIG. 1.—*Gyrostoma glaucum*, sp. nov.

A. Transverse section through the column in the lower part of the stomodaeum.

B. Vertical section of the lower part of the sphincter.

c.m. = circular muscle: *ec.* = ectoderm: *en.* = endoderm: *g.* = gonad: *m.* = mesogloea: *t.* = tentacles thrust into mouth.

The column-wall is thin, the mesogloea in particular being scanty. The circular muscles lie at the base of the endoderm and are not very highly developed. The sphincter is little if at all differentiated from any other part of the sheath in a state of contraction. When the tentacles are fully everted there is, indeed, a region just below the disk in which its folds are a little stronger than in the region immediately succeeding it; but similar folds may also be observed in the aboral half of the column. These features are indicated by increased opacity and stronger annulation of the body-wall (pl. vii*a*, fig. 1).

The length of the column of our largest specimen was, fully expanded, 10 mm.; that of the other adults about half as much.

Type. No. Z.E.V. 6825/7, *Ind. Mus.*

In this brief description I have not attempted more than to give a concise statement of the characters that seem to be of specific importance. Only five adult specimens are available for examination and, so far as I can judge from the species of other families that I have examined in much larger numbers, the so-called anatomical characters of the Actiniaria are liable not only to great individual variation but also to much momentary change in correlation with expansion and contraction of the muscles and mesogloea, apart altogether from the fact that distortion is almost inevitably produced in the course of preservation.

In external appearance *Gyrostoma glaucum* bears some resemblance to von Ehrenberg's figure of *Entacmaea olivacea*[1] (=*Paractis olivacea*, Klunzinger), but differs therefrom in the greater relative length of its outer tentacles.

G. glaucum has been taken as yet only in the Chilka Lake, in which it appears to be very scarce. It occurs both in the main area and in the outer channel. A single specimen was taken near the mouth of Rambha Bay in February, at a depth of between 5 and 7 feet and in water of a sp. gr. of 1·0075, while four others of much smaller size were obtained in the channel between Satpara and Mahosa in March, from about the same depth and in water of sp. gr. 1·02575. Three others[2] of still smaller size and evidently immature were found in the oyster-beds at Manikpatna in the same month.

Family SAGARTIIDAE.

Subfamily *METRIDIINAE*.

In discussing the species of this subfamily found in the Gangetic delta inexperience led me in 1907 into a taxonomic error, but this error, having some biological justification, has proved not unprofitable in considering the actinians of the Chilka Lake. In 1907[3] I ascribed three forms from Port Canning to the genus *Metridium* and to the species described by Stoliczka[4] in 1868 and 1869 as *Sagartia schilleriana*. One of these, there is no doubt, was identical with that species, of which my specimens were topotypes in the strictest sense of the term and of which the actual types are still available for comparison in Calcutta; another I described as a variety (*exul*), while the third I regarded as the young of the second. These three forms are here placed in three distinct genera, of which two are described as new, while Stoliczka's species is left in *Metridium*.

As the two new genera are both represented in the Chilka Lake, it will be convenient to discuss here the relationships of one to the other and of both to *Metridium*. Differences may first be noted. The species of *Metridium* are all anemones with a well-developed basal disk by means of which they cling firmly to solid objects.

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[1] See Zoologica 11, Phytozoa, pl. viii. fig. vi, in *Symbolicae Physicae*, edited by O. Carlgren (1899) and Klunzinger's *Korallthiere des Rothen Meeres* 1, p. 70, pl. v, fig. 7, pl. viii, fig. 8 (1877).

[2] These had only 24 tentacles arranged in two circles, an outer circle of 8 and an inner one of 16; the latter was, however, incompletely differentiated into two subsidiary circles.

[3] *Rec. Ind. Mus.* I, p. 35.

[4] *Proc. Asiat. Soc. Bengal*, 1868, pp. 174, 263, and *Journ. Asiat. Soc. Bengal*, XXXVIII (2), p. 31 (1869).

Their body-wall is thin and not particularly muscular; they have twelve complete mesenteries, an ample oral disk and a large number of slender tentacles arranged in several or many cycles. For the two new genera I propose the names *Pelocoetes* and *Phytocoetes*. The former, as its name indicates, is a dweller in mud, while the latter lives, free or lightly attached, among weeds, in sponges or in holes in logs of wood. The generic peculiarities of *Pelocoetes* are so marked that at first sight it might be placed in a different family from *Metridium*. It is a typical burrower with an elongated vermiform body, and a muscular though by no means thick body-wall. Its oral disk is highly specialized, the arrangement of its tentacles peculiar. *Phytocoetes* has an elongated, but not a vermiform column. Its oral disk remains normal, but the number of its tentacles, which exhibit no marked peculiarity in arrangement, is somewhat reduced. In both genera little practical use is made of the aboral disk, but it has not entirely disappeared and is to some extent functional. In both genera, notwithstanding this fact, the lower extremity of the column bears, both functionally and structurally, a remarkable resemblance to the physa of such types as *Edwardsia* and *Cerianthus* that totally lack an aboral disk.

If this were all that could be said about the three genera it would appear that they were very distinct, and that *Pelocoetes* and *Phytocoetes* differed considerably, one from another and both from *Metridium*. But an examination of the anatomy and even of the external characters reveals very striking resemblances, and, although there would be no difficulty in distributing a set of living anemones into their respective genera, there is often a very real difficulty in sorting out specimens preserved in alcohol. The colouration of the known species is identical or almost so; all have the same translucent watery appearance, the same absence of intrinsic pigment;[1] the arrangement of the mesenteries is the same, except that the cycles of incomplete septa differ in number, while the musculature of the body-wall is very similar; the structure of the gonads, of the muscle-banners and of the individual tentacles appears to be practically identical.

The fact that these three genera live together in circumstances very unfavourable to their group as a whole (*viz.* in estuaries, creeks, pools and lakes in which the water is much fresher than normal sea-water and subject, moreover, to great and even sudden changes in salinity; in which the bottom is composed of soft mud; in which rocks covered at all seasons and even stiff water-weeds are practically absent) must not be forgotten in considering their relationships.

Metridium schillerianum, the species originally described from the Gangetic delta, maintains itself by clinging tightly to floating logs, which are by no means common in the Gangetic delta, and to posts fixed on the edge of canals and creeks. It is a normal member of its genus, which is probably cosmopolitan in distribution and essentially marine. Of the three genera, *Metridium* is certainly the most primitive and, indeed, may be the ancestral form of the other two, both of which are

[1] The colouration of all these brackish-water species appears to be due to the presence of Zoochlorellae and of a minute purple alga in the endoderm.

evidently adapted in structure for life in different phases of the same environment. The peculiarities of *M. schillerianum* are mainly physiological; to these are added, in the case of *Pelocoetes* and *Phytocoetes*, special structural characters.

In 1907 (*op. cit.*) I expressed the opinion, somewhat tentatively, that the type now called *Pelocoetes* was a variety, local race, or possibly an unfixed phase of *Metridium schillerianum* produced by isolation, and that the form here recognized as a distinct genus under the name *Phytocoetes* was merely the young of *Pelocoetes*. This view ignored, perhaps rightly, the fact that many individuals of the *Phytocoetes* type are sexually mature. In any case it is rendered untenable in its entirety by the discovery in the Chilka Lake of anemones of both the *Pelocoetes* and the *Phytocoetes* types. Stress must be laid, nevertheless, on the resemblance between the latter type and the young of the Sagartiidae. In *Sagartia troglodytes*[1] the young, at any rate in some cases, is born as a small actinian differing from its parents mainly in the smaller number of its tentacles and mesenteries, in the poorly developed condition of its basal disk, in the tendency displayed by its column to assume at one time a spherical or subspherical, at another an elongated shape, and in its much more mobile habits. These are precisely the differences between *Phytocoetes* and *Metridium*. Some years ago I obtained the young of *M. schillerianum* from individuals taken from a post in the Mutlah estuary, and kept them in an aquarium full of water from one of the brackish pools at Port Canning. The adults of this species are almost invariably found in hollows on a rough surface (*e.g.* in the empty shells of *Balanus* or among masses of worm-tubes), but the walls and bottom of my aquarium were quite smooth. The young anemones closely resembled those of *S. troglodytes* and were apparently devoid of a columnar collar; they lived for some months and increased considerably in size, without losing their juvenile form. Unfortunately, during my absence from India, the aquarium was allowed to dry up and they perished before a detailed examination could be made. All that can be said about them therefore is that they continued for some months to resemble both *Phytocoetes* and the young of *Sargartia* in outward appearance.

The species of *Phytocoetes* found in the Chilka Lake is distinct from that originally obtained at Port Canning and since taken in the immediate neighbourhood of Calcutta. I have given the latter the name of *P. gangeticus* and the former that of *P. chilkaeus*.

Although on taxonomic grounds I now propose to regard *Phytocoetes* as distinct generically from *Metridium*, the facts of the case, regarded from a biological point of view, seem to point to the probability of the former being no more than a permanent or quasi-permanent larval (or rather post-larval) phase of the latter. In other words, it seems likely that *Phytocoetes gangeticus* bears to *Metridium schillerianum* much the same relationship as the axolotl does to *Amblystoma tigrinum*. *P. chilkaeus* may either be related in the same way to an unknown species of *Metridium* or be a direct descendant of either *M. schillerianum* or *P. gangeticus* in which evolu-

[1] Ashworth and Annandale, *Proc. Roy. Soc., Edinburgh*, XXXV, p. 4 (1904).

tion has produced definite structural changes: the former view seems to me the more probable.

At Port Canning and in the Chilka Lake examples of both *Pelocoetes* and *Phytocoetes* may be found within a radius of a few yards. In both localities the *Pelocoetes* will be deeply buried, at least up to the base of its oral disk, in dense mud. At Port Canning *P. gangeticus* is most abundant in the canals of the sponge *Spongilla alba* and in hollows on its surface, but is also found in abandoned burrows of *Teredo* in the few wooden posts that exist in the pools, and occasionally quite free among filamentous algae; in other parts of the Gangetic delta it occurs, often half-buried in mud, on the roots of reeds. At Rambha *P. chilkaeus* occurs mainly among algae, but there are neither Spongillidae nor worm-bored posts in those parts of the lake in which it has been found.

It is thus evident that while *Phytocoetes* has to some extent the habits of a young Sagartiid, *Pelocoetes* has adopted a mode of life differing from that of any phase of *Metridium*, indeed of any other allied form. All its generic peculiarities—its vermiform body, its reduced disk, even its incapacity to withdraw its tentacles—are correlated with this mode of life, but apart from these features it retains the structure of a Metridiine Sargartiid, and its basal disk is still functional, for if a living individual is examined immediately after being dug out from the mud it will be seen in most instances that the disk, small as it is, adheres to a particle of shell or some other hard body. Although, therefore, the type must be regarded as quite distinct from *Metridium* and *Phytocoetes*, I still believe that it is genetically related to *Metridium schillerianum*, from which it has been evolved directly, most probably in the Gangetic delta. Whether its evolution is due to natural selection (*i.e.* to the survival of individuals that exhibited a slight tendency to burrow, and of their offspring) or to mutation (*i.e.* the sudden appearance of a burrowing strain in the species) there is no evidence to prove; the fact that *Phytocoetes* is intermediate in structure between the two extreme types might seem to support the natural selection theory, but there is as a matter of fact nothing definite to show that the two new genera do not represent different offshoots from the main stem of *Metridium*; and if *Phytocoetes* is a permanent larval form it is difficult to imagine it as an actual step in the ladder of evolution.

My present views on these Metridiinae of Indian estuaries and lagoons, therefore, may be summarized as follows:—

(1) Stoliczka's *Sagartia schilleriana* is a *Metridium*.

(2) The form I described in 1907 as a variety of *M. schillerianum* under the name *exul* is a distinct species and represents a new generic type, for which the name *Pelocoetes* is proposed.

(3) What I took for the young of this form represents a second new generic type, for which I now suggest the name *Phytocoetes*.

(4) *Phytocoetes* is probably a permanent or quasi-permanent post-larval form of *Metridium*.

(5) *Pelocoetes* is probably related genetically to *Metridium schillerianum*, but

has become structurally adapted, without losing certain essentially Metridiine characters, to life as a burrower in mud.

(6) The species of *Phytocoetes* found in the Chilka Lake is distinct from that found at Port Canning, while the *Pelocoetes* is specifically identical in the two localities.

(7) *Metridium schillerianum* does not occur in the Chilka Lake.

The following key to the species of Metridiinae that occur in brackish water in India may be useful to naturalists in this country:—

1. Basal disk large and strongly adherent; column in normal state no longer than wide.
   Tentacles about 168, arranged round the disk in 5 circles .. .. *Metridium schillerianum.*
2. Basal disk reduced, feebly adherent; column elongated.
   A. Tentacles arranged in one circle of 12 and in 12 groups of 5 to 9 each, 72 to 120 in all .. *Pelocoetes exul.*
   B. Tentacles less than 60, arranged in uninterrupted circles.
      i. Tentacles 21–24; anterior sphincter well differentiated, visible on the surface as a prominent ring .. .. .. *Phytocoetes chilkaeus.*
      ii. Tentacles about 36; anterior sphincter practically absent, not visible on the surface .. *Phytocoetes gangeticus.*

Genus **Metridium**, Oken.

1905. *Metridium*, McMurrich, *Zool. Jarhb.*, Suppl. VI, (III), p. 276.

Metridium schillerianum (Stoliczka).

(Plate vii, fig. 1.)

1868. *Sagartia schilleriana*, Stoliczka, *Proc. As. Soc. Bengal*, pp. 174, 263.
1869. *Sagartia schilleriana, id., Journ. As. Soc. Bengal* XXXVIII (2), p. 31, pls. x, xi.
1882. *Sagartia schilleriana*, Hertwig, "*Challenger*" *Rep. Zool.* VI, *Actiniaria*, p. 71.
1907. *Metridium schillerianum* (typical form), Annandale, *Rec. Ind. Mus.* I, p. 45, pl. iii, figs. 1, 2, 5.

