

VIII MATERIALS FOR A SURVEY OF THE MOSQUITOES OF CALCUTTA.

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[NOTE.—The delay in the appearance of this paper is due to the fact that owing to the absence during almost the whole time of the survey as well as for many years previously, of any scientific officer who could devote more than a small part of his time to the supervision of the conservation of our extensive entomological collections, Mr. Paiva has been unable to devote more than a fraction of his time to mosquito work. For the same reason the survey cannot be regarded as exhaustive, or even sufficient for the “fringe area” to which it was confined, since the methods employed were rough and ready in the extreme. Their chief defects lie in the lack of adequate supervision over the collectors, and in the identification by means of the adults only of the larvae and pupae obtained. With regard to the first of these defects, Mr. Paiva tells me that it was easy to keep a check on the truth of the collectors’ statements as to the nature of the breeding-places from which different collections of larvae were brought in, as he quickly found that some species preferred one sort and others preferred others, a fact which could not be taken into account by an ignorant collector anxious to avoid any suspicion that he neglected filthy water. But he was quite unable either to see that every type of breeding-place found was regularly sampled or to instruct the collectors personally in the art of finding larvae in large areas of water over which they might be dispersed; and it is probably on this account that no species known to transmit malaria has been revealed in the collections made either by the corporation kerosening-coolies or by the collectors subsequently employed by the Museum; for it is well known that these mosquitoes breed in clean water. With regard to the second defect mentioned above, it may be pointed out that just as different species of wild animals differ in their ability to thrive in captivity so some species of mosquito develop in captivity more readily than others, and although identifications ought to be checked by rearing up the larvae, they ought always, in the first instance, to be based on the larvae and pupae themselves; for otherwise there is a danger that some species may be completely overlooked owing to their inability to develop under the conditions to which they are subjected. To have done this, however, it would have been necessary for Mr. Paiva to devote the whole of his time to the work at the actual time when the survey was in progress, and this it was impossible for him to do; in addition to which, at the

commencement of the survey, the Museum did not possess a collection of properly named mosquito larvae on which he could have based his identifications. Such a collection has now been formed, both of the common species obtained during the survey, and of some of those found in Calcutta tanks; and I should like to take this opportunity of thanking Major Christophers, I.M.S., and Capt. Davys, I.M.S., for the assistance they have given me by sending isolated larval and pupal skins, together with the adults which emerged from them, of several species not common in Calcutta. But the absence of Mr. Paiva on medical certificate, an absence which will certainly be of long duration and from which it is very doubtful whether it will ever be safe for him to return, has rendered it impossible for the Museum to undertake, as had been hoped might be made possible, a second and more thorough survey on the lines indicated above. And it is in the hope that the experience and unavoidably imperfect results of what has already been done may be of use to others that the present paper has been compiled.—F. H. GRAVELY, Asst. Supdt., Indian Museum.]

Early in October 1909, the Calcutta Corporation commenced the destruction of mosquito larvae in that part of the town locally known as the "Fringe Area," and as it was important to know what species abounded in that area, living specimens of larvae were daily sent to the Indian Museum from every spot which was visited, together with the precise locality and breeding ground of these larvae.

Larvae were received with considerable regularity but for two interruptions which were occasioned by the Durga Puja and Christmas vacations. The larvae were successfully reared in the Museum, and the mosquitoes that emerged from each batch were carefully pinned and labelled. After a large number had been collected, I identified them to the best of my ability.

The Calcutta Corporation stopped the supply of mosquito larvae on the 26th February 1910, without previously informing the Museum authorities that the work was not to be carried on any longer by them. As it was the intention of the authorities of the Museum to carry on the breeding of mosquito larvae for a complete year, arrangements had to be made to secure men to collect larvae during the remaining period, *i.e.*, till the first week of October 1910. It was an extremely difficult task to secure really reliable men for the work and this caused an interruption of a little more than three weeks. On the 22nd March 1910, the work of collecting larvae commenced again, and after several changes of collectors, two men were finally selected for the work. In a short time the daily supply of larvae became enormous and consequently very large numbers of mosquitoes emerged daily. These could not all be pinned, so they were killed and put into separate pill-boxes and after all the mosquitoes had been thus duly arranged, I counted and identified them and made the necessary entries in a rough register. Thus did the work continue till the beginning of October 1911.

In the early part of the survey, I did not think it necessary to separate the *Culex* with the unbanded proboscis from those with the banded proboscis, but later on I considered it advisable to keep them separate. Hence it will be seen that from March 22nd 1910, the two forms are given as *Culex* A (unbanded proboscis) and *Culex* B (banded proboscis).

The following species were bred during the twelve months of the survey:—

Culex A.

Culex B.

Culex concolor, Desv.

Leucomyia gelida, Theob.

Stegomyia scutellaris, L.

Stegomyia fasciata, Fab.

Desvoidea obturbans, Wlk., and varieties.

Toxorhynchites immisericors, Wlk.

Myzomyia rossii, Giles.

Myzomyia ludlowi, Theob.

The area dealt with in the survey has been divided into ten districts which are briefly defined and described in Table I.

Table II gives full particulars of the work done during the year. Each column represents a fortnight's work; Roman figures are used to indicate the districts from which the various larvae were brought in; and the actual number of adults that emerged is shown by Arabic figures in brackets.

In the next three Tables (III, IV and V) the breeding habits for the three principal seasons are compared:—viz. the "hot," "rainy" and "cold" seasons.

The hot season in Calcutta generally commences early in March and extends at least to the end of May or the beginning of June. There are occasional showers of rain during this period, but mosquitoes do not find much stagnant water about to encourage the breeding of larvae. Some species however are rather common at this time of the year.

The rainy season commences in June or July and ends after the 15th of October. At this time water is most plentiful and hence it is the most suitable period for the breeding of mosquito larvae.

The cold season starts in November and lasts till the end of February at latest. There is very little or no rain during this time and mosquitoes do not seem to be so plentiful.

It is generally during the cold season that the Calcutta Corporation undertakes the destruction of mosquito larvae. A more suitable time of the year for this kind of work would perhaps be the rainy season as during that time larvae are found in abundance in all kinds of situations, and mosquitoes are most common then. The constant rain may render it difficult to do this work satisfactorily however.

The most common situation in which larvae were found during the rainy season was in earthen pots, except in the case of one species (*Myzomyia rossii*) which was found chiefly in open drains, but during the other two seasons, tanks, open drains, cisterns, cesspools and earthen pots were all utilized as breeding places with about equal frequency. Other artificial collections of water, such as that in tubs, metal cans, iron and earthen pans also served as breeding places, but did not seem to be patronized very much by mosquitoes; probably because some of these were less common, whilst others, being shallow, quickly dried up. In one instance, a canal served as a breeding place for *Myzomyia rossii*.

Table VI shows the number of specimens of each species that emerged during each of the three different seasons and their relative percentage. It will be seen that *Culex A* was the most abundant mosquito in all the seasons. *Myzomyia rossii* was commoner during the hot and rainy seasons than during the cold weather. The largest number of mosquitoes emerged during the rainy season, being as much as 69.9% of the year's total, clearly indicating that the larvae were more easy to obtain at this time than at any other.

The larvae of *Culex A* were found mostly in open drains during all the seasons.

Larvae of *Culex B* were found in about equal proportion in tanks, open drains and earthen pots during the rainy season, and in open drains during the hot season.

Culex A (with the proboscis unbanded) belongs rightly to the *fatigans* group of that genus, and I have noticed all varieties, both in respect to size and markings, emerge from a batch of larvae collected at one time from a single piece of water.

The forms of *Culex* with the banded proboscis (*Culex B*) belong to the *impellens* group.

These were the only two forms of the smaller species of *Culex* which emerged from larvae received during the year's survey.

Larvae of *Culex concolor*, Desv., were not very plentiful and were chiefly found during the rainy season in small collections of water, viz., cesspools, tubs, iron pans and earthen pots, in company with larvae of *Culex* and *Stegomyia*. These larvae are of carnivorous habits and small collections of water are most suitable for them as they can easily capture any other larvae which may breed along with them in these situations.

Larvae of *Leucomyia gelida*, Theob., were only common during the rains, and were obtained chiefly from earthen pots, although some were got from tanks and open drains. This species appears to be entirely absent in the "Fringe Area" during the other two seasons.

Larvae of *Stegomyia scutellaris*, L., were procured in very large numbers during the three seasons from earthen pots, but chiefly during the rains.

During the other two seasons larvae were obtained from open drains and metal cans as well.

Larvae of *Stegomyia fasciata*, Fab., like *S. scutellaris*, were obtained mostly from earthen pots. These two species generally choose small collections of stagnant water to breed in. They will never be found to breed in any foul-smelling water, at least this is what I have observed. They do not seem to like muddy water either.

S. scutellaris and *S. fasciata* are the two principal mosquitoes which are such a source of annoyance in Calcutta during the day. They are purely day feeders and I have never yet caught one in a room after it has become dark.

Larvae of *Desvoidia obturbans*, Wlk., were found in cesspools and earthen pots during all the seasons, and during the cold season were very plentiful in open drains, which apparently contained foul stagnant water. The larvae of this species find cesspools very suitable for breeding. They seem to thrive in foul water.

Larvae of *Toxorhynchites immisericors*, Wlk., breed chiefly in earthen pots and were found in fairly large numbers in such situations during the rainy season. During the other two seasons very few were obtained.

Larvae of *Myzomyia rossii*, Giles, found open drains most suitable during the rainy season, but during the other two seasons they were very numerous in tanks as well.

Larvae of *Myzomyia ludlowi*, Theob., were most common during the rainy and cold seasons, scarcely any having been got during the hot season. Their principal breeding grounds were open drains and earthen pots.

The last two species closely resemble one another. The only constant difference between *M. ludlowi* and *M. rossii* is that in the former the legs are speckled, and it is doubtful, as Theobald suggests in vol. v of his "Monograph of the Culicidae of the World," whether it is really more than a variety. Theobald still retains *ludlowi* in the genus *Myzomyia*, but Maj. S. P. James, I.M.S., now regards it the type of a new genus.

Table VII indicates the difference between the proportion in which the various kinds of breeding places are utilized in different localities. This may perhaps be due in some degree to selection on the part of the collectors; but I do not think that it can be entirely accounted for in this way, in which case a difference in the relative abundance of the various kinds of breeding places in the different districts is indicated.

Earthen pots in most cases proved to be the most usual breeding places. In some cases open drains were found to be equally suitable.

Earthen pots were quite common in districts i, ii, iii, vi, viii, ix and x. Larvae of every species found during the survey were taken from earthen pots, especially during the rainy season.

District vi gave the largest number of mosquito larvae, then came districts i, ii, viii, ix, x, iii, vii, iv and v according to the number of larvae found in each district.

From the foregoing remarks it will be seen that not a single specimen of the larvae of any species known to carry malaria has been found in the fringe area, where malaria is most common as far as Calcutta is concerned. Adults of some of these species are to be found in houses in the fringe area when carefully searched for but they must either breed beyond the limits of the area, or in comparatively large areas of water where the collectors did not make proper investigations



TABLE I.¹

I. Bounded by Circular Canal, Maniktala Road and Upper Circular Road. Includes many oil mills, rope factories, flour mills and bustees ; tanks very numerous, some of them clean and others dirty.

II. Bounded by Maniktala Road, Circular Canal, Beliaghata Road, and Upper Circular Road. Includes Sealdah station with its extensive railway yards, a large gas works, a large flour mill, an ice factory, and bustees. There is one tank which is covered with weeds.

III. Bounded by Beliaghata Road, Circular Canal, Beliaghata Canal, Convent Road, Middle Road Entally, and Lower Circular Road. Includes Beliaghata railway station, railway workshops, pumping station, Campbell Hospital with a big clean tank in its grounds, a big dirty tank covered with green slime and water lilies, and ground for entraining rubbish ; the rest is composed of bustees with the exception of a small European quarter in the south.

IV Bounded by Beliaghata Canal, Kankurgachi Chord (E.B.S. Ry.), the line to Diamond Harbour, and Convent Road. Includes a small canal of very dirty smelling water running close behind a slaughter-house, and the Roman Catholic Orphanage with open grounds and a clean tank ; all the rest is covered with bustees and small tanks.

V Bounded by Beliaghata Canal, the Municipal Boundary, New Tengra Road, and Tengra Road. Includes continuation of dirty canal found in District IV, with some brackish water tanks to the north of it, many hide godowns, tanneries, etc., and some bustees.

VI. Bounded by Middle Road Entally, the line to Diamond Harbour, Tiljalla First Lane, Karaia Road, and Lower Circular Road. Includes European quarter, cemetery, etc., on the west ; all the rest of the district is occupied by bustees with numerous tanks covered with green slime, and a few tanneries in the south-east.

VII. Bounded by Kankurgachi Chord (E.B.S. Ry.), Tengra Road, New Tengra Road, and Municipal boundary (Topsi Road and Tiljalla Road). Includes Mohammedan cemeteries and bustees with tanks covered with green slime on the west, and more open country on the east.

¹ This table has been compiled, since Mr. Paiva left Calcutta, with the assistance of Mr. Hodgart, who made the necessary investigations; previously it had been thought that a map would perhaps have been sufficient. -- F. H. G.

TABLE I—*continued*.

VIII. Bounded by Beck Bagan Bazaar Lane, Tiljalla First Lane, Molvi Ahmad Khan Bahadur's Road, E.B.S. Railway, Garcha Road, Hazra Road, Ballygunge Circular Road. Includes European quarters and a few bustees ; many tanks both clean and dirty.

IX. Bounded by Lower Circular Road, Ballygunge Circular Road, Hazra Road and Russa Road. Includes Port Trust Offices with small depôts for coolies, large European quarter, and a few bustees ; many tanks, both clean and dirty.

X. Bounded by Lower Circular Road, Russa Road, Hazra Road, Tolly's Nulla, and Bhawanipur Road. Includes General Hospital, Lunatic Asylum, European quarter, and bustees ; there are a few tanks, these including a large municipal tank which is clean and free from weeds.

Rains

TABLE IV.

June to October.

	Tank.	Open drain	Cistern.	Cesspool.	Tub.	Metal can.	Iron pan.	Earthen pot.	Hollow in a piece of wood.	Canal.	Earthen pan.	Total.
<i>Culex A (fatigans group) ..</i>	2.5%	40.7%	2.5%	10.6%	2.7%	3.2%	7.2%	30 %	..	..	..	99.4
<i>Culex B (impellens group) ..</i>	24.4%	26.1%	..	6.7%	5.4%	..	4 %	33.2%			..	99.8
<i>Culex concolor.</i>		8.8%	..	13.2%	25 %	..	23.5%	29.4%	..	..	..	99.9
<i>Leucomyia gelida ..</i>	27.3%	16.4%	1.3%		..	..		54.7%	..	..		99.7
<i>Stegomyia scutellaris ..</i>	..	0.3%	1.4%		5.6%	3.4%	4.9%	83.3%	..		0.7%	99.6
<i>Stegomyia fasciata</i>	4.3%	4.8%	7.5%		16.8%	5.4%	2.7%	57.2%	..		0.9%	99.6
<i>Desvoidea obturbans ..</i>	3.1%	14.8%	1.6%	32%	0.4%	1 %	4.1%	42.8%		..		99.8
<i>Toxorhynchites immisericors ..</i>	..	1.7%		1.7%	15.5%	..		81 %		..	..	99.9
<i>Myzomyia rossii ..</i>	15.4%	59.5%	0.4%	0.7%	0.2%	1.6%	8.4%	13.3%		..	..	99.5
<i>Myzomyia ludlowi ..</i>	0.2%	47.1%	9.9%		3.9%	1.1%	..	37.6%	..			99.8

Cold Weather		TABLE V.										November to February.	
		Tank.	Open Drain.	Cistern.	Cess- pool.	Tub.	Metal can.	Iron pan.	Earthen pot.	Hollow in a piece of wood.	Canal.	Earthen pan.	Total.
Culex A and B ..	7.4%	79.1%	0.2%	0.2%	..	2.8%			10 %		..	..	99.7
Culex concolor..	..	..	..	..	..	..	..	..	..	..	..	..	..
Leucomyia gelida ..	..	..	..	..	..	..	..	..	..	..	..	..	..
Stegomyia scutellaris ..	25 %	..	..	..	..	18.7%	..	56.2%	..	..	..	..	99.9
Stegomyia fasciata ..	8.9%	13.9%	1.6%	..	..	11.4%	..	63.5%	..	..	..	..	99.3
Desvoidea obturbans ..	0.4%	54 %	..	15.3%		4 %		29.8%	..	..	..	..	99.5
Toxorhynchites immisericors ..	..	..	..	..	..	..	..	..	..	..	..	..	..
Myzomyia rossii ..	47.5%	34.9%	..	..		0.6%	..	16.7%	..	..	..	..	99.7
Myzomyia ludlowi ..		71.4%	..	..	..	..	..	28.5%	..				99.9

TABLE VI.