My description of "the typical form" of this species (1907) should render the identification of specimens a comparatively easy matter, but there are one or two points both in its anatomy and its ecology on which further notes may be useful.

Strictly speaking it is perhaps incorrect to talk of the existence of a sphincter in *M. schillerianum*, for all that can be said is that the circular muscle of the column is thrown into more conspicuous folds a short distance below the disk than elsewhere,

but that the condition of these folds varies considerably in different stages of expansion and contraction of the column. There are as a rule no independent muscle-fibres in this region, but in one specimen (fig. 2) I have found a few widely separated in the mesogloea and without any definite arrangement. When the disk is retracted but the column expanded horizontally, the differentiated region of the muscle-sheath extends over a considerable area; part of it is introverted, while part still remains external.

The facts relating to expansion and contraction of the column and to retraction of the tentacles were not fully understood by me in 1907. When the animal is left dry by the retreat of the tide its tentacles are always retracted, but its column fully expanded. The oral disk is withdrawn for some distance into the column and the walls of the latter are partially closed by a constriction above the tips of the tentacles, but as a rule a small opening remains patent. In this condition the actual body-wall is much swollen and remarkably translucent. If the animal is touched, water is squirted violently from the orifice above the tentacles. I was wrong, however, in thinking (1907, p. 64) that any part of this water was contained between the layers of the wall or in its mesogloea. In specimens killed with the body fully expanded—this is easily accomplished by pouring boiling formalin upon them in a small dish—the column wall will be found to be very thin and to be expanded by liquid within the mesenterial chambers. The mesenterial filaments lie bathed in this water in the middle of the body-cavity. A sudden contraction of the circular muscles of the column causes part of the water to be shot violently out of the mouth and consequently out of the orifice lying immediately above it.

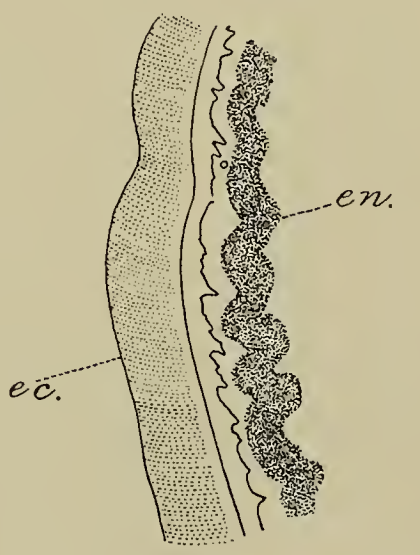


FIG. 2.—*Metridium schillerianum* (Stoliczka).

Vertical section through the sphincter.

ec. = ectoderm : *en.* = endoderm.

When the tentacles are fully retracted the whole of the visible part of the column is smoothly rounded, but as they are extruded a distinct convex ring[1] makes its appearance round the upper extremity. When the oral disk has been completely extruded the column itself contracts strongly both in a transverse and a vertical direction, becoming relatively short and slender. This is due partly to muscular action and partly to the fact that water is expelled from the body-cavity. In the living animal the column in this condition is more or less completely hidden by the tentacles, but if a specimen is bisected vertically a very distinct fold of the body-wall can be seen (pl. vii*a*, fig. 2) some little distance below the base of the tentacles. It is in this fold that the circular muscle of the column is most distinctly strengthened and differentiated.

[1] See Stoliczka, 1869, pl. x, fig. 6.

Metridium schillerianum has recently been found in great abundance on posts and bridge-piers in canals and creeks of brackish water on the outskirts of Calcutta. In such positions it is often surrounded by sponge-like masses formed of the tubes of a small Sabellariid worm that builds in mud. On one occasion the water under a bridge on the piers of which the anemone occurred had a specific gravity of only 1·006, but individuals from this bridge lived for less than three days in pure fresh water, whereas others placed in water of a much higher salinity flourished.

The species has as yet been found only in brackish water in the Gangetic delta:—at Port Canning on the Mutlah river, in canals and creeks connected with the same system near Calcutta, and in the Hughli at Diamond Harbour. It does not occur in the Chilka Lake, in which suitable conditions are very rarely to be found. Mr. T. Southwell, however, recently took a specimen on a muddy bottom near the edge of the river at Diamond Harbour.[1]

Genus **Phytocoetes**, nov.

The genus may be defined concisely as follows:—

> Thin-walled Metridiinae without a collar, with the column capable of considerable elongation but protean in form, with the basal disk small and unmuscular, never strongly adhesive, with the aboral region capable of assuming a physa-like shape and appearance, with retractile tentacles arranged round the margin of an undivided and non-lobulate oral disk; the tentacles thread-like when fully expanded but highly contractile.

In both the species assigned to this genus the body-wall is very thin in a state of expansion, but can be considerably thickened at any point by the contraction of the circular muscle. This muscle lies on the mesogloea at the base of the endoderm, upon which it does not encroach; it forms a continuous sheath over the whole of the column, but, though uninterrupted anatomically, can be differentiated physiologically into numerous transverse strands almost visible to the naked eye and capable of independent contraction and expansion. When the animal is floating in the water or supported amidst filamentous algae or other similar plants the anterior region of the column is as a rule somewhat narrower than the aboral part, which may be swollen and bladder-like; but when it is at rest in mud, on roots or in sponges, the latter region is strongly contracted and cylindrical while the anterior part is more or less barrel-shaped (pl. vii, fig. 2). In all stages of expansion the basal disk is distinct. If the animal be subjected to abnormal or unhealthy conditions the column may assume almost any form, for the thin muscular walls permit constant and almost instantaneous changes of shape. In one species there is a distinct mesogloeal sphincter, in the other it is absent. The contractions and expansions of the circular muscles cause very great changes in the microscopic appearance of the column-wall.

The tentacles are never very numerous; in one species the normal number is from 48 to 60, in the other 24. In the living animal they sometimes exhibit a

[1] *Cf.* Gosse on *Sagartia troglodytes* in *Actin. Brit.*, p. 95 (1860).

tendency to be arranged in groups, but these groups are never pedicellate. In a state of extreme contraction the individual tentacles may become knob-like, but they are always elongate and very slender when fully expanded.

The walls of the column are either smooth or covered with minute solid tubercles produced by swellings of the mesogloea. The cinclides, which are scattered on the upper part of the column, are conspicuous in the living animal but difficult to detect in preserved specimens. The central part of the column is often encased in a loose sheath of mucus and extraneous particles.

The number of mesenteries is never great. The normal number is 12 complete and 12 incomplete; the latter are almost vestigial, lacking muscle-banners, filaments and gonads. All the complete mesenteries are normally fertile and the species appear to be dioecious. Owing to the presence of large mesenterial stomata (which vary greatly in size, shape and position but are as a rule internal), transverse sections through the stomodaeal region frequently show gaps in the membrane of the complete mesenteries. It is possible, however, that the stomata are capable of almost incomplete obliteration by contraction.

So far as can be judged from published figures,[1] the species of *Phytocoetes* bear a remarkable if superficial resemblance to the aberrant genus *Scytophorus*, but they have no morphological relationship to that genus and have probably been derived, as I have already indicated, from *Metridium* in an environment in which solid objects of attachment are scarce and the bottom is almost uniformly soft and muddy.

The type-species of *Phytocoetes* is *P. gangeticus*, sp. nov.

The genus is only known from brackish water and water of variable salinity on the east coast of India.

Phytocoetes gangeticus, sp. nov.

(Plate vii*a*, figs. 3, 3*a*, 3*b*.)

1907. *Metridium schillerianum* var. *exul* (in part), Annandale, *Rec. Ind. Mus.* I, p. 48, pl. iv.

The animal is colourless in spirit; in life it may be described as being of a pale, translucent greenish flesh-colour. When the tentacles are retracted the uppermost visible part of the column is tinted with olivaceous green, but the retractile region immediately below the oral disk is pale. The tentacles are greenish or yellowish, with a pale purplish tinge due to the presence of algae in the cells of the endoderm; they bear no definite markings. When the column is fully expanded the body-wall is remarkably transparent, especially in the anterior parts.

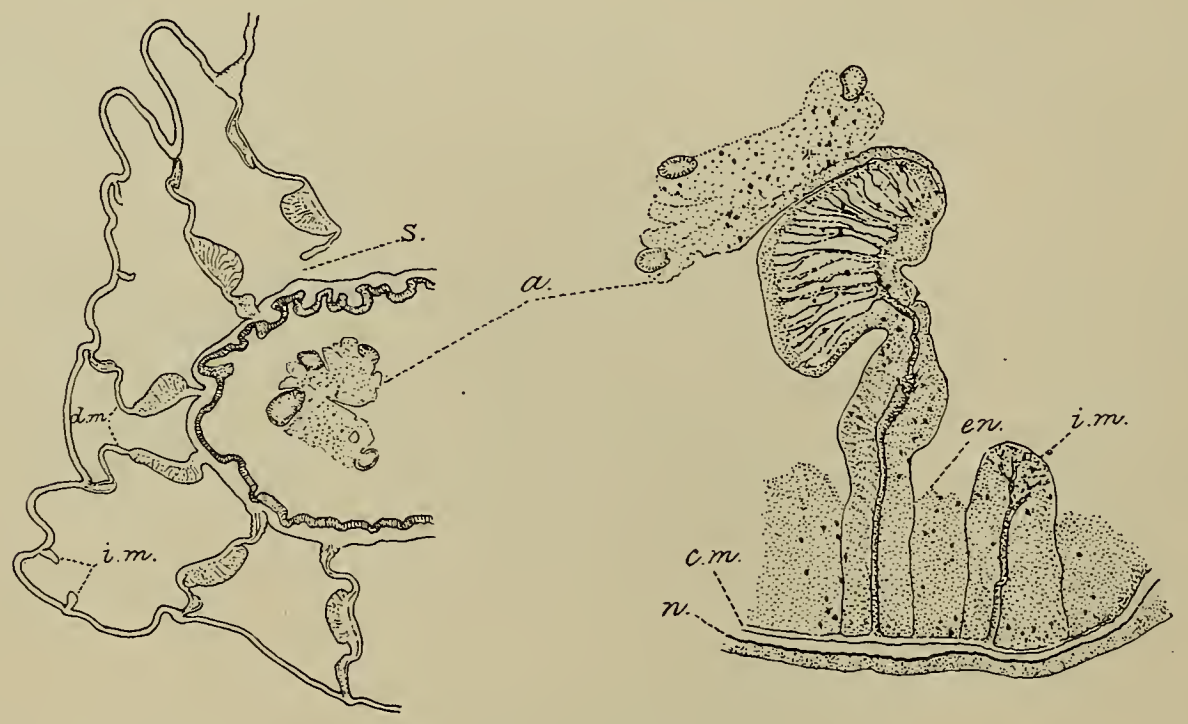
The column is protean in form, sometimes contracted into a subspherical or barrel-shaped mass, sometimes elongate and almost cylindrical and at least four times as long as wide; in either condition it is frequently divided transversely by clear-cut circular constrictions. Sometimes the aboral region is fully extended and very narrow, while the anterior parts are contracted and broad; often the converse is the

[1] Hertwig. "*Challenger*" *Rep. Zool.*, VI (I), *Actiniaria*, p. 104, pl. iii, fig. 6 (1882).

case. Preserved specimens may have practically any form, except that the basal disk is always narrow and inconspicuous; the aboral extremity as a whole is often swollen and bladder-like. In the living animal, when the tentacles are retracted but the column expanded, the anterior end is cone-shaped, the orifice above the tentacles being closed by a constriction of the column-walls.

Large specimens attain a length of 30 mm.

The tentacles are extensile but rarely or never exceed the column in length; when contracted they are bluntly pointed and minutely annulated; each has a terminal pore. The disk is ample and not at all emarginate. The tentacles are arranged



A. B.

Fig. 3.—*Phytocoetes gangeticus*, sp. nov.

A. Transverse section of column in the upper part of the stomodaeum.

B. Transverse section of a complete and incomplete mesentery in the lower part of the column (more highly magnified).

a. = acontium in section: *c.m.* = circular muscle: *d.m.* = directive mesenteries: *en.* = endoderm: *i.m.* = incomplete mesenteries: *n.* = nervous layer: *s.* = mesenterial stoma.

round its margin. The mouth extends for about three-quarters of the breadth of the disk when the latter is fully expanded, but in some preserved specimens seems to be less extensive. The lips are not prominent, but there are six shallow transverse ridges on each side of the mouth.

The number of the tentacles is very variable; there are usually between 50 and 65; but some as a rule are very small. These small tentacles usually occur together in pairs or groups of three and are situated externally. The normal number of fully developed tentacles is probably 48 or 60.

The basal disk has the generic characters.

The surface of the column is smooth, except for the cinclides. These, though

difficult to demonstrate on the preserved specimen, are conspicuous in the living animal. They are confined to a region separated by a short imperforate "neck" from the disk and otherwise occupy approximately the anterior fifth of the expanded column. They have thin but sometimes rather prominent lips and run across from mesentery to mesentery, but only in the spaces separating complete mesenteries and not always in these. Their arrangement is irregular, but their relation to the mesenteries renders it necessary for them to form vertical rows, which contain from 3 to 7 cinclides each. When the apertures are closed they have the appearance, in the living animal, of fine white transverse lines bridging the mesenterial spaces into which they open (pl. vii*a*, fig. 3*a*).

The stomodaeum extends when expanded for about one-third the length of the expanded column, but can contract independently of the body as a whole. Its walls are not very thick, but the endoderm forms a series of distinct ridges. Transversely, in the sulco-sulcular axis, it is relatively wide, occupying by far the greater part of the diameter of the column; it is, however, strongly compressed.

There are as a rule twelve imperfect, infertile mesenteries as well as the twelve complete ones. Sometimes all of the latter bear filaments and gonads, but in some individuals not more than one-half or two-thirds do so; the incomplete mesenteries are almost vestigial. Owing to the great width of the stomodaeum the directive mesenteries are relatively very short. The basilar muscles are small and feeble and the muscle-banners fairly strongly developed. On the directive mesenteries the latter have in some cases a narrow, elongate form in cross-section, while in others they are shorter and distinctly kidney-shaped. Most mesenteries have a stoma, but this aperture is sometimes absent and when present varies greatly in size, shape and position. As a rule it is very large, of a broad transverse or oblique oval or ovoid form and distinctly internal in position; but sometimes it is much reduced in size and situated nearer the column-wall than the stomodaeum. I have seen one mesentery in which not only was the stoma, which was external in position, very large, but the whole of the membrane between the muscle-banner and the body-wall reduced to a narrow band by a great gap or emargination in the lower part of the mesentery. The band was bounded above by the stoma and below by this gap.

As a rule acontia, which are never well developed, are only present on a few of the mesenterial filaments. The upper trilobed portion of the filaments is short—as a rule shorter than the stomodaeum, and the simple portion relatively long; but the proportionate length of the different parts of the filaments varies greatly even in the mesenteries of a single individual.

The gonads are normal in structure, and as far as I can ascertain the animal is dioecious.

The anterior sphincter is even less differentiated than in *M. schillerianum*, but in carefully preserved expanded specimens which have been rendered transparent, a few folds of the muscle-sheath can be detected in the region occupied by the cinclides. These folds lie in the mesogloea at the base of the endoderm and are not accompanied by any independent muscle-spaces. The rest of the muscle-sheath

resembles that of *M. schillerianum*, except of course that there is no basal disk-sphincter. The walls of the column are for the most part very thin, chiefly owing to a reduction of the mesogloea, in this respect resembling those of the other Gangetic species. In the region of the false physa (fig. 3A, p. 80) the endoderm is, however, greatly thickened.

Types.—Nos. Z.E.V. 6804-6/7, *Ind. Mus.*: from the vicinity of Calcutta.

The species has not been found in the Chilka Lake but occurs abundantly in pools of brackish water at Port Canning in the Gangetic delta and in canals and creeks near Calcutta. In the latter district it was on one occasion found in water of a specific gravity of 1·006.

P. gangeticus is distinguished from *P. chilkaeus*, the only other species as yet known in the genus, mainly by its more numerous tentacles and by the lack of a true sphincter; other differential characters are shown in the table on the opposite page.

At Port Canning *P. gangeticus*, which is markedly gregarious, is found in large numbers ensconced in masses of the sponge *Spongilla alba* that have probably grown round it on the roots of grasses. It is also found in the same pools in deserted burrows of *Teredo* in wooden posts. In both situations it is lightly attached by its degenerate basal disk to foreign bodies. Near Calcutta its favourite situation is among the roots of reeds that grow at the edge of small tidal creeks. Here it is frequently accompanied by masses of the polyzoon *Victorella bengalensis*. Although it is found in small holes in mud, I do not think that the anemone is able to burrow, for in this situation it occurs actually attached to roots and accompanied by the polyzoon, which certainly is not a burrower. In both cases the mud seems to be deposited round the animal; the anemone saves itself from suffocation by elongating its column, while the colonial organism buds freely and so forms a dense mass practically impervious to mud, and is thus able to expand the tentacles of its individuals upon the surface. At Port Canning I have seen an individual of *P. gangeticus* lying exposed in the sun at the edge of a pool. The tentacles were retracted, the orifice above them closed and the column fully expanded owing to the amount of water it contained; in the creeks near Calcutta large numbers of individuals may be found in mud between tide-levels. Very few individuals found in winter are sexually mature; probably the real breeding-season begins about February. The species does not seem to be exclusively nocturnal in habits. In an aquarium healthy individuals often cling to the glass in an upright position by means of the mucus that exudes from the surface of the column. They are able to drag themselves upwards by means of their tentacles as well as to progress in a lateral direction.[1]

Phytocoetes chilkaeus, sp. nov.

(Plate vii, fig. 2; plate vii*a*, fig. 4.)

This species, examined alive, resembles *P. gangeticus* very closely so far as the external characters are concerned, except that it has not more than 24 tentacles

[1] For further details of this mode of progression see *Rec. Ind. Mus.* I, p. 67.

and that almost the whole of the external surface of the column is covered with minute papillae. The internal structure of the two species is also very similar, except that *P. chilkaeus* has a true mesogloeal sphincter situated a short distance below the oral disk. This species is also more sensitive to drugs than its Gangetic ally and therefore much more difficult to preserve in a natural condition. Consequently, preserved specimens of the two look as a rule very different (*cf.* figs. 3 and 4, pl. vii*a*). Those of *P. chilkaeus* are darker in colour, being of a glaucous grey shade, and, owing to the strong contraction of the circular muscles, much more opaque; the column is elongated and cylindrical for the most part and the physa-like appearance of its aboral extremity exaggerated, while the tentacles are reduced to mere knobs, though in full expansion they are as long and slender as those of *P. gangeticus*. The position of the sphincter is clearly indicated externally by a convex annulus (pl. vii*a*, fig. 4).

The specific characters in which the two species differ may be tabulated thus:—

	P. gangeticus.	*P. chilkaeus.*
Tentacles	50–65. Never contracted to mere knobs. Concolorous.	21–24. Liable to be contracted to mere knobs. Sometimes with dark angulate rings and a dark tip.
Surface of column ..	Smooth	Covered, except at the aboral extremity, with minute tubercles and bearing a convex annulus a short distance below the disk.
Sphincter	Absent	Well developed, with elongate muscle-spaces.
Body-wall	Very thin	Much thicker, at any rate in a state of contraction.

The tentacles are normally 24 in *P. chilkaeus*, but one or more may be aborted and I have examined a specimen in which there were only 21. Even in specimens preserved in alcohol the darkening of their tips occasionally persists, though the dark angulate rings disappear rapidly. The markings are due to accumulations of minute algae in the cells of the endoderm. In preserved specimens there appear to be two concentric circles of tentacles arranged alternately, but in the living animal they are distinctly grouped in threes with a single tentacle between each triad. The extreme contraction to be noted in most of our examples took place before death and was apparently due to the fact that unsuccessful attempts were made to paralyse the animals with drugs.

The minute papillae on the surface are produced by swellings of the mesogloea

(fig. 4) and cover the whole of the anterior two-thirds of the column. Towards the posterior extremity they gradually disappear and in some specimens are scanty if not altogether absent between the sphincter and the disk. On the anterior part of the body they are arranged in vertical rows.

Fig. 4.—*Phytocoetes chilkaeus*, sp. nov.

Transverse section of the column in the lower part of the stomodaeum; from a highly contracted specimen.

c.m. = circular muscle.

The sphincter (pl. vii, fig. 2) consists of numerous strands, most of which are somewhat elongate in vertical section. They are grouped in a band-like figure, usually with a few that are shorter than the rest lying separated in the mesogloea, to which layer the whole muscle is confined. The muscle extends outwards in an oblique direction from near the base of the endoderm into an external annulus produced by a thickening of the mesogloea. The circular muscle-sheath is not interrupted in this region.

The internal structure of *P. chilkaeus* very closely resembles that of *P. gangeticus*. The body-wall appears to be as a rule thicker in the former, but this is due partly to the fact that it is more highly constricted in the specimens examined. When it is not contracted there is comparatively little difference.

Large specimens of *P. chilkaeus*, with the column constricted and elongated, are about 22 mm. in length and 4 mm. in diameter.

Type-specimens. No. 6803/7, Z.E.V. *Ind. Mus.*: from Rambha Bay, Chilka Lake.

P. chilkaeus has as yet been found only in the Chilka Lake, but in both the outer channel and the main area. The only localities in which it was obtained were the head of Rambha Bay and the channel between Satpara and Mahosa. The actual specific gravity of the water in which it was taken varied from about 1·0105 at Rambha to 1·0265 at Satpara. It was collected in January and March.

At Rambha the anemones were found either floating a few inches below the surface or with their aboral disks lightly attached to a filmy alga that grows luxuriantly on mud in very shallow water. Off Satpara they were brought up from a muddy bottom overgrown with weeds in about 12 feet of water. To judge from their muddy bases they had been attached to the roots of the weeds. The aboral extremity was contracted and cylindrical in these specimens, expanded in those from Rambha. The examples from Rambha were taken in January and March;

those from off Satpara in the latter month. At both seasons some individuals were sexually mature. The species is not markedly gregarious.

Genus **Pelocoetes**, nov.

This genus is closely allied to *Phytocoetes* and may be diagnosed as follows:—

Thin-walled Metridiinae without a collar, with a vermiform column, with the basal disk much reduced, with the aboral extremity capable of assuming a physa-like appearance and shape, with the majority of the tentacles arranged in groups each of which is placed on a flattened pedicel or outgrowth from the reduced oral disk; the tentacles slender, thin-walled and not very highly contractile; the oral disk not retractile.

In the structure of its body-wall the single species of *Pelocoetes* closely resembles *Phytocoetes*, but the circular muscle-sheath is even stronger and has a more intimate relationship with the endoderm, with which it interdigitates when highly contracted (pl. vii, fig. 3*b*). Moreover, there is a considerable region on the upper part of the column in which this muscle is to some extent differentiated, being more powerful and more readily thrown into physiologically independent folds than elsewhere and occasionally being associated with a few scattered muscle-spaces. This region does not extend upwards quite as far as the base of the oral disk, but otherwise is approximately co-terminous with the stomodaeum. There is no separate sphincter. The nervous layer of the mesogloea is particularly well differentiated.

The animal lives buried in mud and its vermiform column, plainly correlated with this mode of life, is not so protean as that of *Phytocoetes*.

The tentacles are more numerous than in the allied genus, but variable in number. There is an inner circle of twelve solitary tentacles and an outer circle of twelve pedicellate groups; but the number in each group varies considerably.

The outer wall of the column is for the most part smooth, but bears a certain number of small vesicular swellings on the upper part. The cinclides are arranged definitely in vertical lines on the upper muscular region.

There are more incomplete mesenteries in *Pelocoetes* than in *Phytocoetes*, but fewer than is usual in *Metridium*, the actual number in *P. exul* being 36. None of these are situated in the intramesenterial spaces. Both internal and external mesenterial stomata may be present, but, as in *Phytocoetes*, their size, shape and position are very variable. Speaking generally, the mesenterial filaments are comparatively well developed in *Pelocoetes*; some of the incomplete mesenteries are occasionally fertile; the acontia are long and relatively stout and are normally present on all the fertile mesenteries. The animal is monoecious and protogynous.

The one species known occurs in the Gangetic delta and the Chilka Lake and has been found only in brackish water.

Pelocoetes exul (Annandale).

(Plate vi, fig. 1; plate vii, figs. 3, 3*a*, 3*b*.)

1907. *Metridium schillerianum* var. *exul* (in part), Annandale, *Rec. Ind. Mus.* I, p. 48, etc., figs. 1, 2, 3, 4; pl. iii, figs. 3, 4.

My original description of the "variety *exul*" of Stoliczka's Gangetic Anemone applies for the most part to *Pelocoetes exul* but is vitiated by the fact that I regarded *Phytocoetes gangeticus* as the young of the species now to be discussed. In the actual diagnosis, however, on p. 48 of the paper cited the characters distinctive of what I regarded in 1907 as young and adult individuals respectively are clearly differentiated. All that is necessary now, therefore, in the way of actual description, is to give a fuller account of the tentacular system, which can only be investigated satisfactorily in specimens killed in a fully expanded condition;[1] for the living animal is too sensitive to permit a very detailed investigation, while specimens killed in the ordinary way do not illustrate the peculiarities of the oral disk to anything like the full extent.

The tentacles, as is stated in the diagnosis of the genus, are disposed in a single inner circle of twelve and in twelve external pedicellate groups. The twelve primary internal tentacles represent the twelve complete chambers, each arising above either an inter- or an intramesenterial space, which is continued into its lumen. In the case of the intramesenterial tentacles the base of each occupies practically the whole of the inner part of the roof of the chamber, while in that of the intermesenterial tentacles it is situated opposite the central incompletely separated compartment formed by two of the six incomplete mesenteries that project into the chamber from the column-wall. These primary tentacles do not differ in structure or form from the others.

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[1] I find by far the most satisfactory method of killing these Gangetic species with degenerate basal disks is to allow them to expand themselves fully in a small vessel of water in which natural conditions are so far as possible reproduced. In the case of *P. exul* I fill the vessel half full of mud, make a hole some two and a half inches deep in the mud by thrusting in a pencil, and plant the anemone, basal disk downwards, in the hole. I then leave it until after dark with just sufficient water from its own habitat to allow full expansion of the tentacles. In the evening, after they are fully expanded, I sprinkle on the surface of the water a few crystals of menthol. In the morning the animals are found completely paralysed. Without disturbing them, a considerable amount of commercial formalin (about sufficient to make up a solution of 5% formaldehyde) is poured into the vessel. The whole is left standing for an hour and the specimens are then removed and cleaned. If they are wanted for histological purposes they are subsequently treated with corrosive acetic solution precisely as though they were fresh material. In cool weather at any rate, I do not find that they suffer from this process to any material extent so far as general histology is concerned, but if any delicate cytological work is to be performed it is better to kill them in a contracted condition. The specimens of anemones of which photographs are reproduced on pls. vi and vii*a* were killed and preserved in the way described; it is apparently applicable rather to species with very thin muscular walls than to ordinary fixed forms, and I have not found it altogether successful in the case of *Metridium schillerianum*. In that of *P. chilkaeus* it failed, possibly on account of the use of too much menthol.

There are two pedicellate groups, alternating with the single tentacle, above each complete intermesenterial space; each group is associated with one complete and three incomplete mesenteries and its lumen is continuous with that of three incompletely separated compartments; one of its internal walls is practically co-terminous with a complete and the other with an incomplete mesentery, while the upper extremities of two other incomplete mesenteries are continued into it. The pedicel itself is a hollow process of the margin of the oral disk; its length is considerably greater than its breadth; it is compressed from above downwards; it has parallel sides. At some little distance from its point of origin the process bifurcates in a horizontal plane and just within the fork a single tentacle, which we may call the furcal tentacle, arises on the upper surface. Each branch of the pedicel bears two, three or four tentacles; the number is variable, sometimes even on the disk of a single individual.