				MARCH TO MAY.		JUNE TO OCTOBER.		NOVEMBER TO FEBRUARY.		Total for the year.
				Total.	Seasonal Percentage.	Total.	Seasonal Percentage.	Total.	Seasonal Percentage.	
Culex A	..	..	..	3,830	55.3%	8,201	47.1%	} 982	59.8%	13,013
Culex B	..	..	..	54	0.7%	475	2.7%			529
Culex concolor	..	..	..	..	..	68	0.3%			69
Leucomyia gelida	..	..	..	..	..	73	0.4%	6	0.3%	79
Stegomyia scutellaris	..			36	0.5%	1,277	7.3%	16	0.9%	1,329
Stegomyia fasciata	..			385	5.5%	1,760	10.1%	236	14.3%	2,381
Desvoidea obturbans	..	..		89	1.2%	2,587	14.8%	248	15.1%	2,924
Toxorhynchites immisericors	..			1	..	58	0.3%	1	..	60
Myzomyia rossii	..	..	..	2,523	36.4%	2,527	14.7%	143	8.7%	5,193
Myzomyia ludlowi	..	..		5	..	356	2 %	7	0.4%	368
Total				6,923	99.6%	17,382	99.7%	1,640	99.5%	25,945
Percentage for the year				26.7%		66.9%		6.3%		99.9%

TABLE VII.

District.	Tank.	Open Drain	Cistern.	Cesspool.	Tub.	Metal can.	Iron pan.	Earthen pot.	Hollow in a piece of wood.	Canal.	Earthen pan.	Totals %
I ..	9(5.6%)	35(21.8%)	8(5%)	9(5.6%)	17(10.5%)	13(8.1%)	5(3.1%)	60(37.5%)	..	1(0.5%)	3(1.8%)	160 (99.5)
II	10(8.2%)	38(31.4%)	12(9.9)	4(3.3%)	4(3.3%)	1(0.8%)	6(4.9%)	44(36.3%)	..	..	2(1.6%)	121 (99.7)
III	14(18.4%)	25(32.9%)	..	5(6.5%)	1(1.3%)	..	3(3.9%)	28(36.8%)	..	..	..	76 (99.8)
IV	5(10.8%)	20(43.4%)	2(4.3%)	2(4.3%)	..	..	1(2.1%)	16(34.8%)	..	..	..	46 (99.7)
V ..	2(25%)	2(25%)	1(12.5%)	1(12.5%)	..	..	..	2(25%)	..	..	..	8 (100)
VI	25(12.7%)	51(26%)	12(6.1%)	12(6.1%)	20(10.2%)	12(6.1%)	14(7.1%)	48(24.4%)	1(0.5%)	..	1(0.5%)	196 (99.7)
VII ..	10(20.2%)	16(32.7%)	1(2%)	2(4%)	2(4%)	1(2%)	..	17(34.7%)	..	..	..	49 (99.6)
VIII ..	11(9.5%)	38(33%)	11(9.5%)	9(7.8%)	6(5.2%)	1(0.8%)	10(8.6%)	29(25.2%)	..	..	..	115 (99.6)
IX ..	11(11.5%)	17(17.8%)	1(1%)	3(3.1%)	12(12.6%)	6(6.3%)	11(11.5%)	34(35.7%)	..	..	..	95 (99.5)
X ..	2(2.6%)	15(19.7%)	6(7.8%)	3(3.9%)	3(3.9%)	5(6.5%)	9(11.8%)	33(43.4%)	..	..	..	76 (99.6)

IX. NOTES ON FRESHWATER SPONGES.

By N. ANNANDALE, D.Sc., F.A.S.B., Superintendent,
Indian Museum.

XIV.—THE GENERIC POSITION OF "*Spongilla ultima*."

In describing the species which I called *Spongilla ultima* I was struck by its resemblance in general structure to those which I assigned to the genus *Corvospongilla* (see *Faun. Brit. Ind., Freshwater Sponges*, etc., pp. 105, 122, figs. 19, 26), but as I failed to find in the parenchyma of the original specimens a single birotulate flesh-spicule, the species was inevitably assigned to *Spongilla*. During a recent visit to Tanjore in the Trichinopoly district of the Madras Presidency I obtained a sponge which agreed closely in most characters with "*Spongilla*" *ultima* but contained many such flesh-spicules. A fresh examination of the type specimen was therefore made and, after much hunting, a birotulate spicule was found, closely resembling those of *Corvospongilla lapidosa*. Moreover, specimens of *C. ultima* sent me from Travancore still more recently contain many birotulate flesh-spicules. It is evident, therefore, that these sponges are specifically identical and should be assigned to *Corvospongilla*. The birotulate spicules of this genus are often so few in number that great difficulty is experienced in finding them, and it is by no means improbable that other freshwater sponges of hard consistency and with gemmules in which the spicules are arranged horizontally may ultimately, on a critical examination of fresh material, have to be assigned to *Corvospongilla*. The Tanjore specimens of *C. ultima* were growing on the edge of a concrete basin which formed the outflow of an irrigation-channel full of very muddy water. They were almost black in colour and grew out from their support in flattened leaf-like expansions, some of which were divided horizontally into two thin layers by a chitinous membrane. The gemmule-spicules were not quite so irregular or heterogeneous as those of the original specimens, which were from Cape Comorin, but very few gemmules were found and it is probable that at the season at which the specimens were taken (October) the outer layer of spicules was not fully formed. The newly acquired Travancore specimens were taken in July and have well formed gemmules.

I take this opportunity to correct another error in my volume in the "*Fauna*." On pp. 54 and 121 it is stated or implied that the megascleres of the Bornean sponge *Tubella vesparium* are spiny. They are perfectly smooth and are distinguished from those of the Burmese *T. vesparioides* by their stouter form.

X. NOTES ON PEDIPALPI IN THE COLLECTION OF THE INDIAN MUSEUM.

By F. H. GRAVELY, *M.Sc.*, Assistant Superintendent, Indian Museum.

III.—SOME NEW AND IMPERFECTLY KNOWN SPECIES OF HYPOCTONUS.

With the exception of *H. andersoni*, Oates, and *H. stoliczkae*, n. sp., all the specimens on which the following descriptions are based have been added to our collection during the last year. Figures will be published in a subsequent paper dealing with the Oriental Pedipalpi as a whole, in which also I propose to discuss generic definitions in the light of the facts here published.

A.—Species with tibial spurs on the last pair of legs only.

H. dawnae, n. sp.

This species is abundant on the eastern slope of the Dawna hills in the Amherst District of Lower Burma from Sukli near the top of the range to Thingannyinaung at the bottom. I obtained a single specimen from Misty Hollow near the top of the western slope. It may, perhaps, be found over the whole of both slopes in the rains.¹ The presence of a distinct though faint and incomplete ridge between the eyes might seem to indicate that the species ought to be placed in the genus *Thelyphonus*. In all other respects, however, it is a typical *Hypoctonus*. The form of the tibial apophysis of the male especially is that of a *Hypoctonus* and not a *Thelyphonus*.

Description.—♂ Length of carapace 9.5–10.5 mm., maximum breadth 5.5–6 mm. Colour black above, with reddish-brown legs; beneath the body and arms are redder though darker than the legs. Carapace usually smooth in front and at the sides, more or less transversely rugose behind the median pair of eyes which eyes are separated from one another by a ridge whose width is about equal to the diameter of each eye. Behind this rugose area two coarsely granular bands extend backwards, one on either side of a median furrow of varying distinctness, each of them separated by a somewhat narrower smooth band from a distinct though not very strong granular ridge which extends forwards from the lateral eyes towards the median ones as in the genus *Thelyphonus*, disappearing about halfway between the two. The whole of the posterior part

¹ My collections were made towards the end of November only.

of the carapace is granular. Terga of abdomen finely granular. Trochanters and femora of second to fourth legs and tibiae of fourth legs granular above, the femora becoming smooth distally. Abdominal sterna finely and closely granular at the sides, finely but less coarsely granular between the muscular impressions on the fifth and sixth (fourth and fifth visible) segments. Arm and hand normally smooth and polished throughout above with only a few sparse punctures.¹ Trochanter with five strong teeth above and two below, the space between these two sets of teeth armed with more or less distinct rows of small denticles; femur and tibia rather large, the former armed with a stout spine below and the latter with a more or less distinct denticle (sometimes obsolete) below and a conspicuous conical process (sometimes double) at the base of the apophysis above; apophysis triangular in section, broad and flat above, strongly grooved along the anterior face, truncate distally, upper anterior margin slightly concave, posterior margin slightly concave proximally slightly convex distally, the former margin meeting distal margin in an even curve, the latter in a dentiform acute angle, distal margin armed in addition with one spiniform tooth. Inner margin of hand denticulate throughout and concave at base of fixed finger; fixed finger denticulate on both sides; moveable finger long and evenly curved; hand armed at base of moveable finger with two stout spines of which the anterior is remarkably large. Foot of antenniform leg evidently very liable to injury and specimens with an abnormal number of joints on one side at least are abundant, the long terminal joint being apparently the first to be regenerated since it is always present when the appendage is healed; normally the joints are moderately long, but the proportions they bear to one another are not altogether constant.

♀ Size, colour, and general texture of integuments as in the male. Arm and hand much smaller than in male, tibial apophysis triangular, with a simple denticle at base, two more just below apex, and a row along anterior margin; second (i.e. first visible) abdominal sternum more than twice as broad as long, posterior margin slightly concave on either side, being moderately produced in the middle line with the convexity thus formed broadly rounded; impressions very faint, apparently four in number, one pair situated close together with another pair even fainter outside and slightly behind them tinged with a faint greyish streak; immediately behind the central pair the sternum is clouded with black; the concave portion of the posterior margin on either side of the median lobe and immediately behind the outer impressions is likewise blackened.

H. browni, n. sp.

The following description is based on the examination of a single specimen found by Mr. J. Coggin Brown at Parni, Monglong,

¹ In a single specimen the arm and hand are slightly dulled by a very fine rugosity which is most marked at the base of the tibial apophysis and fixed finger.

Hsipaw State, North Shan States, Upper Burma. The species is very closely allied to the preceding and may be only a variety of it; but until the male is found this question cannot be settled.

Description.—♂ Unknown.

♀ Length of carapace 8.5 mm., maximum breadth 5 mm. Texture of integuments as in *H. dawnae*, but with the median finely punctured areas of the fifth and sixth abdominal sterna very narrow. Legs of a much darker colour than in the preceding species, the coxae and trochanters above and the femora being almost black. Arm and hand as in the preceding species. Second (first visible) abdominal sternum a little less produced behind than in that species, the posterior margin being almost straight on each side instead of distinctly concave, otherwise the same

H. andersoni (Oates).

No specimen of this species appears to have been found since Oates originally described it from two specimens obtained by the Yunnan Expedition. The badly mutilated specimen which he described as the female cannot, I think, be mature, and the female of the species must be regarded as still unknown, the description of an immature specimen of *Hypoctonus* being worthless.

The male, as is well shown in Oates' figure (1889, pl. II, fig. 12) is one of the most distinct species hitherto described (though closely allied to *H. ellisi* described below), and it is difficult to see how Kraepelin (1897, p. 49, and 1899, p. 231) could possibly come to regard it as a variety of *H. formosus*. In reality it must be classed with Kraepelin's *H. gastrotrichus* on account of the presence of tibial spurs on the last pair of legs only.¹ As Oates

¹ *H. kraepelini*, Simon, also belongs to this group. Simon's description of this species (1901, pp. 77-8) is inadequate and his statement that it is closely related to *H. saxatilis*—more so, one is led to assume, than to any other known species—is misleading. The type specimens (one mature specimen and several young) from Bukit Goah, in the State of Jalor (Siamese Malay States) at an altitude of less than five hundred feet above sea level [I am indebted to Dr. Annandale for the correct spelling of this locality together with information as to the altitude at which he obtained the specimens], have been sent me for examination by Mr. Doncastor, the Curator of the Cambridge Museum, to the collections of which they belong; they may be redescribed as follows:—

♀ Length of carapace 11 mm., maximum breadth of carapace 6 mm. Carapace more extensively granular and rugose than in *H. ellisi* (see below), granulation of legs weaker. Colour much as in that species but slightly darker. Arm and hand resembling those of the female of *H. ellisi* in all points except that the tibia and hand are somewhat more elongated, each being about 1½ times as long as broad. The outermost tooth of the trochanter of the right arm is double in the only mature specimen I have seen, but this is no doubt an abnormality—it does not occur either in the left arm or in any of the young specimens. Second, (i.e. first visible) abdominal sternum about twice as broad as long, posterior margin on each side perceptibly but very slightly more concave than in *H. ellisi*, the rounded middle portion somewhat less obtuse but scarcely produced, impressions very obscure, apparently four in number arranged in a curve opposite the rounded middle portion of the posterior margin with which they enclose a broadly *navicula*-shaped area, the outer pair of impressions tinged with black. Tibial spurs confined to last pair of legs except in the one mature specimen in which one is also present on the second (but not third) right (but not left) leg, which is clearly an abnormality.

makes no mention of this feature and as only the female of *H. gastrotrichus* is known, it is not to be wondered at that Pocock (1900), though he refused to follow Kraepelin in regarding *H. andersoni* as a variety, did not succeed in placing it correctly.

H. ellisi, n. sp.

Mr. C. E. Milner, of the Indian Forest Service, to whom I wrote in the hope of obtaining the unknown female of *H. sylvaticus*, sent me some time ago six specimens of *Hypoctonus* collected by Mr. Ellis in the Zigon Division (Burma) under rocks during blasting operations in connection with a road in the Yoma north-east of Zigon town. Three of these proved to be *H. sylvaticus*, whilst three (one male and two females) belong to a new species closely allied to *H. andersoni*.

Description—♂ Length of carapace 8 mm., maximum breadth 4.5 mm.; colour of body and arms dark brown above, that of legs pale brown; surface of carapace smooth at sides and transversely rugose in middle in front of lateral eyes, finely granular throughout behind, incompletely grooved in the middle line; terga of abdomen finely granular throughout; trochanters and femora of 2—4th legs and tibiae of 4th legs finely granular above; anterior half of hand finely granular below; posterior lateral angles of 1st, whole of 2nd, 3rd and 4th, sides of 6—8th visible abdominal sterna finely and closely punctured and more or less transversely striate; rest of surface of body and appendages smooth and polished or sparsely punctured. Arm with a conspicuous denticle dorsal to the coxal process which is rather long and slender; upper margin of trochanter entirely without teeth, anterior surface with two or three vertical rows of denticles, one obsolete tooth on lower margin; femur very sparsely punctured, rather slender, its free inner edge about equal to anterior margin of trochanter, one obsolete denticle on lower side; tibia also very sparsely punctured, stem of tibial apophysis slender, lightly curved in the middle, expanded on the anterior edge of the upper side at first gradually then very abruptly into a flattened and downwardly curved blade which ends abruptly just before the narrow pointed extremity, lower edge of posterior side likewise expanded below the tip but thicker and the expansion nowhere abrupt; hind margin of dorsal expansion not produced backwards as in *H. andersoni*. Hand somewhat massive; fixed finger very broad, its inner margin strongly convex with the distal half very hairy, outer border finely denticulate; moveable finger with strongly curved and somewhat hairy basal portion, grooved along upper and lower and less strongly along outer margin, and followed by an abruptly defined distal portion which is straighter, slenderer, smoother, and sharply pointed at its extremity.