FIG. 5.—*Pelocoetes exul* (Annandale).

Transverse section of the column in the muscular region, from a highly contracted specimen.

In the lower or posterior wall of the pedicel there are, projecting into its lumen, four muscular ridges, two practically at the lateral margins and two in the middle. These ridges are actual prolongations upwards and outwards of the four mesenteries with which this process is associated; above and opposite each of them on the upper or anterior wall a similar ridge is developed, so that the whole lumen is divided incompletely into three chambers, the two outer pairs of ridges being close to the sides of the pedicel. The separation is incomplete because the united depth of the two ridges of each pair is not so great as that of the lumen. The furcal tentacle is produced at the distal extermity of the central chamber, while each of the lateral chambers corresponds to one branch of the pedicel. The number of tentacles developed on each branch is evidently a matter of secondary importance.

Although one of the lower ridges in each pedicel is connected with a complete mesentery while three are continuations of incomplete mesenteries, no difference in structure can be observed; nor is there any difference between these lower ridges and the corresponding upper ones.

The walls of the pedicel and of the tentacles are very thin, the mesogloea and the circular muscles being poorly developed in them. The longitudinal muscles, though by no means thick are, in spite of the non-retractile and not highly contractile state of the disk, well developed. The mesenteries closely resemble those of *Phytocoetes*, except that there are 36 instead of 12 incomplete mesenteries and that the filaments are more uniformly developed on the complete ones.

In the case of *Phytocoetes* the difference between the microscopic appearance of the

body-wall in specimens in which the circular muscles are contracted or relaxed has already been noted (p. 78); in *Pelocoetes* it is even more marked. When the column is fully expanded the total thickness of the wall is reduced to about 0·02 mm. and the mesogloea is a mere thread even under high powers, whereas in examples killed with these muscles contracted the wall is about 0·17 mm. thick and the mesogloea, including the muscle-band, 0·028 mm. thick.

If the muscles are at all contracted there is always a tendency for the column of *P. exul* to assume an oval form in cross-section and this feature may be observed to some extent even in the living animal; the main axis of the section is sulco-sulcular (fig. 5, p. 87).

The types of the species, which are from Port Canning, are numbered Z.E.V. 2419-21/7 in the books of the Indian Museum.

P. exul has been found only in small pools of brackish water at Port Canning in the Gangetic delta and in the main area of the Chilka Lake, but its habits render it very difficult of detection and capture and it is actually, in all probability, distributed more widely than we know. In the lake it was taken close inshore at Rambha in a few inches of water in January and off Kalupara Ghat in the northern part of the area in very shallow water in April. The salinity of the water is not precisely known, but the specific gravity must have been between 1·005 and 1·010.

This anemone lives, as already stated, buried in the mud up to the base of its oral disk, which can be pulled downwards with great rapidity on disturbance. It is nocturnal in habits to this extent—the tentacles are never fully expanded by day and remain with their tips extending from the hole in the mud for a short distance only, whereas by night they are completely extended. These facts were observed in the case of anemones *in situ* at the edge of the lake in January. A bright light directed on the disk, however, did not cause contraction. Although in early life the animal must be an active burrower as it lives in a vertical burrow several inches deep, adults are very helpless when removed from their proper environment and show no inclination to make a fresh hole. Their vermiform column prevents them from assuming an upright position, and it is very difficult to keep them alive in captivity unless they are literally planted in mud in the way described in the footnote on p. 86. Further particulars as to the habits of *P. exul* will be found in my paper of 1907.

In specimens taken in the Chilka Lake in January the ovaries were mature; this was also the case with specimens taken at Port Canning in December; but in others taken at the latter locality in January it was the testes that were ripe.

Family EDWARDSIIDAE.

1905. Edwardsiidae, McMurrich, *Zool. Jahrb.*, Suppl. VI (III), p. 218.

Remarkably few species of this family have been found in the warmer seas and the occurrence of two genera, representing respectively the *Edwardsia* and the *Halcampa* sections of the family, in a locality so peculiar as the Chilka Lake is therefore noteworthy.

Genus **Halianthus**, Kwietniewski.

1896. *Halianthus*, Kwietniewski, *Jena. Zeitsch. Naturwiss.* XXX, p. 585.

The species hitherto assigned to this genus are mainly Arctic, but McMurrich (*op. cit.*, 1905, p. 223) has described one from the Pacific coast of South America. I can find no previous record from the Indian Ocean.

Halianthus limnicola, sp. nov.

(Plate vi, fig. 2; plate vii, figs. 4, 4*a*, 4*b*.)

When at rest the living animal has a conical shape, slightly swollen in the middle region and slightly constricted at the truncated end, *i.e.* just below the oral disk. The aboral end is bluntly pointed and often not at all inflated; externally there is no apparent separation of capitulum, scaphus and physa, but the last is to some extent retractile. The body can assume practically any shape from spherical to cylindrical and sharp constrictions at one or more points are often a noticeable feature of preserved specimens; when the tentacles are retracted the upper part of the column assumes a subspherical form, while the aboral region is constricted into a cylindrical peduncle; or the whole organism may have an elegant vase-like outline. There is no external cuticle or sheath.

On the external surface there are twelve longitudinal rows of relatively large, though not very prominent, solid tubercles, which correspond roughly in position with the twelve mesenterial spaces; they are mainly due to thickenings of the mesogloea. Towards the aboral extremity these rows, and also the individual tubercles, tend to become obsolete. The whole of the body-wall and the wall of the disk and tentacles is hyaline and practically colourless, but the tentacles are often ornamented on the upper surface with V-shaped translucent bars and the disk is not so transparent as the column. The mesenterial filaments and the gonads are of a bright yellowish flesh-colour, which is communicated by reflection to the remainder of the animal, especially in a state of contraction. Specimens in spirit or even formalin become more or less opaque.

The oral disk is ample, its outline in contraction is broadly oval, the longer axis being that of the mouth, which occupies the greater part of the disk in this axis. The lips are by no means prominent when the mouth is closed; there are six low transverse ridges at each side. The normal number of tentacles is twelve, but occasionally one or more subsidiary tentacles are produced asymmetrically; the normal arrangement is that the tentacles form two concentric circles of equal numbers and alternate round the margin. There is no structural difference between ordinary and subsidiary tentacles; both when fully expanded are stout, cylindrical and blunt and hardly longer than the longer diameter of the disk; they can be contracted into little wart-like projections. The disk is usually flat but can assume a conical or even a clavate form.

The aboral extremity is perforate, but the pore is always small.

Our largest specimens, which have shrunk very little, are about 5 mm. long.

The circular muscle of the body-wall is well developed and in the living animal can be detected readily with the aid of a hand-lens as a series of transverse rings capable of independent contraction and expansion. The differentiation is, however, physiological rather than anatomical and in vertical sections the muscle forms a continuous sheath of minute fibres, having the general appearance of an irregularly serrated line more conspicuously folded at some points than at others. In transverse sections the fibres lie at the base of the endoderm (as of course they do also in vertical sections) but run across the mesogloea at the base of the mesenteries. The muscular sheath is most strongly developed in the wall of the physa.

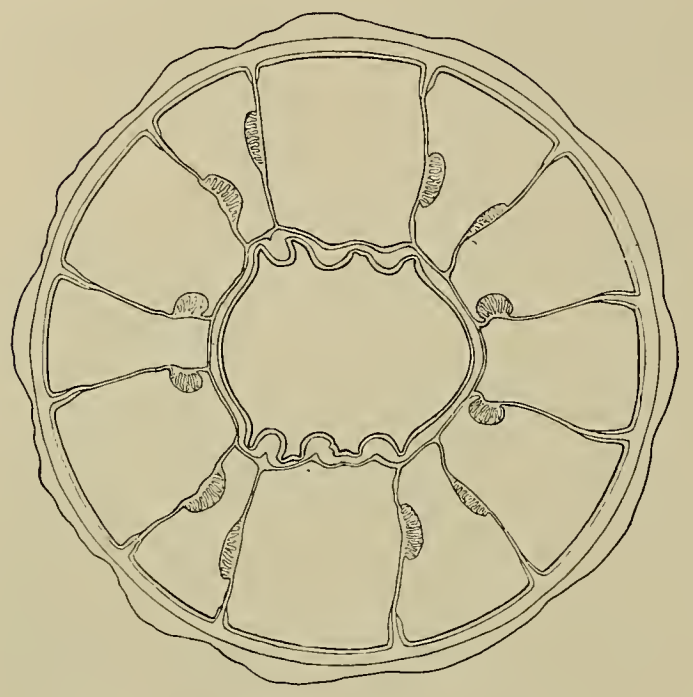

Fig. 6.—*Halianthus limnicola*, sp. nov.

Transverse section of the column in the middle of the stomodaeum.

The sphincter (pl. vii, fig. 4) is well developed but short. It lies close below the base of the tentacles and consists of a number of relatively stout isolated strands surrounding distinct muscle-spaces and well separated by mesogloea from the muscle-sheath.

The stomodaeum is spacious in cross-section; the walls, which are moderately thick, are thrown internally into three distinct though not very deep folds on either side; the sulcus and sulculus are very broad. The sulco-sulcular length in a state of expansion occupies a little less than a half of the width of the column.

There are no rudimentary or incomplete mesenteries. The twelve complete mesenteries are normally fertile. The kidney-shaped muscle-banners are moderately small and separated by some little distance from the wall of the stomodaeum; they contain a considerable number of moderately long and slender folds of the mesogloea. The parietal muscles are slightly and irregularly folded, the projections of the mesogloea on which they are based being by no means clearly defined in sections.

The gonads are normal in structure and not very much folded transversely. The animal appears to be dioecious.

The specific characters of *Halianthus limnicola* may, therefore, be summarized as follows:—

(1) The whole animal (except the internal organs) is colourless and translucent or hyaline, the markings on the tentacles being due to relative degrees of transparency and not to pigmentation.

(2) The normal shape of the column is conical and there is no external differentiation of capitulum, scaphus and physa.

(3) There is no external sheath or cuticle.

(4) There are twelve vertical rows of solid tubercles on the column.
(5) The tentacles are normally 12 in number, but extra subsidiary tentacles are sometimes produced asymmetrically; both the normal and the subsidiary tentacles are (even when fully expanded) stout, blunt and hardly longer than the longer diameter of the disk.
(6) The mouth is relatively wide.
(7) The stomodaeum is spacious, its sulco-sulcular axis occupying nearly one half of the diameter of the column.
(8) The muscle-banners are small, though not so small as in some forms, and separated from the walls of the stomodaeum.
(9) There are no incomplete mesenteries.
(10) The parietal muscles are feebly developed and accompanied merely by somewhat indistinct projections of the mesogloea.

Types. No. Z.E.V. 6032/7, *Ind. Mus.*

This species has been found as yet only in the Chilka Lake, in the main area of which it is abundant at all seasons except the end of the rains; it is also found, much more sparingly, in the muddy parts of the outer channel. It is commonest in from 6 to 12 feet of water and has been found throughout the range of salinities occurring in the lake.

Halianthus limnicola is gregarious, and was usually taken on a muddy bottom in which there was a fairly large admixture of dead Lamellibranch shells. It is very active and not at all shy. When removed from the water or otherwise disturbed it retracts its tentacles instantaneously but extrudes them again the moment that it is comfortable. In a vessel half filled with mud and shells and half with lake-water it begins to burrow almost immediately. This it prefers to do among shells, among which it progresses in an almost horizontal direction, lying prone and dragging itself along with fair rapidity by means of its tentacles. Their movements are accompanied and assisted by rhythmical longitudinal expansions and contractions of the column. No rhythmical transverse contractions of the column were observed, but constrictions often appeared suddenly at different points. The animal has a strange habit of alternately retracting and extruding the proximal part of the physa. No attempt was made to form an external sheath or cuticle, the transparent wall of the column remaining remarkably clean. If left to itself the anemone sometimes formed a vertical burrow, in which, however, it never remained for very long. The muscular nature of the physa would suggest that it is employed in making burrows of the kind, but the process was not observed.

Although numerous individuals of the species were obtained in most hauls of our nets on suitable ground throughout the greater part of the year (even in July, when the rains were established, and in September, when the water had become fresh), yet in November it was found to be very scarce and only a few specimens were obtained. These were, moreover, in a quiescent condition, exhibiting none of the normal muscular activity, and were so contracted and shrivelled that they could not at first

be identified. There can, therefore, be little doubt that prolonged exposure to fresh water has much the same effect as it has on the medusa *Acromitus rabanchatu* (p. 101, *postea*). A larger proportion of the actinians, however, probably perish and the physiological changes are produced more slowly.

H. limnicola does not seem to have any fixed breeding season, for individuals were found with apparently ripe gonads at all times of the year, even in November.

Genus **Edwardsia**, Quatrefages.

1889. *Edwardsia*, Haddon, *Trans. Roy. Dublin Soc.* (2) VI, p. 326.
1895. ,, Faurot, *Arch. Zool. expérim.* (3) V, p. 108.

Edwardsia has been generally regarded as characteristic of temperate seas both north and south of the Tropics, and I can find no reference to any undoubted species from the Indian Ocean. Carlgren[1] has examined a representative of the closely allied genus *Edwardsiella* from the Red Sea and East Africa, which was originally described by Klunzinger[2] under the name *Edwardsia pudica*, and thinks that *Edwardsia adenensis*, Faurot[3] from Aden is probably a synonym. *E. arenosa*, Klunzinger, is also an *Edwardsiella*.

Edwardsia tinctrix, sp. nov.

(Plate vi, fig. 3; plate vii, figs. 5, 5*a*; plate vii*a*, fig. 5.)