♀ Length of carapace 9.0—9.5 mm., maximum width of same 5.0 mm. Colour, granulation, etc. as in male except for absence of all granules from lower surface of hand. Coxal process of arm shorter than in the male, with denticles above it less

conspicuous; trochanter with five long marginal teeth above and two stouter ones below, anterior surface with rows of denticles as in male; femur much shorter than in male, armed with one tooth on lower surface, with or without a smaller one above; tibia and hand each about as broad as long, former larger than latter; tibia with one tooth above at base of apophysis and one below close to anterior margin; hand with two teeth below, the anterior and larger one close to anterior margin, the other immediately behind it; tibial apophysis with two teeth on posterior side near apex, very strongly toothed on anterior side; inner side of hand (including fixed finger), hardly perceptibly concave, toothed throughout except close to base and distal extremity, appposable margins of both fingers more finely denticulate except distally where they are smooth, moveable finger shorter and less strongly curved than in male, its lower margin strongly denticulate. Second (i.e. first visible) abdominal sternum twice as broad as long, posterior margin not produced, being practically straight on each side and very obtusely rounded in the middle; anterior margin raised up to form a strong transverse ridge in front of a pair of large and deep circular pits situated not far from one another on either side of the middle line.

B.—Species with tibial spurs on both third and fourth pairs of legs.

H. oatesii, Poc.

Of this species only the male has as yet been described. Mr. G. Mackrell of the Lungla (Sylhet) Tea Co. has however succeeded in obtaining both sexes for me from Shamsbernager, Sylhet, at an altitude of about 100 feet.

Description.—♂ See Pocock, 1900, pp. 112—3.

♀ Length of thorax 10 mm., maximum breadth 5.5. Colour and texture of integuments as in male, except that the arms are not so strongly granular and the anterior abdominal sterna are not rugose at the sides. Trochanter as in male but with teeth of upper margin longer and sharper, the anterior margin moreover meeting the inner margin in a somewhat sharper angle. Femur much shorter than in male, armed with one small tooth above and one long one below; tibia and hand as in female of *H. ellisi*. Second (i.e. first visible) abdominal sternum scarcely half as long as broad, posterior margin not abruptly produced in middle; one pair of distinct circular impressions present.

H. sylvaticus, Oates.

Of this species only the male has as yet been described. I am indebted to Mr. C. E. Milner for specimens of both sexes which were captured for him by Mr. Ellis under rocks in the Zigon Division (Burma) in the Yoma N. E. of Zigon town during blasting operations in connection with a road.

Description.—♂ See Oates, 1889, pp. 18—9, and Pocock, 1900, pp. 115—6.

The colour of the legs of the Indian Museum specimen are uniformly pale as in *H. saxatilis*, but the specimen agrees perfectly with *H. sylvaticus* and not with *H. saxatilis* in structure.¹

♀ Length of carapace 9.0—9.5 mm.; maximum breadth 5 mm. Colour and texture of integuments as in the male except for the absence of any sign of the extraordinary rugosity of the sides of the anterior abdominal sterna found in that sex. Trochanter of arm with five distinct teeth above and two below; femur shorter than in male, armed with several strong granules on the inner side above and one tooth below; tibia and hand as in the preceding species. Second (i.e. first visible) abdominal sternum scarcely half as long as broad, distinctly and more or less abruptly produced in the middle; one pair of distinct but very broad and shallow circular impressions present.

H. stoliczkae, n. sp.

The three specimens (♂, ♀, and juv.) from which this species is described are all from Punkarbari, and are apparently those from that locality referred to by Stoliczka (1873, pp. 127 and 134—136) under the name *Thelyphonus* (conf.) *angustus*. Oates (1889, p. 6) states that these are referable to the young of *Uroproctus assamensis*, a species which they resemble in the presence of a tooth on the inner side of each coxal process of the arm. Of the ridge between the median and lateral eyes there is however no trace. As the species is obviously related to forms belonging to the Burmese genus *Hypoctonus* (especially *H. wood-masoni*) and not to those of the South Indian genus *Labochirus* I have referred it to the genus *Hypoctonus* in spite of the presence of teeth on the coxal process, although this will necessitate a revision of the generic definition.

Description.—♂ Length of thorax 12 mm., maximum breadth 7 mm. Colour dark brown throughout. Carapace granular (almost spinulose) throughout, granules coarser in front than behind; trochanters and femora of 2—4th legs and tibia of 4th legs granular above; arms, except their coxae which are striate and sparsely punctured, and inner side of remaining joints strongly granular, abdominal terga also granular throughout; abdominal sterna granular at sides only, those of the first three ventrally visible segments being much more coarsely marked than the rest and almost rugose. Coxal process of arms with one or two² more or less distinct teeth on the inner margin near the apex and sometimes one on the outer margin also, one tooth also dorsal to base of coxal process; trochanter armed with one or two teeth below and five somewhat obscure teeth above, anterior surface with rows of denticles; femur moderately stout, its free inner margin

¹ This is not the only case in which I have found the colour of the legs to be misleading. Structure I believe to be alone reliable.

² The two arms of the single specimen before me differ greatly in the extent to which they are armed with spines and teeth.

quite as long as anterior margin of trochanter, with or without one strong tooth below; tibia about as wide as long, stouter than femur, one small tooth below close to anterior margin at base of moveable finger, front margin oblique, the inner side above being about $1\frac{1}{2}$ times as long as the outer; posterior side of tibial apophysis curved, slightly expanded dorso-ventrally at the end, lower anterior margin produced towards the hand to form an extensive plate widening gradually from its commencement at about $\frac{1}{3}$ of the distance from the base of the apophysis to its extremity and terminated abruptly a little before the end. Hand very thick, dorso-ventrally on the outer side; inner side thin, widely excavate at base of fixed finger, the excavation exactly fitting the ventral plate-like expansion of the anterior margin of the tibial apophysis when the two are brought together; fixed finger broad, roughly parallel-sided, almost vertically truncate distally; moveable finger evenly curved, the apex crossing beneath the moveable finger when closed, and apposable to extremity of plate-like expansion of tibial apophysis.

♀ Length of cephalothorax 10 mm., maximum breadth of same 6 mm., colour much paler than in male¹ and granulation weaker throughout. Coxal process of arm as in male; trochanter with marginal teeth well developed; femur thinner and proportionally shorter than in male, armed with one weak tooth above and one very strong one below; tibia and hand scarcely longer than broad, armed as in *H. ellisi*, *H. wood-masoni*, etc. Second (first visible) abdominal sternum about twice as broad as long, middle of posterior margin somewhat abruptly produced, surface traversed by a fine groove extending slightly forwards across the middle-line from about the middle of each half of this margin, a single pair of moderately distinct circular impressions situated about half-way between this groove and the anterior margin of the segment.

IV NEW ORIENTAL TARTARIDES.

Schizomus (s. str.) *cavernicola*.

Locality.—This species lives under stones in the depths of the larger of the two famous Farm or Khayon caves near Moulmein where I obtained two specimens, both adult females. I also saw, but failed to capture, some immature specimens, probably of the same species, that were living under stones in a crevice which forms the approach to an upper entrance of the small cave.

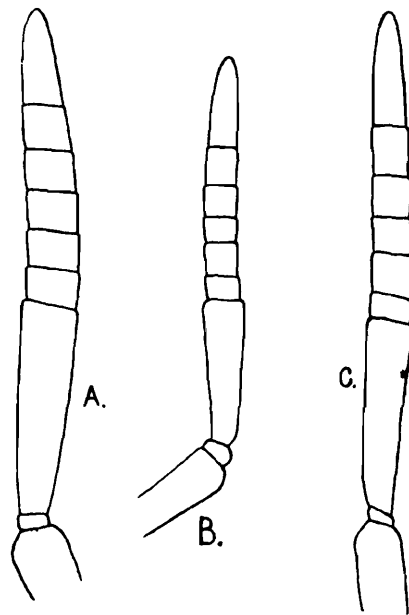
♂ Unknown.

¹ I believe that the colour of these animals is to some extent affected not only by age and by the recency of the last moult but also by the mode of preservation (e.g. the strength and nature of the spirit) employed. In the present instance, however, in view of the small size of this specimen in comparison with the male, it probably indicates that the specimen is scarcely mature; distinctive characters of the anterior abdominal sterna are already developed but they will probably be found to be intensified in perfectly matured specimens.

♀ *Cephalothorax*.—A well-defined pair of white eye-spots present: cephalic sternum about two-thirds as broad as long.

Arms.—Slightly less than half as long as the body. Anterior margin of lower part of trochanter straight or slightly concave, meeting lower margin in an angle of about 60° . The lower angle of the femur about equidistant from basal and distal ends of the upper margin of the joint or a trifle nearer to the former than to the latter. Patella a little more than twice as long as deep; claw about half as long as upper margin of tarsus.

First legs.—Very long and slender, nearly half as long again as body. Coxa terminating behind base of trochanter of arm. Femur a little longer than tibia, tibia a little longer than foot (about one third as long again). Foot nine or ten times as long as



Foot of first leg of new Oriental Tartarides $\times 60$.

- A. *Schizomus* (s. str.) *cavernicola* ♀.
- B. *Schizomus* (*Trithyreus*) *greeni* ♀.
- C. *Schizomus* (*Trithyreus*) *kharagpurensis* ♀.

deep, deepest at end of metatarsus; second metatarsus a little longer than sum of five proximal tarsal joints; terminal tarsal joint not quite as long as sum of three proximal joints and about two-fifths the length of the whole metatarsus.

Fourth legs.—About as long as body; femur two-fifths as deep as long.

Tail.—Short and stout, little more than three times as long as deep, four-jointed, the two proximal joints together about three-fifths or a half of the length of the two distal joints together.

Colour.—The general colour is grey-green, paler below than above. The membranes between the sclerites are white and very conspicuous as in *S. (Trithyreus) vittatus*, although the sclerites are not as dark as in that species. The distal part of the chelicerae but not of the other appendages is reddish brown.

Length.—About 4 mm.

This species is not very closely related to any hitherto described. It resembles Simon's *a* group in the proportions of the claw of the arm and the foot of the first leg, but not in those of the tail.

Schizomus (s. str.), n. sp.

Locality.—Chaibassa, where a single immature specimen was obtained among stones on the shaded side of an old quarry. I do not think it advisable to describe this species till mature specimens are found.

Schizomus (Trithyreus) greeni, n. sp.

Localities.—Mr. E. E. Green found the type specimen under a stone at Ambalangoda, S. Province, Ceylon, in company with *Amitermes quadriceps*. He has also sent me a specimen caught in the compound of the Museum, Colombo, on July 20th, 1911.

♂. Unknown.

♀ *Cephalothorax*.—Eye-spots absent; cephalic sternum rather more than three-fifths as wide as long.

Arms.—About half as long as body. Trochanter with lower front angle (about 120°) rounded and inconspicuous, anterior margin convex. Lower angle of femur also inconspicuous, about equidistant from basal and distal ends of upper margin. Patella rather more than twice as long as deep (about two and a half times). Claw scarcely half as long as upper margin of tarsus.

First legs.—About as long as body. Coxa terminating a little behind base of trochanter of arm. Femur somewhat longer than tibia. Foot about five-sixths as long as tibia, and about ten times as long as deep, deepest at end of metatarsus; second metatarsus scarcely as long as sum of first five joints of tarsus; terminal tarsal joint somewhat longer than three proximal tarsal joints together and quite two-thirds as long as whole metatarsus.

Fourth legs.—About as long as body; femur two-fifths as deep as long.

Tail.—Broken in both specimens.

Colour.—Brown.

Length.—About 3 mm.

This species seems to stand nearer to *S. (T.) modestus* than to any other included in Hansen's table (1905, pp. 51-3.)

Schizomus (Trithyreus) kharagpurensis, n. sp.

Locality.—Kharagpur in the Midnapore subdivision of Bengal where a single female was collected by Mr. Hodgart.

♂ Unknown.

♀ *Cephalothorax*.—Eye-spots absent; cephalic sternum about three quarters as broad as long.

Arms.—About three-fifths of the length of the body. Anterior margin of lower part of trochanter slightly convex, meeting lower margin in an obtuse angle (about 110°). Lower margin

of femur rounded. Patella about two-fifths as deep as long. Claw not quite half as long as upper margin of tarsus.

First legs.—Long and slender, slightly longer than body. Coxa terminating behind base of trochanter of arm. Femur slightly longer than tibia, tibia longer than foot. Foot about twelve times as long as deep, deepest at end of metatarsus; second metatarsus scarcely as long as sum of five proximal tarsal joints; terminal tarsal joint slightly longer than sum of three proximal tarsal joints, and about three-fifths of the length of the whole metatarsus.

Fourth legs.—Somewhat shorter than body; femur about two and a half times as long as deep.

Tail.—About six times as long as deep, four-jointed as in *Schizomus s. str.*, the distal joint about one and a half times as long as the sum of the three proximal ones.

Colour.—Brown.

Length.—About 4.5 mm.

This species differs from all hitherto described in the combination of a divided second thoracic tergite with a four-jointed tail; there seem moreover to be indications of a division of the long distal joint into two parts, though of this I am not certain.

Schizomus (Trithyreus), n. sp.

Locality.—Pass between Chaibassa and Chakardharpur in Chota Nagpur. I obtained a few immature specimens under stones in the bed of a small stream in the jungle.

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XI. DESCRIPTION OF A NEW SPECIES OF FRESHWATER CRAB FROM SOUTHERN INDIA

By J. R. HENDERSON, *M.B., F.L.S., Superintendent,
Madras Government Museum.*

PARATELPHUSA (LIOTELPHUSA) MALABARICA, N. SP.

Carapace moderately flat, its length about three-fourths the greatest breadth, its depth about half the length. Under a lens the surface is seen to be minutely pitted, and there are fine oblique striae near the lateral borders; the striae are faintest posteriorly, and behind the short antero-lateral border of the carapace they curve downwards and forwards on to the under-surface of the branchial area. The anterior striae are finely crenulated.

Cervical groove limited to a well-defined crescentic depression forming the posterior boundary of the mesogastric area; on either side of this crescent, about quarter of the way back from its tip, is a somewhat ill-defined groove, which passes backwards and outwards for a short distance. The post-frontal mesogastric furrow is well-defined, and faintly bifurcate posteriorly.

Front slightly more than two-fifths the greatest breadth of the carapace, strongly deflexed, and with the margin almost straight. Both the front and the upper orbital margin have a clearly defined elevated edge. Outer orbital angle moderately prominent; lower orbital margin elevated, and finely crenulated.

Antero-lateral borders of the carapace short, but well-defined, and faintly crenulated; lateral epibranchial tooth small and subacute.

Epigastric crests scarcely distinguishable as distinct elevations, but represented by oblique faintly eroded patches on either side of the mesogastric furrow. Post-orbital crests low, but fairly distinct, commencing at a point nearly behind the inner orbital angle.

Sixth segment of the male abdomen with its proximal and distal ends practically of equal width, but the segment slightly narrower towards the middle; the length of the segment is greater than its breadth.

Antennal flagellum very short.

Terminal joint of mandibular palp bilobed.

Exopodite of the external maxillipeds reaching the middle of the merus, and provided with a well developed flagellum. The ischium is smooth and not grooved, a very faint hollow, best seen at the proximal end, being the sole representative of the usual groove. The merus is much broader than long.

The chelipeds are unequal in the adult male, but not markedly so; in the female the disparity is but slight. The merus and carpus, particularly the former, are squamulose on the upper surface, while the hand is practically smooth; the spine at the inner angle of the carpus is well developed. The fingers in adult males are shorter than the palm, and somewhat unevenly toothed; they gape slightly when closed, while their tips are horny and somewhat blunt.

The legs are a little longer than the smaller cheliped, and their joints, particularly the three terminal ones, are beset with rows and tufts of setose hairs. The dactyli are armed, above and below, with yellow setose spines, a few of which are also seen on the propodi.

The colour of recent spirit specimens is bronze green above, with the undersurface and chelipeds yellowish. The distal halves of the fingers are pale brown.

Dimensions of the carapace in a male:—length 13 mm.; breadth 17 mm.; depth 6 mm.; width of front 6.5 mm. Dimensions of carapace in a female (the largest specimen taken):—length 16 mm.; breadth 21 mm.; depth 9 mm.; width of front 8 mm.

This species can be readily distinguished from the other species which Alcock (Catalogue of the Indian Decapod Crustacea in the collection of the Indian Museum, part I, fasciculus II, p. 109, 1910) assigns to his subgenus *Liotelphusa*. In *L. lævis* (Wood-Mason) from Assam, the carapace is more convex, the post-orbital crest is fainter, and the post-frontal groove shallower; the ischium of the external maxillipeds is longitudinally grooved, and the length of the sixth segment of the male abdomen just equals its distal breadth. From *L. austrina*, Alcock, the only species hitherto known to occur in Southern India, with which it agrees as regards the long sixth abdominal segment in the male, it can readily be differentiated. In *L. austrina*, the front is distinctly bilobed, and the post-orbital crest is very faint, while the ischium of the external maxillipeds is longitudinally grooved. In *Phricotelphusa campestris*, Alcock, from Bengal, there is a similar arrangement of the epigastric crests, but in this species the exopod of the external maxilliped has no flagellum.

Locality.—I obtained nine males and eleven females, one of the latter with young in the abdominal pouch, from a stream near Kavalai, in the Cochin State Forests, last October. The locality is situated at an elevation of about 1,000 feet above sea level. They were living under stones at the side of the stream, in comparatively dry places, and few were actually observed in the water.

Paratelphusa (*Barytelphusa*) *jacquemontii*, (Rathbun) was common in the same stream, but this crab was only seen in the water.

The type (Crustacea Reg. No. $\frac{7936}{10}$) is preserved in the Indian Museum.

XII NOTES ON DECAPODA IN THE INDIAN MUSEUM

IV.—OBSERVATIONS ON THE PRIMITIVE ATYIDAE WITH SPECIAL REFERENCE TO THE GENUS *Xiphocaridina*.

By STANLEY KEMP, B.A., *Assistant Superintendent, Indian
Museum.*

For the last few years efforts have been made to improve the collection of Atyidae in the Indian Museum and, thanks to the energy displayed by numerous correspondents, the series will, it is hoped, shortly become thoroughly representative of this important part of the Indian freshwater fauna. In course of time a full report on this family and on the Palaemonidae will be issued, forming a part of the Museum Catalogue of Indian Decapod crustacea.

The Atyid fauna of the Indian Empire comprises, so far as is at present known, only three genera, *Atya*, *Caridina* and *Xiphocaridina*. *Ortmannia* (*Atyoida*) does not seem to occur, and this, in view of Bouvier's theory of the mutational origin of that genus and of *Atya*, is a most unfortunate circumstance. It is, however, still hoped that specimens will be found which will provide material for some further consideration of this interesting question.

Atya appears to be very scarce. A few specimens from the Andamans are the only Indian representatives of the genus in the collection, while in addition there is a single example from Ceylon. *Caridina*, the prevalent genus, occurs in great abundance in every suitable locality, inhabiting both fresh and brackish water and ascending to altitudes of at least 6,000 ft. Of *Xiphocaridina* a single species only is known, obtained at Tezpur, on the north bank of the Brahmaputra R. in Assam, and in the native state of Manipur further to the east. It is with this last form that the present note is concerned.

The Atyidae as a whole must be regarded as a very primitive family of Caridea, in spite of the fact that the peculiarly modified chelae indicate a considerable degree of specialization. *Xiphocaridina* is one of the most primitive of the known genera, and it is through such forms as this and *Xiphocaris* that the common ancestry of the Atyidae and the deep-sea pelagic shrimps of the family Hoplophoridae has been traced. Bouvier (1909a), following Ortmann (1895), has laid great stress on this interesting feature of Caridean evolution, and his careful researches leave no room for doubt on the point.

The most conspicuously primitive feature of the genera *Xiphocaris* and *Xiphocaridina* is the possession of well-formed exopods on all the peraeopods, a schizopod-like character which they share with one other Atyid genus, *Palaemonias*, Hay, from the mammoth cave of Kentucky. In three other genera, *Syncaris*, *Troglocaris* and *Atyaephya*, exopods are also found on certain thoracic legs, but never on all, while they are uniformly absent from *Atya*, *Caridina* and *Ortmannia*, genera which comprise the large majority of known species of the family, and from *Limnocaridina*, *Caridella* and *Atyella* that constitute the peculiar Atyid fauna of lake Tanganyika.

Until comparatively recently the distinctions between *Xiphocaris* and *Xiphocaridina* were not recognized; but Bouvier (1909a) had pointed out that the West Indian *X. elongata*, the type of the former genus, differs from its supposed congeners in New Zealand, China and Australia in several important structural features. He consequently created for the latter species a new genus, *Xiphocaridina*.

Xiphocaridina is distinguished from *Xiphocaris* by the presence of supra-orbital spines on the carapace, by the anteriorly excavate carpus of the first peraeopods, by the presence of tufts of hairs on the tips of the fingers of the chelae (a character found in all Atyidae with the exception of *Xiphocaris*) and by the absence of arthrobranchs at the base of the first four peraeopods.

From a consideration of these characters it is evident that *Xiphocaridina* has proceeded on a line of specialization similar to that which has resulted in the evolution of *Caridina* and this fact determined Bouvier in his choice of its name. *Xiphocaris*, as at present understood, is the most primitive genus in the family; except for the complete suppression of the mandibular palp, it bears a very close resemblance to the Hoplophoridae.

Palaemonias, Hay (1902, p. 226), is distinguished from both the preceding genera by the distal excavation of the carpus of the second pair of peraeopods and by the unpigmented and non-faceted eyes. It appears to resemble *Xiphocaris* in the absence of a supra-orbital spine and *Xiphocaridina* in the reduction of its branchial system.¹

Up to the present time only the following species of Atyidae with the full number of exopods on the thoracic limbs have been described:—

Xiphocaris elongata (Guérin).

Cuba; Hayti; Dominica; St. Domingo.

Xiphocaridina compressa (De Haan).

Yokohama; Tokio; Flores; Queensland; Victoria;
New South Wales; Norfolk Is.

¹ Hay states (p. 229) that "the gills seem to be only four in number, on each side attached to the first four peraeopods, but there may be a rudiment on the fifth." In *Xiphocaridina* there are seven gills (one rudimentary) on either side and twelve (one rudimentary) in *Xiphocaris*.

Xiphocaridina curvirostris (Heller).

New Zealand ; Chatham Is.

Palaemonias ganteri (Hay).

Mammoth cave, Kentucky.

It is consequently a matter of some considerable interest that one of these primitive Atyidae still persists in India, and the identification of this species with *Xiphocaridina curvirostris*, hitherto known only from New Zealand, presents a difficult problem in geographical distribution.

The material available consists of the following specimens :—

Tezpur, Darrang District, Assam. Col. H. H. Godwin-Austen. Twenty-four specimens, two of which are ovigerous females, ranging in length from 24 to 42 mm.

Manipur Hills, Manipur state. Col. H. H. Godwin-Austen. Three specimens (none ovigerous) from 24.5 to 28 mm. in length.

These examples were found many years since and it must, I think, be the case that the species is very strictly localised. On a visit to Assam a year ago I had ample opportunities of collecting freshwater crustacea at Mangaldai in the Darrang District and on the neighbouring Assam-Bhutan frontier, localities at no great distance from Tezpur. Special efforts were made to rediscover *Xiphocaridina* ; but the search proved quite unavailing, although several interesting species of *Caridina* were obtained in abundance in the tributaries of the Brahmaputra.

For assistance in the identification of the specimens collected by Col. Godwin-Austen I am under considerable obligation to Prof. E. L. Bouvier, who was kind enough to forward me a transcript of one of his papers on Atyid evolution that had not at that time been received in our Calcutta libraries. He also furnished me with several references which afforded valuable information and spared me from his small series in the Paris museum a specimen of *X. curvirostris* from New Zealand for comparison with the Assam examples.

Subsequently, Dr. C. Chilton, to whom I wish to convey my sincere thanks, furnished me with a considerable number of specimens, obtained in the R. Avon at Christchurch, New Zealand.

I have thus been able to make a careful comparison of Indian and New Zealand examples and no doubt whatever remains in my mind of the complete identity of the two forms. Inasmuch, however, as this determination raises questions of geographical distribution of no little importance a mere statement of fact would not perhaps be acceptable and in searching for some standard of comparison between the two forms it has seemed best to adopt the somewhat laborious method of measurements, as employed by de Man (1908) in the discrimination of varieties of *Caridina nilotica*. The figures are shown in the tables on pp. 116—117 and it will be seen that, judged by this criterion, there is no room for doubt regarding the identity of the forms from the two localities. In the proportions of the antennular peduncle and antennal scale, in the

Measurements of *Xiphocaridina curvirostris* (Heller).¹

		Tezpur, Assam.					R. Avon, New Zealand.				
		♀	♀	♀	♀	♂	♀	♀	♀	♂	♂
Sex ..	..	♀	♀	♀	♀	♂	♀	♀	♀	♂	♂
Total length ..	..	37.5	35	33	29	37	43	39.5	37	34.5	ca. 29
Length of rostrum ..	..	7.0	8.0	?	6.1	6.4	7.7	7.1	6.6	7.1	5.9
Length of carapace ..	..	8.3	7.8	7.1	5.8	6.0	9.2	8.2	8.0	6.8	5.5
Length of antennal scale ..	..	6.0	5.7	5.2	4.5	5.0	6.5	5.8	5.7	5.4	4.6
First peraeopod—											
Length of carpus ..	..	1.42	1.44	1.43	1.05	1.28	1.79	1.57	1.53	1.40	1.16
Breadth of carpus ..	..	.83	.73	.73	.53	.53	.91	.84	.78	.58	.52
Carpus: length ÷ breadth ..	..	1.71	1.97	1.96	2.00	2.41	1.97	1.87	1.96	2.41	2.23
Length of chela ..	..	2.12	2.06	1.90	1.65	1.58	2.48	2.23	2.12	1.84	1.31
Breadth of chela ..	..	.76	.74	.74	.56	.55	.87	.85	.77	.60	.56
Chela: length ÷ breadth ..	..	2.80	2.78	2.57	2.95	2.87	2.85	2.62	2.75	3.07	2.34
Length of dactylus ..	..	1.0	.90	.91	.77	.72	1.09	.96	.84	.89	.62
Chela-length ÷ carpus-length ..	..	1.49	1.43	1.33	1.56	1.23	1.37	1.42	1.39	1.31	1.13
Second peraeopod—											
Length of carpus ..	..	3.45	3.12	2.88	2.24	2.63	3.51	3.16	3.02	2.19	2.25
Breadth of carpus ..	..	.56	.51	.45	.38	.39	.56	.49	.49	.44	.35
Carpus: length ÷ breadth ..	..	6.16	6.12	6.40	5.89	6.74	6.27	6.45	6.16	5.00	6.43
Length of chela ..	..	2.00	1.90	1.79	1.53	1.53	2.20	1.95	1.88	1.67	1.30
Breadth of chela ..	..	.58	.56	.53	.45	.44	.64	.59	.58	.50	.45
Chela: length ÷ breadth ..	..	3.58	3.39	3.38	3.40	3.48	3.44	3.31	3.24	3.34	2.89
Length of dactylus ..	..	1.23	1.07	1.05	.91	.91	1.18	.95	1.02	.91	.77
Carpus-length ÷ chela length ..	..	1.72	1.64	1.61	1.46	1.72	1.60	1.62	1.61	1.31	1.73
Third peraeopod—											
Length of propodus ..	..	3.67	3.58	3.17	2.77	3.02	4.28	3.77	3.59	3.19	2.77
Length of dactylus ..	..	1.03	.91	.91	.77	1.14	1.14	1.08	1.0	1.27	.92
Propodus-length ÷ dactylus-length ..	..	3.56	3.93	3.48	3.60	2.65	3.75	3.49	3.59	2.51	3.01
Breadth of dactylus ..	..	.28	.25	.22	.18	.23	.29	.25	.25	.24	.20
No. of dactylar spines	..	10	10	10	8	16	11	10	11	17	13
Fifth peraeopod—											
Length of propodus ..	..	4.17	3.43	3.58	3.06	3.51	4.84	4.37	4.05	3.81	2.93
Length of dactylus ..	..	1.21	1.10	1.08	.82	1.05	1.35	1.21	1.20	1.25	.93
Propodus-length ÷ dactylus-length ..	..	3.45	3.30	3.31	3.73	3.34	3.60	3.61	3.37	3.05	3.15
Breadth of dactylus ..	..	.31	.26	.26	.24	.21	.33	.24	.30	.24	.22
No. of dactylar spines	..	66	59	63	46	65	70	65	71	70	62
Ova—											
Length ..	..	..	.40	.40	..	..	..	.45	.43	..	..
Breadth ..	..	..	.25	.25	..	..	..	.26	.26	..	..

¹ The measurements of total length are only approximate. Those of the rostrum, carapace and antennal scale are given to the nearest tenth of a millimetre. As regards the dimensions of the eggs the average of six measurements is entered in the case of each ovigerous female examined.

Proportional lengths of segments of peraeopods in *Xiphocaridina curvirostris*.

(FEMALES ONLY.)

	TEZPUR, ASSAM.			R. AVON, NEW ZEALAND.		
	Minimum	Average	Maximum	Minimum	Average	Maximum
First peraeopod—						
Carpus: length ÷ breadth ..	1·71	1·9	2·00	1·87	1·9	1·97
Chela: length ÷ breadth ..	2·57	2·8	2·95	2·62	2·7	2·85
Chela-length ÷ carpus-length	1·33	1·5	1·56	1·37	1·4	1·42
Second peraeopod—						
Carpus: length ÷ breadth ..	5·89	6·1	6·40	6·16	6·3	6·45
Chela: length ÷ breadth ..	3·38	3·4	3·58	3·24	3·3	3·44
Chela-length ÷ carpus-length ..	1·46	1·6	1·72	1·60	1·6	1·62
Third peraeopod—						
Propodus-length ÷ dactylus-length ..	3·48	3·4	3·93	3·49	3·6	3·75
Fifth peraeopod—						
Propodus-length ÷ dactylus-length	3·30	3·4	3·73	3·37	3·5	3·61

Rostral formulae¹ of *Xiphocaridina curvirostris*.

Tezpur Assam

$\frac{3)3+6+7}{5}$	$\frac{2)2+4+2+3}{4}$	$\frac{7)3+4+1+2+?}{4}$	$\frac{2)2+6+1+4}{4}$
$\frac{2)2+5+1+5}{3}$	$\frac{3)3+7+2+5}{5}$	$\frac{2)2+5+1+5}{4}$	$\frac{2)2+8+2+4}{6}$
$\frac{2)2+4+1+4}{4}$	$\frac{2)2+4+1+1+4}{5}$	$\frac{2)2+6+1+?}{4}$	$\frac{2)2+6+4}{4}$
$\frac{2)2+5+1+1+4}{4}$	$\frac{2)2+5+1+4}{3}$	$\frac{2)2+6+4}{4}$	$\frac{2)2+4+1+3}{4}$
$\frac{3)3+4+1+1+?}{4}$	$\frac{2)2+5+1+1+?}{5}$	$\frac{2)2+6+2+4}{3}$	

Manipur.

$\frac{2)2+4+1+1+5}{4}$	$\frac{2)2+4+4}{4}$	$\frac{3)3+5+1+1+5}{4}$
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R. Avon, Christchurch, New Zealand.

$\frac{3)3+5+1+4}{3}$	$\frac{2)2+5+1+3}{5}$	$\frac{2)2+5+1+4}{5}$	$\frac{3)3+2+1+1+6}{8}$
$\frac{2)2+4+1+4}{4}$	$\frac{3)3+4+1+?}{4}$	$\frac{2)2+5+1+4}{5}$	$\frac{2)2+4+1+1+4}{6}$
$\frac{2)2+4+1+4}{4}$	$\frac{2)2+5+1+4}{5}$	$\frac{2)2+5+1+6}{4}$	$\frac{2)2+5+1+5}{4}$
$\frac{3)3+5+1+4}{4}$	$\frac{3)3+7+6}{4}$		

¹ The numbers of dorsal teeth are given above and those of the ventral below the horizontal line. In the case of the dorsal series, the full number is shown to the right of the bracket, the plus signs indicating gaps between individual teeth or series of teeth. The figure on the left, separated by the bracket, represents the number of teeth situated on the carapace behind the orbital notch. In the present species it will be noticed that these teeth invariably form a distinct series, isolated by a toothless space from those further out on the limb of the rostrum.

characters of the mouth parts, in the relative length of the peraeopods and the spinulation of their meral and carpal segments, in the branchial formula and in the armature of the telson there appears to be the closest possible resemblance between the two forms.