When fully extended the whole animal is vermiform, and narrowly sausage-shaped when the capitulum is introverted. The distinction between capitulum, scaphus and physa is well marked in the former condition and that between the two last regions in the latter. The scaphus is relatively long and slender, the capitulum, which is not constricted, short. The naked physa is also short, but not so short as in some species, it has a rather narrow ovoid form when expanded and bears at the tip a circle of eight minute finger-shaped processes. These, however, are apt to disappear in preserved specimens and in any case are so small that they can only be seen under a high power of the miscroscope; in structure they are solid outgrowths, mainly of ectoderm and containing a large number of minute intracellular refractive granules. On the scaphus there are eight vertical rows of small but prominent mamilliform tubercles corresponding in position to the eight mesenterial spaces. The structure of these tubercles will be discussed presently. Not only the whole of the capitulum but also a considerable part of the scaphus can be introverted.

The sixteen tentacles are long, slender and pointed. The oral disk is narrow but more or less tumid; the mouth runs across the greater part of it. The tentacles are not very highly contractile, but can be thrust into the mouth so far that their tips extend into the physa.

The capitulum, with the disk and tentacles, is translucent and often colourless,

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[1] *Mitt. Naturh. Mus. Hamburg*, XVII (2), p. 46 (1900).
[2] *Die Korallthiere des Rothen Meeres* I, p 81, pl. vi, fig. 3.
[3] *op. cit., supra*, p. 121.

but is usually tinged more or less deeply with olive-green; sometimes the endoderm of the tentacles is marked with alternate green and white rings, the pale rings being narrower than the dark. The most characteristic features in the colouration is, however, a series of eight blackish vertical bars that ornament the capitulum just below the disk, one outside each mesentery. Each bar is double, being completely bisected longitudinally by a colourless or pale line, and expands at the upper end, which is sometimes separated as a distinct spot or rather pair of spots. The scaphus has a bright orange-scarlet colour, which, unlike the markings of the capitulum, retains its intensity in spirit; this colour is not intrinsic in the tissues of the animal but due to a staining of the particles of mud incorporated in the delicate "cuticle" that clothes the scaphus.[1] The physa, both in living and in preserved specimens, is of a fairly opaque white.

The tubercles on the scaphus are a characteristic feature of the species, not only on account of their prominent nature but also of their internal structure. In most sections of the column they appear merely as hollow outgrowths of the wall due mainly to a thickening of the mesogloea accompanied by the apparent formation of a large lacuna; but if specimens of the whole animal be mounted for microscopic examination after being rendered transparent it will be readily seen that each lacuna contains, in addition to a quantity of mucus, what appear to be a number of long slender chaetae arranged for the most part almost at right angles to the circumference of the column but converging somewhat to the tip of the papilla, which contains a minute aperture. In a few sections of several large series some of these peculiar bodies remain *in situ* and can be recognized in the slender nematocysts of the type figured more than fifty years ago by Gosse in his *Actinologia Britannica* (pl. xi, fig. 10, 1860). Their threads can be occasionally detected emerging from the pore in the papilla (pl. vii, figs. 5, 5*a*). The cavity of the tubercle has a diameter of about 0·09 mm.

The body-wall is very thin in the capitulum, but considerably thicker in the scaphus, the difference lying mainly in the relative amount of mesogloea present; in the physa the mesogloea is thin but the endoderm rather thick. There is no special sphincter, but the circular muscle, which lies at the base of the endoderm, is well developed both in the scaphus and in the physa. The nervous layer is well developed. The wall of the tentacles is thick, but their mesogloea relatively thin.

The stomodaeum is ample at its upper extremity, occupying in its longer axis more than half of the diameter of the column and having a rather narrowly oval shape in cross-section; it is very short vertically and does not quite reach the lower end of the capitulum.

There are, in addition to the usual eight complete mesenteries, eight rudimentary ones, but these are confined to the upper part of the stomodaeum. They have the arrangement apparently normal in the genus, *i.e.* there are two in each sulco-lateral

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[1] A similar staining of muddy particles is often produced at the edge of the mantle in some of the Chilka Lamellibranchs (*e.g. Theora opalina*) and in the tubes of Maldanid worms.

chamber and one in each of the other chambers except the sulcar and sulcular. Most of these rudimentary mesenteries consist merely of the basal (parietal) longitudinal muscles and the folded mesogloea that supports them, but those in the sulcolateral chambers are distinctly better developed and possess a rudiment of the

Fig. 7.—*Edwardsia tinctrix*, sp. nov.

A. Lateral view of the capitulum (from a sketch by Mr. G. Henry).
B. Transverse section through the upper part of the capitulum.
C. Transverse section of a fertile male mesentery through the upper end of the gonad.

membranous part as well; indeed, they are at least as well developed as the incomplete mesenteries of *Phytocoetes*.

The longitudinal muscles of the complete mesenteries differ in different regions of the column. In the upper part of the capitulum the parietal series are poorly developed, whereas the muscle-banners are large and powerful, occupying the greater

part of the width of the mesentery (fig. 7A, p. 94). A little lower down these latter structures become much thinner and weaker, practically disappearing at the lower end of the stomodaeum, while the parietal muscles become better developed. Below the stomodaeum the muscle-banners again become large. The mesogloea in the basal part of each mesentery is thrown on each side into five or six folds, all of which are moderately stout and have an approximately similar form and depth.

The gonads are normal and the animal is apparently dioecious.

Our largest specimen of this species is about 30 mm. long in a fully extended condition, the greatest transverse diameter of the scaphus being 3 mm. and the length of the tentacles 6·5 mm., but this specimen is unusually large.

Types.—No. Z.E.V. 6819/7, *Ind. Mus.*

The most important specific characters of *Edwardsia tinctrix* lie in the shape and colouration of the column, the presence, peculiar structure and comparatively large size of the tubercles on the scaphus, the relative length of the sulco-lateral rudimentary mesenteries, the form and relative size of the longitudinal muscles of the mesenteries and the proportions of the stomodaeum; but in the identification of specimens of the genus attention must be paid to the general sum of characters rather than to separate features or to single organs or parts. Perhaps the most peculiar feature of the Chilka species is the structure and size of the tubercles, but those of *E. claparedi* (Panceri) are probably similar, if relatively smaller, for the nematocysts in these organs are very liable to disappear from sections.[1]

E. tinctrix is, for the greater part of the year, one of the most abundant members of the fauna of the main area of the Chilka Lake, over the whole of which it occurs from the shore to a depth of 16 feet; in the muddy parts of the outer channel it is much less common. It was found in water of which the specific gravity varied from that of the Bay of Bengal at the time to that of pure fresh water. Outside the Chilka Lake it has not yet been discovered.

The anemone lives buried in mud as far as the base of the disk. It is extremely shy and sensitive. When removed from mud individuals almost invariably have the disk and capitulum introverted into the scaphus, and it was not found possible to cause them to expand by daylight. If planted in mud covered with water in a glass they often did so by night[2], but even then showed no tendency to shift their position or to construct fresh burrows for themselves.

E. tinctrix is much less common in the Chilka Lake at the end of the rains than at other seasons, but a few individuals were found even in November. They were much contracted and did not expand in captivity even at night. It is probable, therefore, that they are affected by long-continued residence in fresh water much in the same way as *Halianthus limnicola*.

In specimens taken between March and July inclusive the gonads were ripe, as

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[1] See Walton and Rees, *Journ. Mar. Biol. Ass. Plymouth* X, p. 64, fig. 2, 1913.

[2] Walton and Rees (*op. cit.*, p. 62) found that an individual of *E. claparedi* (Panceri) at first refused to expand by daylight but after a time did so.

they were occasionally in September; but this was not the case in those collected between November and February.

SCYPHOMEDUSAE.

(Plate vi (in part); plate viii.)

The only medusa of this group found in the Chilka Lake belongs to the order Rhizostomata and the division Triptera. The species is here described as new and belongs to a genus recently discovered in the Philippines, in which the only form hitherto recognized occurs. The Chilka species is of considerable biological interest, not only because it has been able to establish itself as a permanent resident in water of very variable salinity, but also because we found it possible to estimate the direct effect of fresh water upon the physiology of individuals (p. 101, *postea*). Some post-larval forms were obtained and are here described briefly and figured; they throw light on the evolution of the Rhizostomatous mouth-arm. The species is also common in the Bay of Bengal.

Order RHIZOSTOMATA.

Division *RHIZOSTOMATA TRIPTERA.*

Genus **Acromitus**, Light.

1914. *Acromitus*, Light, *Philippine Journ. Sci.* (D) IX, p. 210.

This genus has recently been described to contain a single species (*A. maculosus*, Light) from the Philippines. Its most striking diagnostic character is the possession at the tip of each mouth-arm of a single greatly elongated tentacle-like filamentous process. This process is very much longer and stouter than the small sensory filaments scattered among the mouths on the arms.

In describing a new species from the Chilka Lake and the Bay of Bengal I have closely followed the descriptions of representatives of the order published in Meyer's *Medusae of the World* (1910). In all the features accepted by Light (1914, *op. cit.*) as of generic importance this species agrees with *A. maculosus*, the only other member of the genus yet known.

Acromitus rabanchatu[1], sp. nov.

(Plate vi, figs. 4-6; plate viii.)

The disk is no flatter, at any rate in living medusae and in specimens recently preserved in formalin, than a hemisphere. In large individuals its diameter is as

[1] *Raban-chatu* is the vernacular name given to this medusa by the Uriya fishermen of the Chilka Lake, who would probably apply it also to any other medusa of similar shape. It means "the umbrella of Ravana", the demon-king of Ceylon who plays the part of chief villain in the *Ramayana*.

much as 20 cm. The exumbrella is smooth to the naked eye, but under the microscope appears minutely granular, each granule consisting of a little prominence beset with nematocysts. There are eight rhopalia, each flanked on either side by a small, elongate, tapering marginal lappet. A furrowed exumbrellar pit extends inwards down each rhopalium; as seen from above the outline of the pit is somewhat expanded towards the margin and constricted inwards. The rhopalar lappets, which are longer than the others, are not expanded inwards at the base and do not meet at any point. The velar lappets, of which there are four pairs in each octant, are short and broad; their tips are very broadly rounded or subtruncate, and the incisions that separate them short, those separating the two lappets that form a pair being shorter than those that separate one pair from another. There are thus 16 rhopalar and 64 velar lappets, or 80 in all.

The width of the arm-disk at its base is about two-thirds, and at the point at which the arms originate from it about one-half that of the bell.

There are four narrow genital ostia, each a little narrower than the pillar which separates one ostium from the next. Each is constricted below by a thick, wide, gelatinous process of the bell-disk, and a little distance outside each a broad triangular process with a bluntly pointed tip is directed downwards and inwards from the subumbrellar surface. It occupies a position immediately below one of the rhopalar canals. The arm disk is very slightly emarginate in each perradius. The subgenital cavity is broadly cruciform.

At their bases the eight mouth-arms are joined together in a circle for a short distance. Their relative length is somewhat variable and one or more, perhaps owing to accident, are sometimes shorter than the others; they are always comparatively long in proportion to the vertical axis of the bell. The lower, bifid portion of each arm occupies about four-fifths of its total length. In this region the mouths are arranged in a single row down each margin of each edge of the three lamellae. On the upper, simple part of the arm they extend up the inner edge, in the same formation, to its point of origin. The fringed lips, however, are so contorted, and the minute capitate stinging-tentacles so numerous upon them, that it is difficult to make out the precise arrangement without studying immature medusae. Normally the arm is bluntly pointed at the tip.

The sensory filaments on the sides of the arms are short, slender and bluntly pointed; they are often entirely concealed among the capitate tentacles and seem to be much better developed in some individuals than in others. Their arrangement is not very regular, but, generally speaking, they are set in short transverse lines parallel to and alternating with the mouths. The elongate terminal filament characteristic of the genus is rather stout at the base and tapers gradually. When fully formed it is of great length, but it is rarely well-developed on all the arms of an individual and may be altogether absent from some. This is probably due to accident, for the tip of the arm itself is sometimes lacking. Not infrequently the filament has one or more short branches at its base. Possibly this is due to regeneration after injury.

The stomach is cruciform. There are eight rhopalar and eight adradial canals. The former reach the broad zone of anastomosing circular canals externally, but the latter are usually separated therefrom by an inwardly projecting portion of this peripheral system. Even in adult medusae an adradial canal can sometimes be traced in a straight line through this projecting portion to the outer zone, but more frequently it loses its identity on entering the former. The gastric filaments are numerous but very small. They are short, cylindrical and bluntly pointed.

The colour of the bell, arm-disk and arms is milky white, neither transparent nor altogether opaque. As a rule the bell is ornamented with dark spots, but their size, number and arrangement are variable, and often they are absent. Sometimes (perhaps most frequently) there is a broad immaculate peripheral zone and the spots, which are about 2 mm. in diameter, are densely scattered over the remainder of the bell; but sometimes they extend outwards to the marginal lappets, and I have seen medusae, apparently quite uninjured, in which there were only some half a dozen minute specks on the central part of the dome. Sometimes the spots are rather large and fewer than usual; I have examined one individual in which they ran together to form large irregular blotches on the margin. The pigment appears, in the living medusa, almost black to the naked eye, but if the animal is allowed to die in water it streams out in a deep purple cloud. In spirit or formalin the spots fade to a reddish brown and gradually, after some months, disappear altogether. The gastric filaments and the gonads are naturally of a yellowish flesh-colour, but fade immediately to opaque white in spirit or formalin.

Type.—No. Z.E.V. 6740/7, *Ind. Mus.* Preserved in 5 % formol.

Distribution.—This medusa is common in shallow water on both sides of the Bay of Bengal and in backwaters in the Madras Presidency. I have examined specimens from the coast of Tenasserim and of Orissa. In the Chilka Lake it occurs at all times of the year both in the outer channel and in the main area. We found it in water of every degree of salinity up to that normal in the Bay of Bengal, and even in pure fresh water; it evidently breeds in brackish water. The effect of fresh water upon it is discussed below (p. 101).

Acromitus rabanchatu is closely allied to the type-species of the genus (*A. maculosus*, Light[1]), from which it differs in colouration, in having the velar lappets shorter and blunter than the rhopalar, the terminal arm-filaments stout and tapering at the base, in the shape of the rhopalar pits and rhopalar lappets and in several other minor characters.