In point of fact, the sole difference that I have been able to discover is one of colour. In the majority of the New Zealand specimens received from Dr. Chilton the proximal part of each of the setae which fringe the antennal scale and uropods is bright purple and the same coloration is found on the terminal spinules of the telson. This curious pigmentation undoubtedly vanishes in alcohol and, although it is well shown in most of Dr. Chilton's specimens, which were collected in 1910, it could hardly be expected to have persisted in the examples from Assam which have been lying in alcohol for many years.

Xiphocaridina curvirostris was first described by Heller (1862) as a species of *Caridina* from specimens obtained at Auckland. A fuller account by the same author appeared in 1865 and in 1876. Miers included it, also under the genus *Caridina*, in his Catalogue of New Zealand Crustacea. Three years later (1879) Thomson described it as a new species of Palaemonidae, *Leander fluviatilis*; but in 1903 he realized his mistake and gave a fresh account of it¹ under the name *Xiphocaris curvirostris*. In Ortmann's revision of the Atyidae (1895) it appears as *Caridina curvirostris* with a note to the effect that it probably belongs to the genus *Xiphocaris*. Bouvier does not refer to the species in his valuable paper published in 1905; but he mentions it subsequently—using Thomson's name, *fluviatilis*—as a member of his new genus *Xiphocaridina* (1909, a, b).

The curious distribution of *Xiphocaridina curvirostris* does not, I believe, find any exact parallel among other freshwater Crustacea.

Perhaps its most peculiar feature is that the other species of the genus, *X. compressa*, which inhabits S. Australia, Flores, China, Korea and Japan appears to extend in a band completely separating the two localities in which it is known to exist. But in the present state of our knowledge it is impossible to lay any emphasis on this point, for it may well be that *X. curvirostris* still remains to be discovered in many other localities.

On turning to Ortmann's work on "The geographical distribution of freshwater Decapods and its bearing on Ancient Geography" (1902) it is at once seen from the maps illustrating the hypothetical distribution of land and sea in past geologic periods that, according to this author's views, no direct land connection between New Zealand and Assam has existed in any recent epoch. In the Lower Cretaceous, however, when a land-bridge connected S. India with Madagascar and S. Africa, and when the whole of Northern India was submerged and formed the eastern limit of the

¹ The figures given on Pl. xxix are poor.

great central sea now represented by the N. Atlantic and the Mediterranean, there existed a 'Sino-Australian' continent. This involved Eastern Asia, the Indo-Malaysian Archipelago and Australia, extending southwards to the Antarctic regions and from it a tongue of land reached out to New Zealand by way of New Guinea and Norfolk Island. During Upper Cretaceous times the 'Sino-Australian' continent was divided by a neck of water extending across the region now occupied by Sumatra and Celebes and the land extension from Madagascar to S. India reached north to the northern or Asiatic part of that continent. In Lower and Upper Tertiary times New Zealand was completely isolated as it remains at the present day; in the former period India was merely an island, an eastern sea-connection between the 'Mediterranean' and Indo-Pacific extending across Assam and Burma, while in the latter it approaches the shape which it at present bears.

On these theories the explanation of the discontinuous distribution of *X. curvirostris* is possible, though it can hardly be said to be very convincing. We must assume that *Xiphocaridina curvirostris* evolved from some unknown marine or freshwater ancestor in early Cretaceous or pre-Cretaceous times and remained unchanged until the present day. In the Lower Cretaceous period it would have opportunities of spreading to New Zealand on the one hand and to Lower Burma on the other. Subsequently, while becoming isolated in New Zealand it must have persisted in Burma or in the country existing to the west of it until Assam reappeared during the Upper Tertiary period.

The existence of *Xiphocaridina compressa* both in China and Japan and in Australia seems to show that this species also, according to Ortmann's theories, must have remained without sensible modification for almost as long a period. Every zoologist will readily call to mind other instances tending to a similar conclusion.

Although no exactly parallel case of geographical distribution seems to be known among freshwater Crustacea, the Megascolecid Oligochaeta of the sub-family Octochaetinae afford an instance of a closely similar nature. According to Michaelsen (1909) this sub-family is found only in India and New Zealand¹ and although no species appear to be common to the two, two genera, *Octochaetus* and *Hoplochaetella*, occur in both localities.

Michaelsen holds that the only possible interpretation of these facts is that at one period a direct land connection existed between India and New Zealand. He remarks (p. 203): "I need not explain to any zoo-geographer that the discontinuation of these two regions of distribution in the Octochaetinae is quite a common matter in geographical distribution, the two regions, New Zealand and India, perhaps together with a third region, Madagascar, the home of *Howascolex*, representing the peripheral parts

¹ Michaelsen mentions that another genus, *Howascolex*, known only from Madagascar, might perhaps also be regarded as a member of this sub-family.

of a circular distribution, the internal parts of which have been obliterated by the mighty development of younger and stronger forms, in this case the vigorous genus *Pheretima*, which, from Burma to New Hebrides in one direction and Japan in another, has suppressed and partly exterminated all other genera of earth-worms, those of its own phylum or sub-family as well as those of other tribes."

It is, however, difficult to bring the case of *X. curvirostris* in line with this view. There is no evidence that *X. compressa* represents a young and vigorous type which has exterminated its nearly in localities lying between Assam and New Zealand; on the contrary it would rather seem that both species are archaic forms that must have arisen almost simultaneously and, while it is by no means impossible that *Caridina* may have suppressed *X. curvirostris* in Eastern Asia, it is difficult to see why the same cause should not have effected its destruction in Assam.

The genus *Xiphocaridina* is unquestionably a very primitive one and it may be predicted that such forms are less liable to evolve varieties, local races or other species than those exhibiting a greater degree of specialization.¹ That this is so is indeed self-evident, for a primitive form, if it be primitive, must necessarily have existed without considerable modification for a prolonged period and the mere fact that it has done this is an indication that it is less likely to adapt itself to any altered conditions of its environment than is a form which by its very specialization showed that in the past it had given a more ready response to such changes.

The full significance of the unchanged condition of *X. curvirostris* is, indeed, only realized when the great range of variation in certain other Atyidae is considered. *Caridina nilotica* is a species of wide African and Asiatic distribution. Specimens found in Bengal differ in certain measurable features from the type which occurs in Egypt and Dr. de Man has distinguished them under the name of *C. nilotica* var. *bengalensis*. Among other varieties of the same species it agrees most nearly with var. *gracilipes* found in Celebes and Salayer Is. Even within the limits of India and Ceylon, however, the form exhibits a most remarkable tendency to split into races, and series of specimens from Calcutta, Madras, Tuticorin, Ceylon and the Andamans each seem to possess its own particular characteristics.

¹ Pocock (1889) has described several species very closely allied to *Xiphocaris elongata*; but subsequent authors have preferred to regard them merely as varieties. I am, however, of the opinion that these forms are not deserving even of varietal recognition and believe that the suggestion which Pocock himself made, that they only represent stages in the growth of a single species, is likely to prove true. The rostra of large specimens of *Xiphocaridina curvirostris* are as a rule relatively shorter than in smaller examples, and this is also the case with several species of *Caridina*. In these instances, however, the variation has not nearly so great a range as in *X. elongata*. On the other hand there appears to be some evidence that two distinct races of *X. compressa* exist on Norfolk Is. (see Thomson 1903, p. 449, and Grant and McCulloch, 1907, p. 151).

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XIII FAUNA SYMBIOTICA INDICA.

INTRODUCTORY NOTE.

The following papers are the first in a series that I propose to publish as occasion offers. It will deal with Indian animals of different species found living together in a manner that apparently implies something more than fortuitous concurrence. Such relations actually range in an almost unbroken chain from parasitism on the one hand through commensalism to temporary, if not accidental association on the other. In these days of extreme specialization in systematic zoology, it is perhaps just as well that, even in describing new species, attention should be called not only to their taxonomic position but also to their bionomics. Many of the species described in this series will be Polyzoa or Cirripedia, but I do not pledge myself to restrict my investigations to any particular group or groups of animals and I hope to have the help of specialists from time to time.

N. A.

No. 1.—POLYZOA ATTACHED TO INDO-PACIFIC STOMATOPODS.

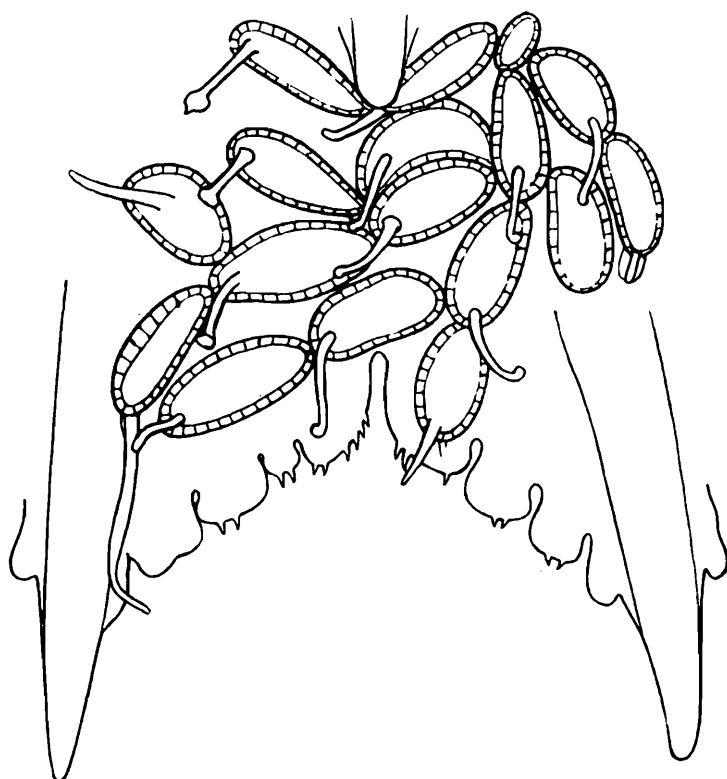
By N. ANNANDALE, D.Sc., F.A.S.B., *Superintendent of the Indian Museum.*

A biological feature of the Stomatopoda which they share to some extent, at any rate in Indian seas, with the Decapoda Natantia and Anomoura, is the rarity with which other living organisms are attached to any part of their body. In this respect they are in strong contrast with the crabs and Reptantia, which in a large proportion of cases have small Cirripedia (usually species of *Dichelaspis* or *Poecilasma*) attached to the gills, even when the external surface is quite clean. In the collection of Stomatopoda belonging to the Indian Museum, or at present on loan in Calcutta, Mr. Kemp and I have not succeeded in finding more than half a dozen instances of sessile organisms being attached to any part of the animal.

In the case of a *Squilla*, unfortunately not identified, from the Bay of Bengal a few immature barnacles of the genus *Dichelaspis* (probably *D. warwickii*) were found attached to the pleopods, while on the dorsal surface of the carapace and abdomen of an example of *Squilla holoschista* from S. India there are several small *Balani* which I have not yet been able to identify. Mr. H. B. Preston is describing in this part of our

“Records” a peculiar mollusc taken on an Indian species of *Gonodactylus* (p. 126, *postea*).

In two instances only (one instance embracing two individuals of the Stomatopod) did we find polyzoa on the integument, and in none did we come across Hydroids or other Coelenterates. The two polyzoa are of considerable interest, one as representing a new genus and species of uncertain affinities and the other as being identical with a British species. Both species belong to the suborder Ctenostomata.



Platypolyzoon investigatoris on telson of *Squilla investigatoris*, $\times 17$.

Triticella koreni, G. O. Sars.

T. koreni, Hincks, *Brit. Mar. Polyzoa*, p. 545, pl. xlv, figs. 8—10; pl. lxxx, fig. 6, and text-figure No. 31.

The carapace, mantidiform limbs and telson of a specimen of *Squilla fasciata* from the Bay of Tokyo, Japan, lent by Prof. K. Kishinouye, bear numerous little tufts of a polyzoan which appears to be in every way identical with the above-mentioned species. Hincks states that in European waters it is found on various crustacea, from between tide-marks to very deep water.

PLATYPOLYZOON, gen. nov.

Zoarium consisting of flattened, recumbent zooecia growing directly one from another in linear series with occasional lateral

(also recumbent) branches originating from lateral buds; sometimes more than one lateral bud on each side of a zooecium.

Zooecia membranous, hyaline, oval, very flat but with the margin supported by vertical chitinous rods; orifice situated at the summit of an elongate but slender vertical tubule which rises from near the anterior end of the dorsal surface of the zooecium. Parietal muscles consisting of short vertical strands situated round the periphery of the zooecium within the chitinous rods. Gonads arranged round the margin of the zooecium just within the parietal muscles.

Polypide elongate and slender; tentacles not numerous; no gizzard or cardiac antechamber.

Platypolyzoon investigatoris, sp. nov.

Zoarium with comparatively few lateral branches, forming a sparsely ramifying figure; no branches with subsidiary branches observed; rarely more than one lateral bud on each side of a zooecium, not more than two observed; the terminal bud of a branch sometimes drawn out into an elongate, slender process.

Zooecia oval, measuring about 1.0 mm. by 0.5 mm.; colourless except for the chitinous rods, which have a yellowish tinge. Orificial tubule of great relative length, very slender. Parietal muscles forming short, vertical, somewhat fan-shaped strands with the narrow end arising from the inner surface of the ventral wall and the broad end attached to the dorsal wall of the zooecium.

Polypide with the tentacles very long; the stomach slender and elongate; the retractor muscles delicate.

Habitat, etc.—Attached to the telson of two of the type specimens of *Squilla investigatoris*, Lloyd, from off the S. W. Coast of Arabia; 110 fathoms (R.I.M.S. "Investigator").

The affinities of the new genus and species are somewhat doubtful. The zooecia have a superficial resemblance to those of *Flustrella* and it is possible that *F. flabellaris*, Kirkpatrick,¹ from the China Sea may be related. Nothing, however, seems to be known about either the method of budding or the anatomy of Kirkpatrick's species. The structure of the orifice and the method of budding of *P. investigatoris* differ greatly from those found in *F. hispida* (Fabr.), the type-species of its genus, and possibly the former is related rather to *Arachnidium*, from which; however, it differs in that the zooecia are not separated by stolon-like processes. This is perhaps a difference of no great morphological importance, for the terminal bud in the branches of *P. investigatoris* sometimes takes the form of a slender elongate process. The form of the zooecia and the general appearance of the zoarium are strongly reminiscent of the freshwater genera *Arachnoidea* and *Hislopia*,² and indeed the relationship between

¹ *Ann. Mag. Nat. Hist.* (6), vol. v, p. 23, pl. iv, figs. 3, 3a (1890).

² Annandale, *Rec. Ind. Mus.*, vol. vi, p. 198 (1911).

Arachnidium and the new genus may be strictly compared with that between these two genera; but the structure of the polypide differs from that of any of the *Paludicellina* and the method of budding, although superficially similar, may be distinguished at once by the fact that more than one lateral bud is sometimes produced on the same side of a zooecium. On the whole, therefore, I am inclined to regard *Platypolyzoon* as allied to *Arachnidium*.

A word may be said about the function of the chitinous rods that surround the zooecium in the new species. They appear to be capable of being straightened into erect supports, but in most of the zooecia in the type specimens are bent in a >-like manner, so that the dorsal wall of the zooecium is closely approximated to the ventral. This appears to be due to the fact that the parietal muscles are strongly contracted and is possibly connected with the extrusion of the tentacles of the polypide, which in nearly all the zooecia are in a semi-extruded condition.

No. 2.—ON A NEW GENUS AND SPECIES OF
MARINE PARASITIC GASTROPOD
FROM THE INDIAN REGION.

By H. B. PRESTON, F.Z.S

Epistethe, gen. nov.

Shell imperforate, subhyaline, vitroriform with sunken spire, the last whorl overhanging the penultimate.

Epistethe gonodactyli, sp. nov.

Shell thin, semi-transparent, sub-covneous, ovate, depressed, greyish white above, shading to brownish yellow on the last whorl; whorls 3, rapidly increasing, the first minute, the second overlapped and partly concealed by the last which is, towards the latter portion, developed above into a membranaceous infrasutural projection, and is proportionately very large, marked with radiate creases and sculptured with microscopic, silky, arcuate, transverse striae; suture impressed in the earlier, cavernous in the later stage; base of shell somewhat convex; columella callously, outwardly margined, descending in a curve; labrum thin, membranaceous, receding below, very slightly projecting in front; aperture depressedly sub-ovate. Alt. 3.5, diam. max. 6.5, diam. min. 5 mm. Aperture: alt. 3.5 (nearly), diam. 3.75 mm.

Habitat.—Parasitic on the ventral surface of a Stomatopod crustacean, *Gonodactylus chiragra*, from shallow water in the Persian Gulf; also found on specimens of the same species from the Andaman Islands.

Through the unfailing courtesy of Mr. A. C. Robson of the British Museum, who very kindly examined the animal for me,



Epistethe gonodactyli, $\times 2$.

as far as it was possible to do so without actually abstracting it from the shell, I am able to supply the following note:—"The parasite is found closely adhering to the ventral surface of its host's thorax. The means of fixation were not evident under the circumstances in which the animal was examined, though it seems likely that the foot may be modified as an adhesive organ. The only other character of interest that can be made out without dissection, is the presence of (?) epipodial fringes displayed all round the region of the foot extending two or three millimetres beyond the shell aperture as it rests applied to the body of the host. These fringes have a nodulated surface and are in many places extensively foliated. As a mere guess I am inclined to think they may be respiratory in function, but such a question can only be solved by dissection. There seems to be no reason, upon superficial anatomical grounds, for identifying it with *Cochliolepis parasiticus* (Stimson, *Proc. Bost. Soc. N. Hist.*, 1859, Vol. VI). Examination of from sixty to seventy specimens of *Gonodactylus chiragra* from the same and other eastern localities, in the collection of the British Museum, failed to reveal more examples."

I am in some doubt as to the actual systematic position of the present genus; from the shell characters alone and from the fact of its being parasitic in its habits, I would suggest the neighbourhood of *Robillardia*¹ though the foliated surface of the foot recalls certain members of the Trochidae.

¹ *Ann. Mag. Nat. Hist.*, London, 1889, vol. iii, pp. 270—71.

XIV OBSERVATIONS ON THE INVERTEBRATE FAUNA OF THE KUMAON LAKES, WITH SPECIAL REFERENCE TO THE SPONGES AND POLYZOA.

By N. ANNANDALE, *D.Sc., F.A.S.B., Superintendent*, and
STANLEY KEMP, *B.A., Assistant Superintendent*,
Indian Museum.

[The following notes are, in the main, the results of a visit paid to the Kumaon lakes in May, 1911, by Mr. Kemp. We have, however, incorporated also observations made by myself in October, 1907.—*N. A.*]

PART I.—GENERAL.

By STANLEY KEMP and N. ANNANDALE.

The Kumaon lakes¹ are situated at altitudes of from 3,600 to 6,400 feet in the lower ranges of the Western Himalayas in the administrative district of Naini Tal. According to Theobald their origin "is due to the obstruction of local drainage caused by the debris of old moraines on the retrocession of the glaciers at the termination of the glacial epoch." None of them are of any great size, the largest, Naini Tal, covering an area of about 120 acres. The depth is as a rule considerable and in Naukuchia Tal may reach as much as 132 feet.

The principal lakes are five in number :—

	Altitude.	Maximum depth.
	Feet.	Feet.
Malwa Tal	3,600	127
Naukuchia Tal	4,000	132
Bhim Tal ..	4,450	87
Sat Tal	4,500	61½
Naini Tal	6,400	93

The banks of the lakes are steep and in most cases composed of stones, at some points with a considerable amount of fine mud.

¹ For particulars of the geology and structure of these lakes see Theobald's paper "The Kumaon Lakes," *Rec. Geol. Surv. Ind.* XIII, p. 161 (1880), and Holland's Report on the geological structure and stability of the hill slopes around Naini Tal, *Mem. Geol. Surv. Ind.*, 1897.

Although water-plants occur in the lakes, they do not form the rank masses of vegetation that often choke small ponds in the vicinity. In the middle the bottom is composed, probably in all cases, of very fine mud ; but little dredging has been undertaken. In Bhim Tal and Naini Tal a certain amount of fine silt is always held in suspension in the water ; this is less conspicuously the case in Sat Tal and Malwa Tal, while the water of Naukuchia Tal is remarkable for its clearness.

MALWA TAL.

This lake, which was visited only in May, is situated in a narrow gorge some 3,000 feet in depth. The most striking feature of its fauna appears to be the great luxuriance of the Phylactolaematus Polyzoa.

The most abundant form was *Fredericella indica*, a species hitherto known, in an evidently depauperated phase, from lakes in the Western Ghats and in the plains of Travancore. In Malwa Tal the species formed a luxuriant growth consisting of numerous vertical branches, sometimes as much as 35 mm. long, closely pressed together and entangled. It exhibited, however, no tendency to the formation of solid bodies such as are composed by the zoaria of "*Alcyonella*." *F. indica* was found in greatest profusion at the east end of the lake, covering the under surfaces of stones in dense bushy masses ; but it also occurred, though more sparingly, in other parts of the lake on the stems of water-plants. The polypides were for the most part (in May) in a state of activity and very few statoblasts could be found in the zooecia.

Plumatella diffusa was also abundant, but its polyparia were as a rule of small size. This species always forms recumbent colonies on flat horizontal or vertical surfaces but in some places the individual zooecia reach a greater length than is the case in Malwa Tal. The specimens were found most abundantly in this lake on the under surface of stones, in many cases together with *Fredericella*. *Plumatella emarginata* and *P. allmani* were both rare, the latter species being found on the stems of a rush.

One of the most interesting animals found in the lake was a new species of *Stolella*, a genus allied to *Plumatella* and recently described from the Indo-gangetic plain. The new species (*S. himalayana*) grew on the lower surface of stones together with *Fredericella* and *Plumatella*, but was very rare, only three specimens having been obtained. It formed a sparse and absolutely flat growth and seemed in danger of being overwhelmed by the more vigorous species associated with it. In all three specimens there were indications that active growth had not long been in progress and numerous minute colonies, in which it was evidently just starting, were found in the vicinity of the larger zoaria. In some cases the valves of a statoblast still adhered to the pair of polypides which as yet formed the whole polyparium. The typical form of *Lophopodella carteri* was found in abundance on the

lower surface of stones and less frequently on the stems of water plants. Many of the polyparia were undergoing division and the majority contained fully formed statoblasts. This polyzoon was also found in all the other lakes of Kumaon except Naukuchia Tal and nowhere in the district was it associated with any species of alga as was the case in Igatpuri lake in the Western Ghats.¹

The only sponge obtained in Malwa Tal was *Spongilla lacustris* subsp. *reticulata*, a form which is common in the plains of India and occurs in the W Ghats at an altitude of over 2,000 ft. The sponge formed a small basal mass with delicate branches and was of a green colour. It occurred, in no great abundance, on the stems of plants growing in the south-eastern corner of the lake.

Of the higher crustacea only a single species (*Potamon atkinsonianum*) was obtained. As Alcock² has shown, *P. atkinsonianum* is closely allied to *P. koolooense*. The latter form extends from the Nepal Terai to Afghanistan, while the former ranges from the Shan States to Simla. The species are characteristic respectively of the Eastern and Western Himalayas; but the two occur together over an area reaching from Nepal to Simla and both have been taken on the shores of the Kumaon lakes.

The entire absence of Palaemonidae and Atyidae is characteristic of all the lakes and of the streams in their immediate vicinity.

When Malwa Tal was visited in May the plankton was anything but rich. Small Copepods occurred, but not in large numbers, while Cladocera and Ostracoda were extremely scarce. A few specimens of a Rotifer belonging to the family Anuraeidae were obtained and also a few Hydrachnids. A minute Peridiniid was found in small numbers. It resembles *Ceratium longicorne*, Perty, in the length of its processes, but agrees with *C. kumaonense*, Carter,³ in having three processes instead of four: in some individuals, however, a rudiment of the fourth process can be detected, springing laterally from the anterior surface. The only adult aquatic insects which were observed were a Gerrid and a Corixid; small dragon-fly larvae were abundant and a few Ephemeridae were obtained.

NAUKUCHIA TAL.

This lake, also only visited in May, is, as is implied by its name ("the Lake of Nine Corners"), of irregular shape, not being situated in a narrow gorge.

The fauna is at once distinguished from that of Malwa Tal by the entire absence of polyzoa, so far as could be ascertained, and by the profuse growth of sponges.

The most abundant of the latter was a form of the widely distributed *Ephydatia fluviatilis*, a species not hitherto known to

¹ Annandale, *Fauna of British India*, Freshwater Sponges, etc., p. 234, pl. iii, fig. 4, and West, *Journ. As. Soc. Bengal*, 1911, p. 83.

² *Cat. Ind. Dec. Crustacea*, pt. I, fasc. II (Potamonidae), p. 26 (Calcutta, 1910).

³ *Ann. Mag. Nat. Hist.* (4), VII, p. 229 (1870).

occur in India, throughout the plains of which it is apparently represented by the allied "*Spongilla*" *meyeni* of Carter. In Naukuchia Tal the species was found in two phases the peculiarities of which were probably due solely to environment. When attached to water weeds it assumed the form of solid irregular masses often of considerable size and when attached to stones round the margin of the lake grew as thin films usually more or less circular in outline.

A new variety of *Spongilla bombavensis*, a species hitherto recorded from the Western Ghats, the Mysore plateau, the Island of Bombay and S. Africa, was distinguished from all forms previously found by the production of delicate vertical branches on a basal film. It grew on branches of trees at the edge of the lake. Specimens of *Spongilla cinerea* found in the same situation showed no tendency to the formation of branches, but coated the bark in an almost uniform layer about 1 cm. thick. This sponge has hitherto only been found in the island of Bombay and in the Western Ghats.

The only large crustacean which was obtained was a specimen of *Potamon atkinsonianum*.

The plankton resembled that of Malwa Tal, but Entomostraca seemed less abundant, while Peridiniaceae were more plentiful. In addition to *Ceratium longicorne*, which here appeared not infrequently in its typical development, a few specimens of *Peridinium apiculatum*, Ehrenburg, were observed. Insects again were exceedingly scarce, but a Rhynchoton belonging to the Naucorid genus *Heleocoris*, not seen in Malwa Tal, was found clinging to the under surfaces of stones on the margin of the lake.

Cladocera, aquatic insects and molluscs occurred in great abundance in a small pond lying above the level of the lake near its northern end.

BHIM TAL.

Owing to the fact that this lake has been dammed at its eastern corner and provided with sluices in connection with the water-supply, the level of the water and the area covered by it can be regulated artificially to a considerable extent. It was visited in October, 1907, and in May, 1911, and on both occasions the sluices were closed and the lake full.

Both sponges and polyzoa are fairly abundant in Bhim Tal; but the former grow less luxuriantly than in Naukuchia Tal, and the latter than in Malwa Tal. The following species were found:—*Ephydatia fluviatilis*, *Spongilla carteri*, *Plumatella diffusa*, *P. allmani*, *P. emarginata*, *P. tanganyikae*, and *Lophopodella carteri*. *Fredericella indica* was not obtained.

Of the sponges in this list only gemmules¹ were found in October, 1907; but growing specimens were collected in May, 1911

¹ Annandale, *Journ. As. Soc. Bengal*, 1907, p. 24.

Both sponges and polyzoa were found in greater abundance than elsewhere on branches of trees growing towards the north end of the lake, in an area left entirely dry when the sluices are opened. *Lophopodella carteri* appeared to be equally abundant on the two occasions on which the lake was visited; but *Plumatella allmani* was only taken in October, 1907, and *P. diffusa*, *P. emarginata* and *P. tanganyikae* in May, 1911.

Most of the specimens of *Ephydatia fluviatilis* exhibited a peculiar external modification; growing on narrow twigs, their base necessarily covered a narrow but elongated surface; in consequence their growth was mainly in a vertical plane, the best developed having the form of a large cockscomb.

Here, as in Naukuchia Tal and Malwa Tal, a small leech belonging to the genus *Glossosiphonia*¹ was found in considerable numbers. In May it was noticed that in small pools in the partly dried river bed at the north end of Bhim Tal, individuals of this leech were in the habit of attaching themselves to large water beetles belonging to the genera *Hydrophilus* and *Cybister*: as a rule to the former. The position chosen was invariably the apex of the dorsal surface of the elytra, where in some cases as many as four specimens were found. Leeches could not be discovered beneath the wing-cases and it is difficult to suggest any reason for the association of the two forms, except that leeches attached to water-beetles must have a considerable chance of escape from pools that are drying up, owing to the fact that the beetles have the power of flight. The species of the genus *Glossosiphonia* are known to feed chiefly, if not entirely, on soft-bodied animals, and in the present case it was clear that they were unable to penetrate the hard integument of the insects. Mollusca were abundant in these pools, but only to one specimen, belonging to the genus *Limnaea*, was a leech attached.

In Bhim Tal itself no large water-beetles appeared to exist. *Glossosiphonia* was found under stones round the margin of the lake, frequently with young ones of a pale green colour attached to the ventral surfaces. At least three other Hirudinea were found together with this form, one of them probably representing the genus *Limnatis*. In addition a small dark grey planarian was not uncommon.

As regards the plankton the most notable feature on both occasions was the enormous abundance of a *Ceratium*; but whereas in 1907 the form that occurred could be identified with *C. longicorne*, Perty, in May, 1911, the majority of the specimens agreed closely with Carter's original figure of *C. kumaonense*. It is obvious that much research on the Peridiniaceae of the Indian lakes is necessary before any statement can be made as regards the limits of the "species"—even of those already recorded.

¹ Mr W. A. Harding has kindly informed us that this species is closely allied to the British *G. heterodita* but probably represents a form hitherto undescribed. It is perhaps specifically identical with a species occurring in Calcutta but not as yet found in association with beetles in that locality.

Although there appears to be some evidence that these two forms are merely phases of one species, it is noteworthy that *C. kumaonense*, to use the name without prejudice, is the common form in Bhim Tal at a time of year at which *C. longicorne* predominates in other lakes situated in the same district and at approximately the same altitude.

SAT TAL.

This lake is situated about two miles west of Bhim Tal at a slightly greater elevation. Originally, as is implied by the name, seven lakes existed, but only two sheets of water of any considerable size now remain. The larger, Sat Tal proper, is U-shaped and in former times comprised two separate lakes; but a neck of shallow water now connects the large eastern part with the smaller, but much deeper western part.

The fauna of Sat Tal is in some respects similar to that of Bhim Tal, but the plankton is poor and the *Ceratium*, found in such abundance in the latter lake, was (in May) almost entirely absent. Two species of sponge were found, *Ephydatia fluviatilis* and *Spongilla carteri*, the latter being very common. Of polyzoa, *Lophopodella carteri* was plentiful on the branches of trees growing in the eastern part of the lake and *Fredericella indica* was found in the same situation along with a few colonies of *Plumatella tanganyikae*. The water bug *Heleocoris*, noticed in Naukuchia Tal, was not uncommon; but other aquatic insects were, as usual, extremely scarce. Small leeches similar to those obtained in Bhim Tal occurred under stones on the margin of the lake.

The plankton was very scanty; a few copepods were found and *Peridinium apiculatum* was comparatively plentiful. The few examples of *Ceratium* that were obtained had the same form as those observed in Malwa Tal.

In May a small pool of water existed at the bottom of a deep ravine situated close to the weir at the north-west corner of the lake. This, as was found to be the case with the ponds in the vicinity of Bhim Tal and Naukuchia Tal, sustained an abundance of insect and molluscan life.

Gurud Tal, a small lake situated close to Sat Tal but at a slightly greater elevation, could not be examined systematically owing to the absence of a boat. Judging, however, from an inspection of the bank, its fauna did not appear to differ in any notable way from that of the larger lake.

NAINI TAL.