Young stages.

Many small specimens were obtained in tow-nets, especially in November, 1914 in the immediate neighbourhood of Barkuda Id. The smallest are about 3 mm. in diameter and represent an interesting stage in the development of the species. Practically every other stage up to the full-grown medusa is represented in our collection.

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[1] *Philippine Journ. Sci.* (D) IX, No. 3, pp. 210–216, figs. 4–6 (1914).

In our smallest specimens the disk is flat and membranous, with only a slight convexity in the central region of the exumbrella. The margins can, however, be everted upwards so that the structure becomes deeply concave, resembling a chalice in form (fig. 8). The muscular system is poorly developed and that of the canals is still in a primitive condition. The sixteen radiating canals are well developed, but they open outwards directly into a circular canal on the periphery. The walls of the latter canal are irregular in outline and somewhat indefinite projections can already be detected, representing the anastomosing channels that will be developed later. The actual margin is so delicate that it is invariably injured in specimens taken in a tow-net, but the rhopalar lappets are relatively large and conspicuous and the velar lappets short and broad and perhaps not very clearly separated. There appear to be four in an octant. The actual rhopalia are well-developed, but the furrowed pit above them is represented only by a slight depression in the exumbrella.

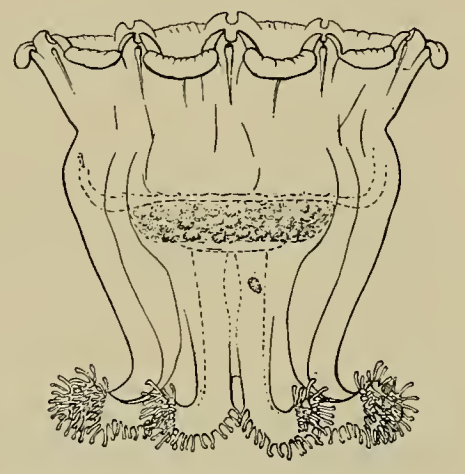

FIG. 8.—*Acromitus rabanchatu*, sp. nov.

A very young medusa with the bell everted upwards.

The most interesting features of these young medusae are to be found in the mouth-arms. The arm-disk has already assumed its final shape, but the ostia are relatively smaller than in the adult and are not protected by depending processes of the subumbrella. These processes do not appear until a much later stage in post-larval development is attained, and the ostia remain relatively small until the bell is considerably larger. In the smallest specimens the arms themselves (pl. viii, fig. 2) are still in the Semostoman stage and may be compared with those of the adult medusa in *Aurosa*. They are united in a circle at their base to a slightly greater relative extent than in the adult, to form what may be called a short manubrium, and are arranged in four pairs. Each arm is an elongate, membranous, flattened process of the margin of this manubrium, bilobed at the distal extremity and having the tips of the lobes slightly everted. The lobes are rounded and do not diverge widely. The inner (endodermal) surface is concave and a single row of minute capitate tentacles run round the whole arm (including the lobes), and also along the margin of the manubrium between the bases of the members of each pair of arms. The tentacles are least numerous in the latter position.

It would be out place to discuss the post-larval development in any great detail, but one or two points of general interest may be noted. It may be stated firstly that there appears to be very little correlation of a definite kind in the origin or full elaboration of different organs in different individuals. In some very small specimens the canal-system is already more elaborate than it is in others of much larger size; the bell is much deeper, and has a shape more near that of the adult, in some young examples than it has in others of more advanced development as regards the canal-system; the terminal filaments of the arms rarely appear at the

same time on all the arms of the same medusa, and are frequently absent in individuals of later growth than in some of those in which they are fully formed; the lateral sensory filaments of the arms usually appear later than the terminal ones, but can sometimes be detected in the form of minute buds before the latter make their appearance.

A second point of interest lies in the fact that in the development of the canal-system the inward projections of the peripheral plexus connected with the adradial canals first make their appearance as irregular processes of the primitive circular canal and are in no way connected with the radiating channels. Each projection is formed in two halves, one half on each side of the canal with which the whole is ultimately to fuse. Even after the two halves have become joined to the two sides of the radiating canal, it runs straight through them and maintains its identity to the margin of the disk. This condition prevails for a considerable period and may occasionally be found persisting as an abnormality in one or more octant of a large medusa.

But the most interesting feature of our series of young specimens of *Acromitus* lies in the clear manner in which it illustrates the evolution of the Rhizostomatous mouth-arm (plate viii, figs. 2 to 3*b*). The peculiarities of the structure of this organ are due in the first instance to unequal growth in its different parts. The everted terminal lobes of the arm of the young medusa grow more rapidly than the simple basal part, and the margins in both regions grow more rapidly than the middle portion. The first consequence of the accelerated growth of the terminal lobes is that the whole arm is definitely folded inwards along the middle line, while the fact that the margins become longer than the middle region causes them to be thrown into a series of short transverse pleats. This double folding causes certain parts of one side of the arm to be brought into close contact with the corresponding parts of the other side, and also certain parts of each margin to be pressed against others on the same side; but prevents the whole of one vertical half coming into contact with the whole of the other. In fact, a central vertical canal is left open down the mid-ventral line of the primitive arm, while lateral canals of smaller calibre diverge from it obliquely to the margin on either side. The whole figure thus formed is pinnate. Simultaneously with the production of this system of canals a great increase in the bulk of the mesogloea of the arm takes place. Where endoderm meets endoderm in the folding, the two surfaces fuse together and are invaded by mesogloea, which cuts off one canal from another, leaving those endodermal tracts free that have not been in contact. The endoderm in the interior of the greatly strengthened and thickened arm that is thus produced is now confined to the lining of the vertical and lateral channels formed by the folding of the originally membranous structure and its consolidation in the manner indicated. The distal extremities of the lateral canals remain open and form two linear series of mouths, extending, one on each side of the new margin, down the arm and along each of the terminal lobes.

Yet another folding takes place owing to the growth of these lobes. At first

slightly everted, they tend to grow upwards rather than outwards and so to be folded against the outer margin of the undivided part of the arm. Their ectoderm thus comes in contact with the ectoderm of that part. Ectoderm fuses with ectoderm and is invaded by mesogloea, but as the folding is a simple one no new channels are left open. The characteristic arm of the Triptera is thus produced, formed in its distal region of three lamellae meeting in a vertical line and having a >--shaped cross-section.

Another point that may be noticed is the large size of the gastric filaments in the young medusa, in which they are actually as large as—relatively of course much larger than—in the adult.

Acromitus rabanchatu is a sluggish medusa usually seen on the surface with its main axis nearly horizontal. Its pulsations are slow and feeble. Probably the fixed stage occurs on rocks or weeds near the south end of the lake, where the young were found in April, July, September and November, but not in January or February. Small copepods were noticed in the stomach of the young. The stinging-cells have little or no effect on the human skin. Personally I could detect none.

The most striking point in what we ascertained as to the biology of this medusa is the effect that an irruption of fresh water has on its habits and physiology. We noticed that medusae were absent from the surface of the northern part of the main area of the Chilka Lake for a considerable part of the year in which they were fairly common in Rambha Bay, although the prevailing wind had a tendency to drive them northwards. The season at which we did not find them on the surface off Barkul and Nalbano was that at which fresh water, which never penetrates fully into Rambha Bay, was prevalent in the northern parts of the lake. At this season our nets often brought up specimens of *Acromitus* from the bottom; they seemed to be unusually sluggish, to have unusually flat disks and long arms; but we did not notice anything very definitely peculiar. By a fortunate chance abnormal meteorological conditions made it possible to make a much more definite observation in the Ennur backwater near Madras in January, 1915. At that time, at a season at which the weather is usually dry, heavy rain had fallen and the specific gravity of the water in the upper reaches of the lagoon had sunk, probably quite suddenly, at least as low as 1·001. No medusae were seen on the surface, but every haul of the bottom-nets brought up specimens; in one case as many as twenty in a haul. At first sight they appeared to be dead; no movement of any kind could be detected and the circular muscles of the disk were uncontracted and flaccid. The disks were so flat, owing partly to the condition of the muscles but mainly to an actual shrinkage of the jelly, that the specimens were recorded provisionally as representing either a distinct species or a phase of *A. rabanchatu* in which the disk retained the post-larval form; the arms, in consequence of the shrinkage of the bell, appeared to be exceptionally long. That the medusae were not dead was proved by two facts—they exhibited no signs of decay and the spots on their umbrellas were clear and well-defined. The latter fact is particularly important, because in medusae of this species

that are allowed to die in water the pigment of the spots begin to "run" immediately, staining the surrounding medium. The Ennur specimens were of all sizes from a diameter of about 3 cm. to about 20 cm.

These facts, taken in conjunction with the observations recorded on *Halianthus limnicola* and *Edwardsia tinctrix* on pp. 91, 95 of this paper, justify an expression of the belief that some individuals of certain coelenterate species, if forced to live temporarily in water of very low specific gravity (*i.e.* greatly decreased salinity), are able to survive in a state of quiescence or torpidity for considerable periods, and that the most obvious direct structural effect of such conditions is a shrinkage of the mesogloea. If unduly prolonged these conditions cause the deaths of many individuals. The more marked results at Ennur, as compared with those noticed in the Chilka Lake, were probably due to the greater suddenness of the change.

In the Chilka Lake, but not at Ennur, a small amphipodous crustacean was almost invariably observed among the tentacles on the mouth-arms of large individuals of *A. rabanchatu* and occasionally also on the subumbrellar surface. It was not present on very young medusae. In the gastric cavity of these latter, among the gastric filaments, ova were frequently observed, giving, together with the large relative size of the filaments, a false appearance of sexual maturity. The ova, however, were not confined to the gastric cavity but occurred scattered throughout the vascular system and in particular in the circular canals; they are shown as white spots in the photographs of young medusae reproduced on plate vi. A microscopic examination revealed no ovarian tissue, and there can be no doubt that the ova were not proper to the medusae. Mr. T. Southwell has been kind enough to examine a series of well-preserved specimens. He agrees with me in thinking that the eggs are not those of the commensal amphipod but probably belong to some helminth parasite. They are in various stages of segmentation and the formation of a blastula, but unfortunately have not reached in any case a higher stage of development and have not as eggs any distinctive structural character. In size and shape, however, they closely resemble eggs found with immature Distomid Trematoda in the canals of a Ctenophore common in the Chilka Lake (p. 118). No eggs of the kind were observed in adult medusae.

The main breeding season of *A. rabanchatu* occurs in the Chilka Lake, to judge from the condition of the gonads in specimens, towards the end of the cold weather, *i.e.* in February and March.

HYDROZOA.

(Plate ix, in part.)

We obtained in the Chilka Lake specimens of eight or nine species of Hydrozoa, representing four orders, seven families and eight or nine genera. The alternative numbers in species and genera are due to doubt as to the association of a medusa

with its hydroid generation. All the orders of the group except the Trachomedusae and the Hydrocorallinae are represented, but the Narcomedusae and the Siphonophora each include only one casual visitor. The true hydroids are better represented; among the Calyptoblastic families, the Campanulinidae have a single medusa (a casual visitor), and the Campanulariidae two hydroids, each belonging to a separate genus, as well as a medusa that may very well be co-specific with one of the hydroids. One Calyptoblastic hydroid is a casual visitor, while another establishes itself in the outer channel, in which a medusa belonging to the same group was also found as a casual visitor, in the salt-water season. The Gymnoblastea are represented by three hydroids, two of which are permanent inhabitants of the main area of the lake, while the third was found only in the outer channel and in the salt-water season.

Most of the casual visitors and periodic immigrants are marine species of wide distribution. Of the four free-swimming forms included in these categories one is cosmopolitan and one Indo-Pacific, one is widely distributed in the Bay of Bengal and the neighbouring seas, while the fourth, though only known as a medusa from the outer channel of the lake, is perhaps the other generation of an Indo-Pacific hydroid found with it. Of the three fixed forms that are not permanent residents two are Indo-Pacific while one was described from Ceylon.

The two permanent residents, on the other hand, are both species that were originally described from the Gangetic delta and are as yet known only as inhabitants of brackish water on the east coast of India.

Order NARCOMEDUSAE.

Family AEGINIDAE.

Genus **Solmundella** Haeckel.

Solmundella bitentaculata (Quoy and Gaimard).

1904. *Solmundella bitentaculata*, Browne, *Faun. Geogr. Maldives and Laccadives* II, p. 741, pl. lvi, fig. 3.

1905. *Solmundella bitentaculata, id., Rep. Ceylon Pearl Fish.* IV, p. 153, pl. iv, figs. 1-6.

1910. *Solmundella bitentaculata*, Mayer, *Medusae of the World* II, p. 455, fig. 301 (p. 457).

An excellent figure of this peculiar little medusa as it appears when contracted is given by Browne (1904). In his paper of 1905 he gives further particulars. Mayer regards the *Aeginopsis mediterranea* of Müller as no more than a variety. If this is so, the species occurs in all seas but has become sufficiently differentiated in the Mediterranean to be distinguished there as an endemic race. As Mayer points out, referring to Vanhoffen's report on the Narcomedusae of the 'Valdivia' (*Narcomedusen der 'Valdivia' Exp.*, p. 45), "*Solmundella* is the most widely distributed Narcomedusa known, ranging from the North Atlantic, through the tropical Pacific

and Indian Oceans to the Antarctic. Living at temperatures of 27° to 1° C, and in depths ranging from 1,500 fathoms to the surface."

A single small specimen was taken in a tow-net on the surface of the outer channel of the Chilka Lake near Barhampur Id. on March 14th, 1914. The salinity of the water at the time was practically identical with that of the Bay of Bengal outside the bar. The medusa must be regarded merely as a casual and perhaps involuntary visitor to the lake.

Order SIPHONOPHORA.

Family DIPHYIDAE.

Genus **Diphyes**, Cuvier.

Diphyes bojani (Chun).

1911. *Diphyes bojani*, Bigelow, *Mem. Mus. Zool. Harvard*, XXXVIII, No. 2, p. 251; pl. vii, figs. 2, 3; pl. viii, fig. 6; pl. ix, figs. 1, 2; pl. x, figs. 2, 3; pl. xi, fig. 5; pl. xii, fig. 1.

The synonomy of this species is discussed by Bigelow in the paper cited. Our specimens agree well with the figure of *Diphyes gegenbauri* published by Lens and Van Riemsdijk in their report on the Siphonophora of the 'Siboga' (*Siboga-Exp.* LX, pl. vii, fig. 57), or in some cases with that of *Doromosia pictoides* (*op. cit.*, pl. i, fig. 1). The species is evidently a variable one and the shape of the anterior nectophore depends to some extent on the condition of preservation of specimens.

In our collection from the Chilka Lake I have found anterior nectophores only.

D. bojani is widely distributed in the Indo-Pacific Region. It is not a permanent inhabitant of the lake, but is to be found in considerable numbers in the outer channel in the salt-water season. It was usually present in our tow-nettings obtained there in March, 1914.

Order CALYPTOBLASTEA.

Family CAMPANULINIDAE.

Genus **Campanulina**, van Beneden.

1868. *Campanulina*, Hincks, *Brit. Hydr. Zooph.*, p. 186.

Campanulina ceylonensis (Browne).

1905. *Irene ceylonensis*, Browne, *Rep. Ceylon Pearl Fish.*, p. 140, pl. iii, figs. 9-11.

1905. *Irene palkensis, id., ibid.*, p. 141, pl. iii, figs. 12-16.

1907. ,, *ceylonensis*, Annandale, *Journ. As. Soc. Bengal* (n. s.) III, p. 79, pl. ii, fig. 5.

1907. ,, *ceylonensis, id., Rec. Ind. Mus.* I, pp. 38, 142, fig. 2.

1910. *Phortis palkensis* + *Ph. ceylonensis*, Mayer, *Medusae of the World*, p. 309.

The position of the medusa of this species is somewhat enigmatical. Browne placed it in *Irene* (or *Eirene*), and Mayer, relying wholly on Browne's description, in *Phortis*. It seems to me to have affinities with *Tima*,[1] but does not altogether agree with that genus, although its gonads, when fully adult, reach practically from the base of the manubrium to the edge of the disk; there are no cirri and no conspicuous band of longitudinal muscles on the lower side of the tentacles. I have, however, been able to detect a very thin band of the kind in this position. As the hydroid is merely a dwarfed *Campanulina*, it seems best to place the species in that genus, in which the adult medusae have not been satisfactorily identified.

The hydroid[2] forms a minute colony barely visible to the naked eye. It consists of a sparsely branching adherent rhizome that gives origin at intervals to single hydrothecae borne on short ringed pedicels about one-seventh as long as the cup. The hydrothecae are nearly cylindrical and can be closed above by an operculum consisting of several triangular flaps. The hydranth has about 14 very long slender tentacles with regular rings of stinging-cells and but slightly webbed at the base. The hypostome, which is conical, is small and inconspicuous.

Medusae from Port Canning in the Gangetic delta exhibited every gradation between Browne's two nominal species (1907 (2), pp. 140, 141). An increase in the number of concretions in the otocysts was regularly correlated with the production of extra tentacle-bulbs that did not reach their full development. Both changes were apparently due to degeneration and took place towards the end of the season at which the medusa flourished (December to March), when the water of the pools in which it was found began to grow hot.

The hydroid was found on the leaves and stems of water-plants at Port Canning in November, December and January. Both medusa and hydroid have now disappeared from the pools.

The medusa is common off the coast of Burma in winter. It was taken in the Gulf of Manaar and Palk Straits in March and July. At Port Canning, the only locality at which the hydroid has been found, both generations flourished for a time in brackish water. Neither was, however, found in the main area of the Chilka Lake and the species is represented in our collection by a single medusa that was taken in the outer channel, in salt water, in March.

In the second of my papers published in 1907 I dealt with the feeding habits of the medusa, which sucks out the contents of filamentous algae as well as swallowing small Gastropod molluscs and finally ejecting their shells. It is the hardiest medusa with which I am acquainted and will survive for some hours corked up, several individuals together, in a small tube carried in the waistcoat pocket.

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[1] For definitions of the different medusoid genera here referred to see Mayer's *Medusae of the World* II, pp. 307, 311, 314.

[2] All my specimens of this hydroid are now in the hands of Dr. Ritchie of the Royal Scottish Museum, who will, I hope, give a full description in his account of the shallow-water hydroids of the Indian Seas. Dr. Ritchie will describe shortly in the *Records of the Indian Museum* a minute and very interesting hydroid from brackish water in the Gangetic delta.

Family CAMPANULARIIDAE.

Genus **Obelia**, Peron and Lesueur.

Obelia spinulosa (Bale).

1888. *Campanularia* (?) *spinulosa*, Bale, *Proc. Linn. Soc. N. S. Wales* (2) III, p. 756, pl. xii, figs. 5-7.

1910. *Campanularia* (?) *spinulosa*, Ritchie, *Rec. Ind. Mus.* V, p. 5.

A single specimen of this species was taken in the main area of the lake in July, 1913. It grew on a piece of drift-weed stranded among rocks near Patsahanipur and though many of the polyps were alive, was in a somewhat degenerate condition. A few gonothecae were present but did not contain gonosomes.

The information that the hydroid is an *Obelia* I owe to Prof. K. Ramunni Menon of Madras, in whose laboratory the medusa has been reared. I have also to thank him for the sketch reproduced (fig. 9), which was made from life by his pupil Mr. A. V. Narayananvami Ayer.

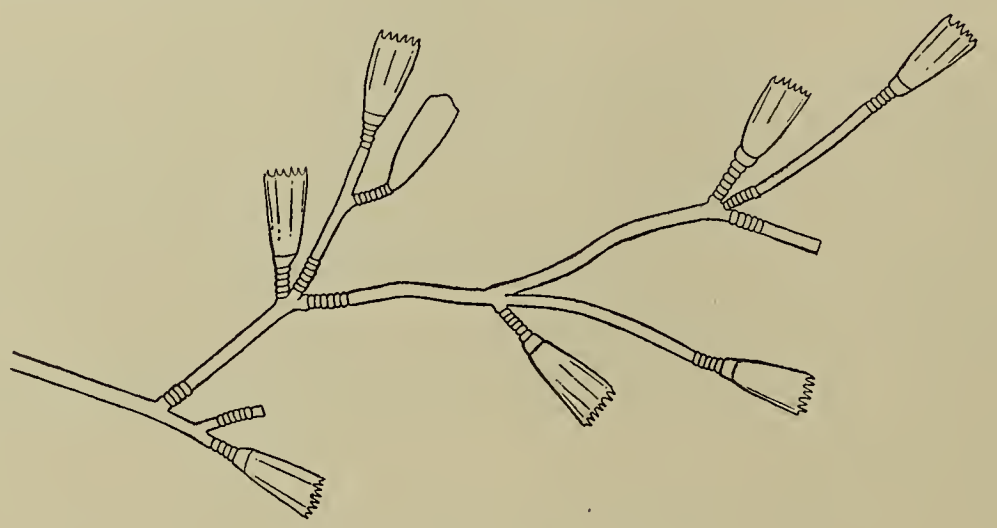

Fig. 9.—*Obelia spinulosa* (Bale).

O. spinulosa was originally described from N. S. Wales and has since been recorded from Java and the Andamans. It is very common (with *Clytia geniculata*, Thornely) in Madras harbour, in which it grows on the shells of mussels, etc.

Genus **Clytia**, Lamouroux (Hincks).

1868. *Clytia*, Hincks, *Brit. Hydr. Zooph.*, p. 140 (Hydroid).

1910. ,, Mayer, *Medusae of the World* II, p. 261 (Medusa).

Clytia serrulata (Bale).

(Plate ix, figs. 1, 1*a*, 1*b*.)

1888. *Campanularia* (?) *serrulata*, Bale, *Proc. Linn. Soc. N. S. Wales* (2) III, p. 257, pl. xii, fig. 4.

So far as can be judged from well-advanced embryos in the gonothecae, this species is a *Clytia*; it is certainly neither a *Campanularia* nor a *Gonothyraea*. The

possibility of its being the hydroid of a *Phialidium* is not, however, excluded, and it may be the vegetative generation of the medusa described below as *Phialidium cruciferum*. Of this there is no direct proof, but the fact that the medusae and hydroid were found together in a fauna so poor as that of the Chilka Lake is at any rate noteworthy.

The hydrothecae and the other purely vegetative parts of the colony agree well with Bale's description and figures. The hydranth is much stouter in structure (pl. ix, fig. 1) than that of *Obelia spinulosa* and has a wider and more trumpet-shaped hypostome. The tentacles are less attenuated. The basal part of the hydrotheca is separated off from the remainder by a delicate membrane.

The gonothecae are mostly produced in groups and arise directly from the anastomosing rhizome. They are placed vertically on very short, obscurely annulated stalks. Sometimes they also arise on the stems, near the base of the stalks of the hydrothecae; in this position their stalks are longer and more distinctly annulated. They are somewhat variable in form, and often distinctly irregular and asymmetrical in outline. Generally speaking, they may be described as being narrowly oval, *ca.* 4 times as long as broad and truncate distally, with a slight constriction near the distal extremity and sometimes another about half way down. They vary in length from 0·68 mm. to 0·85 mm. There are no annuli on the surface.

In the specimens of an *Obelia* from New Britain assigned by Miss Thornely[1] to this species the hydrotheca was evidently much shorter than in Bale's types.

Clytia serrulata was originally described (with *Obelia spinulosa*) from New South Wales. We found a considerable number of specimens at two stations in the outer part of the outer channel of the Chilka Lake in March, 1914, in salt water. The species is probably a periodic immigrant into this part of the lake.

The original Australian specimen was growing on another hydroid (*Tubularia*). Ours were on a fragment of *Pennaria* that had been washed in from the sea, on roots of grass, a dead leaf and dead Lamellibranch shells Many hydranths of those taken at the mouth of the lake contain larval appendicularians in the gastric cavity and these animals would seem to constitute an important element in the food of the species.

Genus **Phialidium**, Leuckart.

1910. *Phialidium*, Mayer, *Medusae of the World* II, p. 265.

Although many medusae of this genus have been described none have been associated with the hydroid in a satisfactory manner. Probably it is identical with *Clytia*.

Phialidium cruciferum, sp. nov.

(Plate ix, figs. 2, 2*a*, 2*b*.)

As I have pointed out above, this may be the medusa of *Clytia serrulata* (Bale). Our specimens met with an unfortunate accident, owing to which they are all some-

[1] *Obelia serrulata*, Thornely, "The Hydroid Zoophytes", etc., in Willey's *Zoological Results*, p. 453, pl. xliv, fig. 5.

what distorted. This has made it impossible to obtain a satisfactory profile figure, but the medusa possesses several distinctive characters that can be illustrated in detail even from our material.

In outline the medusa resembles *Ph. globosum* (Mayer)[1] having abundant jelly and an evenly curved bell. The manubrium, gonads and tentacle-bulbs are deep flesh-colour. The bulbs are tinted with brown externally and there is a dark brown cross on the base of the manubrium as seen from the exumbrellar surface. It is composed of four pairs of parallel lines of equal length, one pair on the proximal part of the roof of each radial canal. As a rule the four lines do not quite meet in the centre. Specimens with fully developed gonads are about 6 mm. in diameter.

The number of tentacles is variable and their arrangement irregular. In all the specimens examined a considerable proportion of them are not fully developed and the number of perfected tentacles is often different in different quadrants of the same individual. The radial tentacles are no longer than some of the others. The number, as well as the arrangement, of the otocysts is also variable. Sometimes two are situated close together, but more often several tentacles intervene. They are very small and inconspicuous.

The velum is narrow.

The manubrium is relatively long and has four long deeply-fringed lobes.

The gonads are narrowly spindle-shaped and about equidistant when young from the margin of the bell and from the manubrium. When mature they occupy more than half the length of the radial canals and approach the margin, also becoming more band-like and somewhat contorted.

Type.—No. Z.E.V. 6827/7, *Ind. Mus.*

Distribution.—Taken in large numbers on the surface in the outer channel of the Chilka Lake (Orissa) in salt water, March, 1914.

This species is apparently related to *Ph. iridescens*, Maas,[2] from which it differs in colour, in its much larger manubrial lips, and probably in other characters. *Ph. iridescens* has been found only in the Antarctic Ocean.

Order GYMNOBLASTEA.

Family HYDRACTINIIDAE.

Genus **Clavactinia**, Thornely.

Clavactinia gallensis, Thornely.

1904. *Clavactinia gallensis*, Thornely, *Rep. Ceylon Pearl Fish.* II, p. 111, pl. i, fig. 3.

In sorting out our collection we found on several small shells colonies of a minute Hydractiniid that agrees with Miss Thornely's description sufficiently well. The animal escaped our attention in the field.

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[1] *Oceania globosa*, Mayer, *Bull. Mus. Zool. Harvard*, XXXVII, p. 51, pl. x, figs. 20, 20*a* (1900); *Phialidium globosum* (in explanation of plate "*globulosum*"), *id.*, *Medusae of the World* II, p. 272, pl. xxiv, fig. 4.

[2] *Exp. Antarct. 'Belgica'*, *Medusen*, p. 12, pl. i, fig. 6 (1906).

The colonies are evidently young or dwarfed. Only one bears fully developed gonosomes and even in this colony the basal crust is still imperfectly developed and remains at many points openly reticulate. In one colony it is still in the primitive condition of a branching and anastomosing rhizome bearing upright hydranths at intervals. The largest shell to which a colony was attached was only 23 mm. long.

The largest hydranths are not more than 2 mm. long and the majority are much shorter. The number of tentacles is variable, but I have not seen more than 14. Their nematocysts are very small. Even when fully expanded the tips are blunt.