This, the largest of the Kumaon lakes, is situated at an elevation of about 6,400 ft., nearly 2,000 ft. higher than Bhim Tal; but notwithstanding its greater altitude the fauna did not present any considerable difference from that found in the lower lakes, though, on the whole, it appeared to be less rich.

In May almost all the margin was occupied by a dense belt of water-weeds, many of which possessed very long stems and grew from considerable depths. These weeds afforded support to large colonies of *Lophopodella carteri* and *Fredericella indica* and it was noticed that *L. carteri* invariably lived on the upper parts of the stems, extending to within a foot or so of the surface, while *F. indica* always occupied a lower position. Together with these polyzoa large colonies of Vorticellids were conspicuous, more particularly near the surface of the water. The only sponge observed was *Ephydatia fluviatilis*, which grew both on the stems of water-plants and on the under surface of stones on the western bank.

The scarcity of aquatic insects was again a very noticeable feature; but a leech of the predaceous family Herpobdellidae which seemed to be rare in the other lakes was not uncommon under stones.

In May the plankton was decidedly richer than in Sat Tal. Copepods were comparatively abundant and Rotifers of the family Anuraeidae were by no means uncommon. *Ceratium* was exceedingly scarce; the few specimens observed had the same form as those found in Malwa Tal.

At the northern end of Naini Tal, situated at an elevation of about 7,000 ft., there is a small temporary sheet of water bearing the name of Suka Tal. In May, 1911, this was completely dried up, but from earth brought back to Calcutta and placed in an aquarium a few Cladocera and Ostracoda were reared. It was in Suka Tal in October, 1906, and May, 1909, that specimens of an interesting Anostracous crustacean, *Pristicephalus priscus*, were obtained. This species, which has recently been described by Prof. von Daday,¹ seems to be restricted to the Western Himalayas. It has been found in two localities in the Simla Hills and, in addition to Suka Tal, at Bhowali, a village on the road between Bhim Tal and Naini Tal. In May, 1911, the species seemed to be entirely absent from small pools in the vicinity of the Kumaon lakes, although it was abundant in 1907 in the same months near Simla. The erratic appearance and disappearance of the species of Branchiopoda is well known.

The table on the next page illustrates the distribution of Porifera and Polyzoa in the five principal lakes of the district. None of our specimens are from deep water, none having been procured from a greater depth than about 6 feet.

¹ "Mon. Syst. Phyllopo des anostracés" (Ann. Sc. Nat. Zool. (Paris), 9e série, XI, p. 224, fig. 29; 1910).

			Malwa Tal, 3,600 ft.	Naukuchia Tal, 4,000 ft.	Bhim Tal, 4,450 ft.	Sat Tal, 4,500 ft.	Naini Tal, 6,470 ft.
PORIFERA—							
<i>Epydatia fluviatilis</i>	..	..		C	+	+	+
<i>Spongilla carteri</i>		..	..		+	C	
<i>Spongilla cinerea</i>	.	..	+	+			
<i>Spongilla lacustris</i> subsp. <i>reticulata</i>		.	+	C			
<i>Stratospongilla bombayensis</i> var. <i>pneumatica</i>							
POLYZOA—							
<i>Lophopodella carteri</i>		..	+	..	C	C	C
<i>Fredericella indica</i>	..	..	C	..	+	+	C
<i>Plumatella diffusa</i>	..	..	+		+		
<i>Plumatella allmani</i>	..	..	+				
<i>Plumatella emarginata</i>	..	..	R		R		
<i>Plumatella tanganyikae</i>			..	..	+	R	
<i>Stolella himalayana</i>	..	..	R				

[C = common; + = present; R = rare.]

Imperfect as the above observations are, the following general conclusions as regards the fauna of the Kumaon lakes may be stated with some confidence:—

1. The zoo-plankton (more particularly the smaller crustacea) is, at any rate in the month of May, much more abundant in the small pools in the neighbourhood of the lakes than in the lakes themselves; this is also the case as regards aquatic insects.
2. Sponges and polyzoa are remarkably abundant in most of the lakes, but no specimens of the latter group were taken in Naukuchia Tal.
3. Both sponges and polyzoa, with a few exceptions (*e.g.* *Stolella himalayana*), contain numerous resting reproductive bodies in May. This agrees with what occurs in the plains of India, except that the production of these bodies is usually completed and the vegetative part of the organism has decayed about a month or six weeks earlier. It is very different from what occurs in European lakes, in which the resting reproductive bodies are usually found at the approach of winter.
4. Mollusca such as *Limnaea* and *Planorbis* reach a larger size in the small pools in the vicinity of the lakes than in the lakes themselves.
5. No species of Caridea occurs in the lakes. Decapoda are represented solely by two species of *Potamon* (s. s.).

6. A 'species' of *Ceratium* occurs in abundance in the lakes and exhibits great variation. One form of this "species" predominates in each lake at a given date (at any rate in May) but the predominant form is not always the same in different lakes at the same date.

PART II.—SYSTEMATIC AND GEOGRAPHICAL NOTES ON THE SPONGES AND POLYZOA.

By N. ANNANDALE.

PORIFERA.

1. SPONGILLA (EUSPONGILLA) LACUSTRIS subsp. RETICULATA, Annand.

This sponge was only taken in the lowest of the lakes, Malwa Tal (alt. 3,600 feet), in which it was abundant and bore numerous well-developed statoblasts in May. The race is widely distributed in the plains of India, in which it flourishes chiefly in wet weather.

2. SPONGILLA (EUSPONGILLA) CINEREA, Carter.

Specimens were taken in Naukuchia Tal (alt. 4,000 feet) in May. They formed a layer never more than about 10 mm. thick on twigs and are (in a dry condition) of a pale yellow colour. The oscula were small and to some extent radiate, and the skeleton-spicules a little more coarsely spined than in the type, in which the oscula are much larger and non-radiate. The dark greyish colour of Carter's specimens was probably due to their having grown in muddy water. Specimens from the R. Godaveri at Nasik and the R. Bhima at Khed in the Poona district were of a bright green colour but resembled those from Kumaon in the structure of the skeleton-spicules and oscula. Except for the specimens from Naukuchia Tal the species is only known from the Bombay Presidency, the specimens recorded by Prof. Max Weber¹ from the Malay Archipelago as *S. cinerea* actually representing not this species but *S. proliferens*, mihi.

3. SPONGILLA (EUNAPIUS) CARTERI, Carter.

Sponges were taken in Bhim Tal (alt. 4,450 feet) and Sat Tal (alt. 4,500 feet) in May and gemmules were found floating on the former lake in October. This is perhaps the commonest of the Spongillidae in India. The specimens from Kumaon bore well-developed gemmules in May, a month in which these bodies are also fully formed in the plains. At lower altitudes, however, the sponge has usually disintegrated by this date, whereas in Kumaon it was evidently still in declining vegetative vigour.

¹ *Zool. Ergeb. Niederl. Ost-Ind.*, vol. i, pp. 35, 46 (1890).

4. 'SPONGILLA (STRATOSPONGILLA) BOMBAYENSIS, Carter.

Specimens from Naukuchia Tal (alt. 4,000 feet) differ sufficiently from the typical form as found in Bombay and Mysore to be regarded as the types of a new variety for which, in the *addenda* to my volume in the *Fauna of British India* (p. 241), I have proposed the name *pneumatica*. Their most striking feature is the thick but irregular pneumatic coat superimposed on the gemmule outside the gemmule-spicules. They are also remarkable for possessing short vertical branches, and one specimen takes the form of a delicate cup attached by its base to a twig.

EPHYDATIA FLUVIATILIS subsp. HIMALAYENSIS, nov.

Ephydatia fluviatilis, Annandale, *Faun. Brit. Ind.*, Freshwater Sponges, etc., p. 242 (1911).

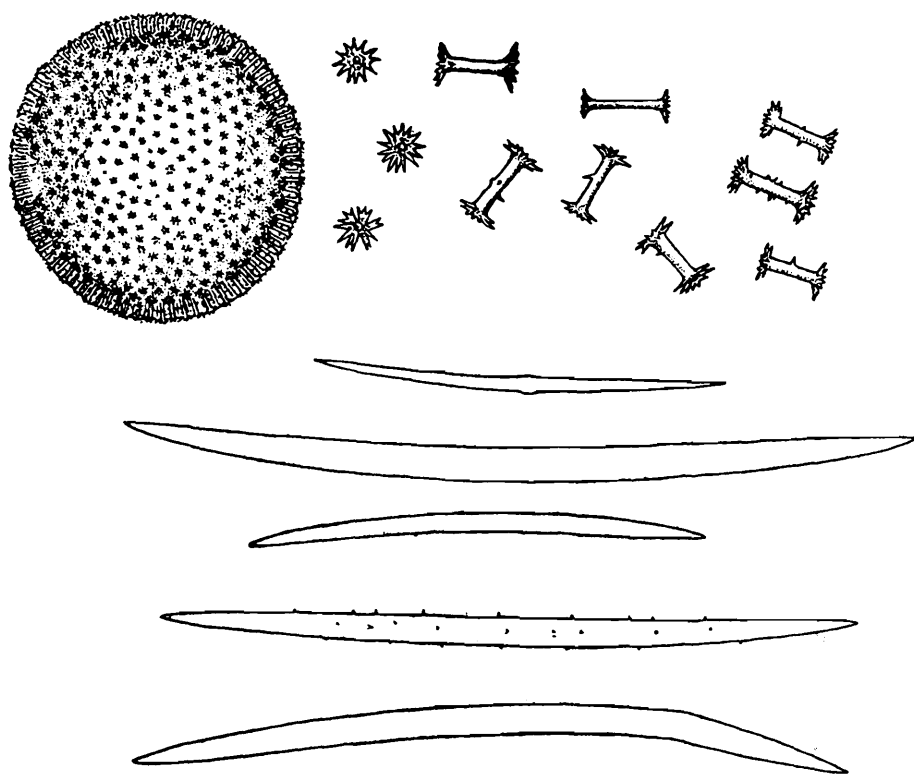


Fig. 1.—Gemmule ($\times 75$) and Spicules ($\times 240$) of *Ephydatia fluviatilis* subsp. *himalayensis*.

Specimens belonging to this common and widely distributed species were taken in May in several of the lakes, in which it appears to replace *E. meyeri*, Carter, the form common in the plains of India. In Naukuchia Tal, the water of which is remarkably clear, Mr. Kemp was able to see that they did not occur at depths much greater than 10 feet. Gemmules were also taken on the surface of Bhim Tal in October and were attributed to *E. robusta*¹ (Potts), which is probably only a variety of *E. fluviatilis*. The sponge from the lakes of Kumaon, however, although very

¹ Annandale, *Journ. As. Soc. Bengal*, 1907, p. 24, fig. 7.

near to *E. robusta*, exhibits certain peculiarities which seem to entitle it to be regarded as a distinct local race. For this new subspecies the name *himalayensis* is proposed. Many of the specimens are well preserved but I can detect no trace of "bubble-cells" in their parenchyma.

E. fluviatilis subsp. *himalayensis*, may be distinguished from the typical form of the species by the following characters:—

- (i) The skeleton-spicules are very variable in length and usually rather slender. The majority are long.
- (ii) Scattered amongst the smooth skeleton-spicules of the ordinary type there are a few particularly slender ones which have, widely and sparsely scattered over the middle region, a comparatively small number of very minute spines, the tips being always smooth.
- (iii) The gemmule-spicules are somewhat variable in proportions but as a rule rather shorter than is ordinarily the case in the species. Their rotulae are narrow and often almost regularly, although always deeply indented round the margin. The shafts are slender and either smooth or provided with a few comparatively short spines.

The external form of the sponge is very variable and seems to depend to a large extent on the nature of the object to which it is attached. Specimens growing on slender twigs at the surface form a compressed crest like a cockscomb, those attached to stones at the bottom spread out in a flat film of little depth, and those fixed to delicate water-weeds form irregular nodules. No large specimens were obtained, none having a superficial area of more than a few square centimetres. The specimens (dry and in spirit) have a faint yellowish colour. They contained (in May) numerous well-formed gemmules.

Habitat.—Kumaon, W Himalayas: Naukuchia Tal (4,000 feet), Bhim Tal (4,450 feet), Sat Tal (4,500 feet) and Naini Tal (6,400 feet) (*Kemp*, May, 1911).

In the possession of spined skeleton-spicules *E. fluviatilis* subsp. *himalayensis*, resembles a form of the species which Weltner¹ has recently described from Issyk-Kul in Turkestan. It does not possess, however, the monstrous amphistrongyli of the latter and appears to have less spongin in its skeleton. The external surface is also smoother and the canals are less capacious.

POLYZOA.

The following is a list of the polyzoa taken in the Kumaon lakes; the species have been described in my volume on the Fresh-

¹ "Beiträge zur Kenntniss der Fauna Turkestans—viii. Spongillidae des Issyk-Kul-Sees und des Baches bei Dschety-Ogus." *Travaux de la Société Imp. des Naturalistes de St. Pétersburg*, xlii, p. 63, text figures 8-39, and pl. I, figs. 1-7 (1911).

water Sponges, Hydroids and Polyzoa in the "Fauna of British India," but it now seems necessary to regard one (*Plumatella tanganyikae*) as the type of a new subgenus.

I. FREDERICELLA INDICA, Annandale.

Taken by Mr. Kemp in Malwa Tal, Sat Tal and Naini Tal (3,600—6,400 feet) in May. The specimens from the Himalayas differ from those on which the original description of the species was based (from lakes in the W Ghats near Bombay and in Travancore) in their much more luxuriant growth. They form dense bushy masses, in some cases with vertical branches as much as 3.5 cm. long. The type specimens were, however, taken in November and were evidently just re-assuming active growth after a period of quiescence.

I have recently (March 2nd, 1912) found this species growing with fair luxuriance on the leaves of *Vallisneria spiralis* in a canal at Cuttack in Orissa. Some of the zoaria contained statoblasts; in others they were absent. The ectocyst was paler in colour than in Mr. Kemp's Kumaon specimens.

2. PLUMATELLA EMARGINATA, Allman.

Bushy masses of this common and universally distributed species were taken in May in Malwa Tal and Bhim Tal.

3. PLUMATELLA DIFFUSA, Leidy.

Common in Malwa Tal and Bhim Tal in May: one of the few species as yet taken in the plains of North-Western India.

4. PLUMATELLA ALLMANI, Hancock.

Taken in Malwa Tal in May by Mr. Kemp and in Bhim Tal in October by myself. Specimens from these lakes show every gradation between the form originally described by Hancock and Allman's *P. elegans*; they possess, however, an apparent peculiarity in coloration in that the older zooecia are invariably surrounded by a band of dark pigment near the middle.

AFRINDELLA, subgen. nov.

This subgenus is distinguished from *Plumatella* (s.s.) by the manner in which the orifice is closed when the polypide retracts its lophophore. The stiffened ectocyst of the zooecium, instead of merging gradually into the much softer and more flexible tentacle-sheath, terminates abruptly and the tip of the zooecium therefore becomes truncate—as a rule obliquely truncate, because the stiffened ectocyst is produced at the dorsal end of the periphery, which is oval in outline, further than at the ventral. Immediately following the sharply defined official margin thus produced and in direct

continuity with it, the dorsal end gives rise in some zooecia to a small semicircular projection or hood even darker than itself but somewhat more flexible. At each side of the periphery a projecting valve, which is colourless, softer and still more flexible, is formed in continuation of the stiffened wall, and the two valves are joined together round the ventral end by a narrow fringe of integument similar to that of which they are themselves formed. The terminal wall of the zooecium may therefore be said to be surrounded for the greater part of its extent by a projecting fringe or border the surface of which has the roughened appearance characteristic of the external ectocyst, although the colour and stiffness of the latter are absent. Although I talk of this structure as a projecting border, its distal margin is, as a matter of fact, in direct continuity with what becomes the proximal end of the tentacle-sheath when the polypide is fully extended, just as its proximal margin is in continuity with the wall of the zooecium.