There are no true dactylozooids, but young gonophores were at first sight mistaken for them. These individuals have a large central cavity at the base, which is somewhat inflated. The region on which the gonosomes are borne is elongated and slender. Its tip is blunt and not at all capitulate. In this region the structure forms a solid finger-shaped mass. Brownish granules occur abundantly in its internal cells. Each female gonosome bears three ova. Except in being a little more inflated at the base, the whole gonophore, in mounted specimens rendered transparent, somewhat resembles the larger spines but may be distinguished therefrom, in the absence of gonosomes, by its basal cavity and by the absence of a thickened chitinous external coat. The gonophores are shorter than the largest hydranths.

Clavactinia gallensis was originally taken in Galle Bay on the west coast of Ceylon in two fathoms. Our specimens were found close inshore in not more than two feet of water at Satpara in the outer channel of the Chilka Lake.

The former specimens were attached to shells of *Eburna* and *Neritina*; Miss Thornely does not say whether these shells were inhabited. Ours were in most instances on shells of *Potamides fluviatilis*, and in one on a shell of *Nassa labecula*. In both cases small hermit-crabs (*Diogenes avarus*, Heller) were living in the shells, both species of which are abundant at Satpara. The hydroid was present on a small proportion only of the shells collected, though many had been appropriated by hermit-crabs. Our specimens were taken in March, in water practically as salt as that of the upper part of the Bay of Bengal at the same season. It is probable, in view of the immature condition of most of the colonies in March, that the planulae are brought in by the tide in the season of salt water and that the species does not survive the irruption of fresh water that takes place later in the year.

A minute Campanularian hydroid accompanied *Clavactinia* on one shell, but the specimen was unfortunately too imperfect for even partial identification.

Family CORYNIDAE.

Genus **Dicyclocoryne**, nov.

This genus may be defined as consisting of Corynidae in which the tentacles of the hydranth are all capitate and are disposed in two quite distinct circles. The gonosomes, which are borne on the proximal part of the hydranths, are free medusae and have, when liberated, four short, stout capitate tentacles, one at the end of each radial canal, but no ectodermal ocelli. The manubrium, at the same stage, is short,

conical and apparently imperforate. Nothing is known of the development of the gonads.

Type-species.—*Syncoryne filamentata*, Annandale.

The genus is at present known only from brackish water on or near the east coast of India.

Dicyclocoryne filamentata (Annandale).

(Plate ix, figs. 4, 4*a*, 4*b*, 4*c*.)

1907. *Syncoryne filamentata*, Annandale, *Rec. Ind. Mus.* I, p. 139, figs. 1, 2.

The colonies of this species often have a peculiarly lax appearance owing to the fact that the rhizome is adherent only in places and is sometimes produced into long filamentous free processes that bear terminal polyps. These, or rather the stalks from which they arise, may again become attached at their base to the object on which the colony is growing, so that loops of free rhizome are formed. The whole colony, except of course the hydranths, has a fairly thick chitinous investment. The rhizome branches sparingly and does not anastomose. Short vertical stems are produced at intervals, but as a rule bear only one (terminal) hydranth. A second (lateral) polyp is, however, sometimes present. The stems and rhizome, including the free portions of the latter, are often irregular in outline without being exactly annulate. Their diameter does not exceed 0·19 mm.

When fully expanded the hydranths are slender and spindle-shaped. They have a well-developed sheath of ectocyst at their base. As a rule there are about four tentacles in the proximal and six in the distal circle, but the number is variable and individual hydranths are occasionally found in which they are aborted and reduced in number. When normally developed they are capable of great extension and even in contraction the cylindrical part of the tentacle is longer than the terminal swelling. The latter is very large, circular and somewhat flattened. The largest hydranths are probably never more than 2·5 mm. long.

The gonosomes are borne at the bases of the proximal ring of tentacles or distinctly below them at the base of the hydranth.

The medusa is about 0·4 mm. in diameter when liberated. Its bell in life is slightly deeper than broad. In profile, the sides, except in extreme contraction, are nearly straight and the upper outline moderately convex. The cross-section is subquadrate. The surface is minutely tuberculate but has no conspicuous projections or specialized organs. The velum is broad. There are no marginal processes of any kind between the tentacles.

The tentacles are incapable of great elongation and in all circumstances remain shorter than the bell. They are somewhat flattened from without inwards and bear on each side a series of minute projections which decrease in size from above downwards. The terminal expansion, which is full of large nematocysts, is circular and somewhat flattened from above downwards. The tentacle-bulbs are relatively large but lack all traces of ocelli. As a rule they contain one or several large nematocysts. Immediately below them there is a broad band of stinging cells; below this band

there is another narrower and less prominent one of the same nature. In the living animal the two bands can hardly be distinguished.

The endodermal parts are colourless. The manubrium is a stout conical body much shorter than the bell. Its walls are very solid and I can detect no orifice. There is, however, a relatively large lumen at the proximal end.

The radial canals are simple and slender.

Types.—Hydroid, No. Z.E.V. 2424/7 : Medusa, No. Z.E.V. 2436/7, *Ind. Mus.*

This species is closely allied to those that form the genus *Syncoryne* (Ehrenberg) as restricted by Allman, but the hydranth is distinguished from their hydranths by the arrangement of the tentacles. The medusa is distinguished from *Sarsia*, Lesson, by its capitate tentacles and lack of ocelli.

Distribution.—The hydroid, from which medusae were hatched in Calcutta, was originally found in a small artificial pool of brackish water at Port Canning in the Gangetic delta. In the Chilka Lake we found the hydroid, with developing medusae, on two occasions in the main area, in Rambha Bay and near Pigeon Island, in both cases on the surface.

The type-specimens, which were taken in December, 1907, were growing on a grass-stem in water of low salinity. Our examples from the Chilka Lake are on a leaf of *Halophila ovata* and on the stem of an indeterminate water-plant. They were collected in July, 1913. The salinity of the water was not ascertained at the time, but in July, 1914, the specific gravity in Rambha Bay was about 1·015. The species is evidently scarce in the lake, but is probably a permanent resident in the main area.

Family BOUGAINVILLIIDAE.

Genus **Bimeria**, Wright.

1868. *Garveia+Bimeria*, Hincks, *Brit. Hydr. Zooph.*, pp. 101, 103.
1871. *Garveia+Bimeria*, Allman, *Mon. Gymn. Hydr.*, pp. 249, 297.
1902. *Bimeria*, Torrey, *Zool. Pub. Univ. California* I, p. 20.
1905. *Perigonimus* (in part), Motz-Kossowska, *Arch. Zool. expérim.* (4) III, p. 71.
1905. *Pruvotella, id., ibid.*, p. 77.
1907. *Bimeria*, Browne, *Journ. Mar. Biol. Ass. Plymouth* VIII, p. 19.

Bimeria fluminalis, sp. nov.

(Plate ix, figs. 3, 3*a*.)

1907. *Bimeria vestita*, Annandale (*nec* Wright), *Rec. Ind. Mus.* I, p. 141, fig. 3.

I am acquainted with two phases of this species, a luxuriant bushy form and a dwarfed one consisting of simple pinnate stems arising at intervals from an adherent rhizome.

In the latter phase the stems are never much more than 20 mm. high and may be reduced to stalks less than a millemeter long and bearing only a terminal

hydranth. The bushy masses of the more robust phase may, on the other hand, reach a length of 20 cm. In both phases the stems are single and even when the colony is most luxuriant they never become agglutinated or even intertwined, its luxuriance being due solely to the profuse production of stems from the rhizome and their still more profuse branching in one plane. Even the largest masses are soft and lax, for the stems and branches are not thickened, and it is only when the former are very short that they are at all stiff.

The chitinous investment of the hydrophyton, though not hard, is thick and brown. It extends up the stalks of the hydranths, round the base of the latter and for a short distance up the tentacles, on which, however, it is thin and almost colourless. Consequently the exact point it reaches can be detected with difficulty. When the hydranths are contracted the thin investment of their bases is to some extent invaginated into the thicker and stiffer covering of the stalk (pl. ix, fig. 3).

The hydranths are spindle-shaped and fairly slender when fully extended, their tentacles are capable of great elongation. As a rule the tentacles, which are borne in two alternating circles, are 8 or 10 in number.

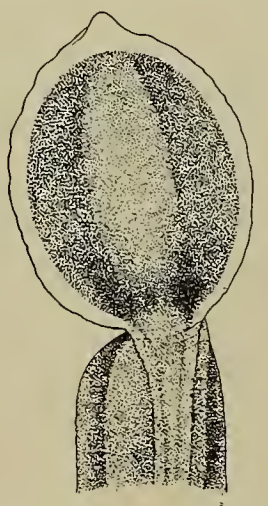

Fig. 10.—*Bimeria fluminalis*, sp. nov. Male gonophore, from a stained specimen.

The base of the stems and lateral branches is always annulated for a short distance, but the annulation is often very obscure. So far as I can see it is never spiral. This is also the case with the stalks of the gonophores, which (the stalks) are always shorter than the gonothecae.

These thecae are borne at the base of the considerably longer stalks of the hydranths. When immature they are almost spherical and when mature vary considerably in size and outline. Generally speaking, those of the female gonophores tend to become cylindrical as the ovum ripens, whereas those of the male gonophores assume an ovoid form with the growth of the gonad and become almost pointed distally. There is usually a small pimple-like projection at the extreme tip, especially in mature male gonothecae (fig. 10).

Traces of the circular canals persist at the base of the gonophores but are not well developed. In both sexes the spadix is a simple cylindrical or somewhat spindle-shaped body. In the female gonophore, which produces a single egg, the spadix extends up one side of the egg and arches over it slightly. The distal extremity is slightly emarginated outwardly, so that the spadix has precisely the shape of the human finger (pl ix, fig. 3*a*). In this sex it is of an orange or brownish colour. The ovum and the young planula are usually white but, at any rate in the bushy form of the species, sometimes have a bluish tinge. The spadix of the male gonophore is symmetrical and somewhat less curved; it extends up the interior of the gonophore nearly to the tip of the latter and is invisible externally in the living animal.

Type.—No. Z.E.V. 6643/7, *Ind. Mus.* The specimen belongs to the bushy phase and was taken in a canal of brackish water on the outskirts of Calcutta.

Bimeria fluminalis is common in both phases in canals, creeks, pools and back-waters of brackish water in the Gangetic delta. In the Chilka Lake the dwarfed form is abundant, especially in the main area, at all seasons.

The species is closely allied to *Bimeria vestita*, Wright, the type of its genus, which occurs in the North Sea and Irish Channel and in the Mediterranean and has been recorded from the Pacific side of South America.[1]

From the British form it differs only, so far as the hydrophyton is concerned, in the more obscure annulation of the stems and the thinner and less conspicuous covering of the base of the hydranth and the tentacles. The cup-like invagination produced at the base of the contracted hydranth is doubtless correlated with the latter feature and is certainly not a generic character. Until I was acquainted with the structure of the gonophore in both sexes I was of the opinion (see *Faun. Brit. Ind., Freshw. Sponges*, etc., p. 140; 1911) that the Indian hydroid was at most a local race of the British one, but the spadix differs in the two, for in the male of *B. vestita* (*fide* Allman) it is branched instead of being simply cylindrical, while in the female,[2] instead of forming a cylindrical process on one side of the ovum, it forms a symmetrical cup in which the ovum rests.

B. fluminalis plays much the same part in the aquatic fauna of the Gangetic delta as *Cordylophora lacustris* does in that of the estuarine tracts at the mouths of the Thames and the Mersey. It reaches its maximum development on submerged timber and there provides a support or a refuge to numerous fixed and free Protozoa, while the Indian race or species (*bengalensis*) of the Polyzoon *Victorella* grows on its branches just as *V. pavida* does on those of *Cordylophora* in England. In the Chilka Lake the dwarfed form of the hydroid is found on rocks and stones and on the stems of water-plants, avoiding only those spots reached by direct sunshine. On stones it is confined to the lower surface, but on rocks it often covers vertical faces. In the Gangetic delta, where there are no stones, this form is usually found on hard artificial objects such as bricks and potsherds but also grows on water-plants in pools. I have never seen the species in places where the water was permanently fresh, but it flourishes in a medium of very slight salinity and can exist for a considerable period in fresh water. The positions it affects in the Chilka Lake are for the most part the same as those affected by *Laxosuberites lacustris*, except that, when the lake is full, it grows higher up the rocks than the sponge. The rhizome is very often completely buried in the sponge, through which the branches protrude. In these circumstances the hydroid is more completely dwarfed as a general rule than it is when growing free; often the hydranths die and the branches disintegrate, leaving only the rhizome, which retains its vitality and doubtless produces new stems if anything happens to the sponge.

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[1] Hartlaub, *Zool. Jahrb.*, Suppl. VI, p. 534 (1905).

[2] I can find no published description of the female gonophore of *B. vestita*. My statement is based on a specimen from Port Erin that Mr. F. H. Gravely has kindly lent me.

The maximum vegetative growth of the hydrophyton, which in favourable conditions must be rapid, takes place in the lake in the salt-water season, but gonophores are produced in the greatest numbers at the time when the lake is inundated with fresh water. Indeed, the most favourable conditions for their production seem to be those most unfavourable for the survival of the hydranths. In the northern part of the main area in September, when the water was quite fresh, we found both male and female colonies covered with gonophores on stems of drift-weed that had been carried by the wind into corners among rocks and had begun to decay. Most of the hydranths had perished, but most of the gonads were developing normally, though a few were degenerate, especially in the male colonies—a circumstance that occurs even in conditions that seem to be more normal. In active colonies growing in water of moderate salinity gonophores were never found in profusion so great, but many are present on the type-specimens, which were taken in water of a specific gravity of 1 006. In these they are almost entirely confined to those parts in which the organism is congested by its own luxuriant growth. They are accompanied by few hydranths, though the younger and freer parts of the colonies were evidently in full nutritive vigour and well supplied with active polyps. It is thus clear that in *Bimeria fluminalis*, as in many other species, sexual reproduction is stimulated by changes in environment that ultimately prove fatal to the colony.