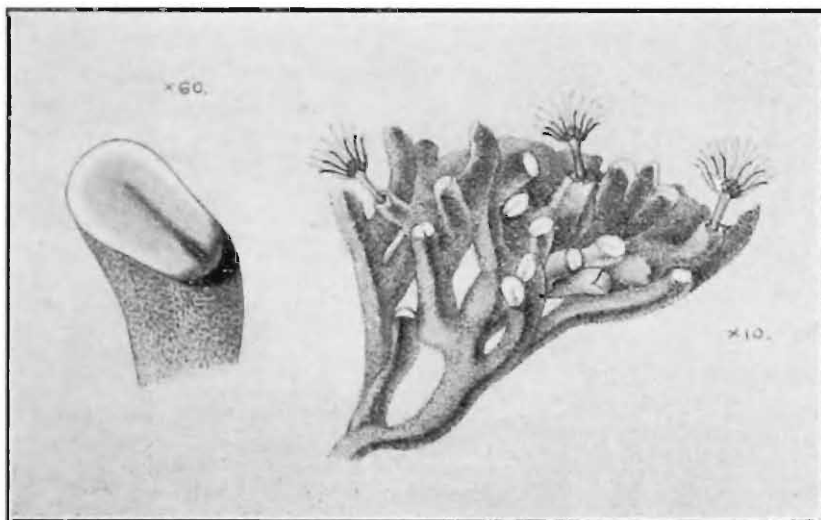


Fig. 2.—Part of zoarium of *P. tanganyikae* from Cuttack, $\times 10$, with the tip of a single zooecium, $\times 60$.

When the polypide retracts its lophophore, the hood (when it is present) is drawn downwards to a slight extent, owing to the fact that it is attached distally to the tentacle-sheath, and bends over the orifice. For the same reason the lateral valves close together tightly, completely covering the orifice. If retraction of the lophophore is spasmodic or unusually violent the valves are dragged into the zooecium so far that a kind of antechamber is formed above them, of course open at the tip. When the lophophore is extended, the valves are thrust apart and the hood is forced into line with the end of the orificial wall. Before the tentacles emerge, however, a bulbous transparent mass appears between the valves and forces them asunder. It is the still partially-invaginated tentacle-sheath.

It was not until I had had an opportunity of examining at leisure with a binocular microscope healthy living colonies of

Plumatella tanganyikae that I realized the complexity of the opercular apparatus in this species, but once this had been realized, it was not impossible to trace the same structures in preserved specimens from both Africa and India, although the much paler colour of the ectocyst in the former made the observation more difficult than it was in the case of Indian examples of the species. The peculiarities described in the preceding paragraphs would fully justify the recognition of *P. tanganyikae* as the type-species of a distinct genus, were it not for the fact that the different species of *Plumatella* (s. s.) exhibit considerable variation in respect to the manner in which the orifice is closed. In those species (e.g., *P. repens* and *P. fruticosa*) in which the zooecial wall is fairly flexible and there is no furrow along its dorsal surface, the polypide is merely withdrawn by the retractor muscles, in the same way as the tip of the finger of a glove might be withdrawn by pulling strings attached to its internal surface. The walls of the zooecium collapse together and the result is a rounded tip with a minute round aperture in the middle. In those species, however, (e.g., *P. emarginata* and *P. diffusa*) in which the external ectocyst is somewhat inflexible, a furrow (that is to say, a narrow longitudinal area on which the ectocyst is thinner and softer) extends from the orifice along the dorsal surface of the zooecium and forms at one end the dividing line between valves not dissimilar to those which close together over the tentacle-sheath in *P. tanganyikae*. The lophophore emerges between them just as it does in that species. In *P. tanganyikae* there is usually no furrow on the distal end of the zooecium proper, although there often is one on the proximal part; but occasional zooecia may be found in which, in the absence of a dorsal hood, the soft integument of the valves and the separation between them extend for a short distance along the dorsal surface of the zooecium. Even in such zooecia, however, the separation between the stiff zooecial wall and the soft opercular part of the ectocyst is much more clearly defined than it ever is in such species as *P. emarginata*.

P. tanganyikae must be recognized as the type-species of the new subgenus *Afrindella*, for it is not certain, though highly probable, that a similar method of closing the zooecium occurs in Kraepelin's *P. philippinensis*, which in other respects appears to be closely related.

5. PLUMATELLA (AFRINDELLA) TANGANYIKAE, Rousselet.

P. tanganyikae, Rousselet, *P.Z.S.*, 1907 (1), p. 252, pl. XIV, figs. 1-4

P. bombayensis, Annandale, *Rec. Ind. Mus.*, II, p. 169, figs. 1, 2.

P. tanganyikae, *id. Faun. Brit. Ind.*, Freshwater Sponges, etc., p. 225.

I do not think that the form I described as *P. bombayensis* can be distinguished specifically from Rousselet's African species,

as intermediate specimens occur; but Indian specimens represent a distinct race for which the name *bombayensis* must stand. Mr. Kemp found this species somewhat sparingly in Bhim Tal and Sat Tal in May. His specimens have a peculiar reddish colour and their zooecia are longer and slightly less recumbent than those from the W Ghats. They were attached to small stones.

I have recently (March 2nd, 1912) found several colonies of this species growing, together with *Fredericella indica*, on the leaves of *Vallisneria spiralis* in a canal at Cuttack in Orissa. They resembled those found on the lower side of stones from Igatpuri but were evidently young.

It is curious that no species of *Plumatella* with broad statoblasts (except the aberrant *P. punctata*, Hancock) has as yet been found in India. Braem¹ has recently described (together with a new species of *Victorella*) a form allied to, if not identical with, *P. fungosa* (Pallas) from Issyk-Kul in Turkestan, but I know of no similar form in this country.

6. *STOLELLA HIMALAYANA*, Annandale.

Annandale, *Faun. Brit. Ind.*, Freshwater Sponges, etc.,
p. 246, fig. 49.

This species is described and figured in the *addenda* to my volume in the "Fauna" (p. 246, fig. 49) from specimens taken by Mr. Kemp in Malwa Tal in May. At that season the species was evidently scarce, but the zooecia contained few statoblasts (only free ones) and numerous young colonies were being formed by the budding of old statoblasts on the stones to which the adult zoaria were attached.

S. himalayana differs from *S. indica*,² the type species of the genus, in the following characters:—(i) the zooecia are entirely recumbent; (ii) each zooecium is separated from all others by the stolon-like prolongation of their bases; and (iii) the zoarium produces lateral branches almost in a cruciform manner.

7. *LOPHOPODELLA CARTERI* (Hyatt).

I found this species fairly common in Bhim Tal in October and Mr. Kemp took it in great profusion in the same lake and in Malwa Tal and Sat Tal in May. At both seasons statoblasts were being produced in large numbers, but in my specimens a large proportion of these were more or less ill-formed, the hooked processes being deficient or obsolete. These specimens were made the types of my variety *himalayana*. Mr. Kemp's were, however, quite normal. *L. carteri* was originally found in the island of Bombay and is abundant in November in Igatpuri lake in the

¹ "Beiträge zur Kenntniss der Fauna Turkestans—viii. Bryozoen und deren Parasiten," *Trav. Soc. Imp. Naturalistes St. Petersburg*, vol. xlii, p. 5, figs. (1191).

² *Rec. Ind. Mus.*, iii, p. 279, fig. (1909). Professor K. Ramunni Menon of Madras has recently sent me specimens of *S. indica* from that city.

W Ghats. A record of "*Lophopus*" from Madras may actually refer to this species, statoblasts of which have been found in German East Africa. A race (*davenporti*, Oka) occurs in Japan and is distinguished by the stronger development of the hooked processes at the ends of the statoblasts.

GEOGRAPHICAL DISTRIBUTION OF THE SPECIES.

The following list shows practically all that is known of the distribution of the sponges and polyzoa that have been found in the Kumaon lakes, at any rate so far as India is concerned. It would seem to provide evidence that the aquatic fauna of the Malabar Zone¹ is less restricted than it at one time appeared to me. Recent investigations, however, undertaken in different parts of India, prove that the African element which is so marked a feature of that fauna is more widely distributed in India than was at first realized. In particular, a species (a somewhat peculiar species, it is true) of *Corvospongilla* has been found in the Ganges valley,² while both *Fredericella indica* and *Plumatella tanganyikae* have been discovered in the main Peninsular Area of India. It is noteworthy that the Gangetic *Corvospongilla* differs from its congeners in having free statoblasts provided with a well-developed pneumatic layer, but a species of the genus more typical in this respect (*C. ultima*)³ has also been found at Tanjore far to the east of the Western Ghats.

¹ See Alcock, *Cat. Ind. Dec. Crustacea Ind. Mus.*, part i, fasc. ii (Potamoniidae), 1910; also the general introduction to my volume on the Freshwater Sponges, etc., in the *Fauna of British India*, p. 10.

² Annandale, *op. cit.*, p. 243.

³ This species is wrongly attributed to *Spongilla* in the "*Fauna*" (p. 105).

Geographical Distribution of the Sponges and Polyzoa of the Kumaon Lakes.

[Forms of which the names are marked with an asterisk are apparently peculiar to the lakes of Kumaon.]

Name of Species.	Malabar Tract.	Peninsular India (Main Area).	Indo-Gangetic Plain.	Distribution outside India.
SPONGES.				
<i>Spongilla lacustris</i> subsp. <i>reticulata</i> .	Igatpuri, W. Ghats ..	Madras, etc. ..	Gangetic delta ..	Typical form of the species widely distributed in Europe, N. Asia and America.
<i>Spongilla cinerea</i> ..	Bombay (island); Igatpuri; Poona district. ....	....	....	....
<i>Spongilla carteri</i> ..	Many localities ..	Many localities ..	Many localities ..	Mauritius; Malay Archipelago; E. Europe; ? Central Africa.
<i>Spongilla bombayensis</i> var. <i>pneumatica</i> *	Bombay (island); Igatpuri (<i>typical form</i>).	Bangalore (<i>typical form</i>)..	....	Natal, S Africa (<i>typical form</i>).
<i>Ephydatia fluviatilis</i> subsp. <i>himalayensis</i>.*	....	....	....	Europe; America; N. Asia (<i>typical form</i>) Turkestan (? var.); S. Africa (<i>var</i>).
POLYZOA.				
<i>Fredericella indica</i> ..	Igatpuri, W. Ghats; Travancore (plains).	Cuttack, Orissa	....	A specimen from N. Assam may belong to this species, but it is doubtful even whether it is <i>Fredericella</i> .
<i>Plumatella emarginata</i> .	....	....	Gangetic delta ..	Europe, N. America, etc.
<i>Plumatella diffusa</i> ..	..	....	Gangetic delta. etc. ..	Europe, N. America.
<i>Plumatella allmani</i> ..	....	..	....	England.
<i>Plumatella (Afrindella) tanganyikae</i> .	Igatpuri, W. Ghats ..	Cuttack, Orissa	..	Central Africa (L. Tanganyika).
<i>Stolella himalayana</i>*	..	..	....	..
<i>Lophopodella carteri</i> ..	Bombay (island); Igatpuri.	? Madras ..	..	E. Africa (<i>typical form</i>); Japan (<i>subspecies</i>).

1912.]

N. ANNANDALE and S. KEMP : Kumaon Lakes.

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XV FAUNA SYMBIOTICA INDICA

No. 3.—POLYZOA ASSOCIATED WITH CERTAIN GANGETIC TORTOISES.

By N. ANNANDALE, D.Sc., F.A.S.B., Superintendent, Indian
Museum.

(Plate XIII.)

It was noticed that peculiar lichenoid patches were present on the carapaces of a number of tortoises captured in the Ganges near Rajmahal in March, 1912, by Mr. B. L. Chaudhuri and brought alive to Calcutta. At first sight the patches were taken for algae, but a close examination showed that they were formed of one or both of two species of polyzoa, namely *Hislopia lacustris* and an undescribed form of *Plumatella* closely allied to *P. tanganyikae*. The tortoises in the collection belonged both to the Testudinidae and the Trionychidae, the former being represented by three species of *Kachuga* (*K. dhongoka*, *K. lineata* and *K. smithii*) and one of *Hardella* (*H. thurgii*), while the Trionychidae comprised *Trionyx gangeticus* and *T. hurum*. The polyzoa were not found on either species of *Trionyx* or on *K. smithii* (a small species), but one or both occurred on most of the larger specimens of Testudinidae. Probably the skin of the mud-turtles is too soft and slimy for their proper attachment or growth.

The tortoises had been out of the water for at least twenty-four hours before they were examined and the polypides of the polyzoa had perished, but fortunately the zooecia remained in sufficiently good condition for an investigation of the general structure and specific characters.

HISLOPIA LACUSTRIS, Carter.

Annandale, *Faun. Brit. Ind.*—Freshwater Sponges, etc., pp. 190, 200—205, figs. 35A, 38 and 39.

The zoaria on the tortoises' shells each cover an area of several square inches and are of luxurious growth, almost every zooecium producing its full complement of three buds and the whole colony being closely compacted, without, however the zooecia overlapping. The individual zooecia are small, measuring on an average slightly over 1 mm. in length and being very variable in breadth; they are as a rule irregularly polygonal in outline and have the proximal end narrower than the distal. The orifice is circular or subcircular and as a rule lacks spines, although it

has a well-marked chitinous border. The zooecia are too closely fitted together for a flat membrane to intervene, but their chitinous margins are well developed.

Most of the zoaria in the collection had been overgrown by the Phylactolaematous species next to be described. They were only found on the carapace of *Hardella thurgii* in this instance, but *Hislopia lacustris* commonly occurs on the shells of molluscs of the genus *Vivipara* as well as on the leaves of *Vallisneria spiralis*, on logs, stones and other inanimate fixed or floating objects. Major Walton discovered the polyzoon *Stolella indica* growing over large zoaria in the United Provinces and the bases of the type-specimens of the sponge *Corvospongilla burmanica* from Pegu contained the remains of zooecia. The species is widely distributed in the tropical parts of eastern Asia.

PLUMATELLA (AFRINDELLA) TESTUDINICOLA, sp. nov.

Zoaria forming quite flat, oval or circular lichenoid patches with undulating or sinuous borders and in some instances as much as 10 cm. in diameter; consisting of zooecia laying parallel and closely adjacent in one plane and radiating in branches from a common centre.

Zooecia entirely recumbent, narrow, elongate, with the orifice opening almost vertically; the proximal part a little flattened, without dorsal keel or furrow, the ectocyst densely covered with minute sand-grains, translucent brownish, indistinctly annulated, paler on the distal than on the proximal part.

Polypide not observed.

Statoblasts.—Only fixed statoblasts are apparently developed. They occur in great profusion, entirely filling many dead zooecia and arranged in moniliform series. As the dorsal wall of the zooecium decays they are left adhering with its ventral wall to the host's carapace and reproduce the pattern of the zooecium, often almost completely. They are, as a rule, broadly oval, measuring about 0.52×0.35 mm., but sometimes they are circular and occasionally kidney-shaped. The surface is polished and without a trace of reticulation and the capsule is surrounded by a stout chitinous ring separated from it by a deep peripheral groove; the colour is black or very dark brown.

Localities and hosts.—R. Ganges near Rajmahal, on carapace of *Hardella thurgii*, *Kachuga dhongoka* and *K. lineata*: statoblasts also observed on young specimens of *K. dhongoka* from Allahabad and Fatteghar.

The structure of the zooecium closely resembles that of the zooecia of some forms of *Plumatella tanganyikae*, which I have recently adopted as the type-species of the new subgenus *Afrindella* (Rec. Ind. Mus., vii, p. 140) and I have little doubt that I am right in referring the new species to that subgenus. It is unfortunate, however, that the polypides of the type-specimens are not in a fit state for examination. The statoblasts somewhat

resemble those of *Fredericella*, to which belong the only species hitherto described in which all of these bodies are devoid of a ring of air-cells. The fixed statoblasts of *Plumatella*, however, always resemble those of *Fredericella*, and that to a different extent in different species. It is probable in the present instance that the production of fixed statoblasts only is an adaptation correlated with the peculiar method of life adopted by the polyzoon. As the tortoises to which it is attached leave the water for purposes of oviposition, if not for other purposes also, it is perhaps necessary that the *Plumatella* should not altogether lose their services as beasts of burden at any period in its life-cycle, solid objects to which it can affix itself being few and far between in the mud of the Ganges.

In its general appearance *P. testudinicola* bears a remarkable but of course quite superficial resemblance to certain Cheilostomes and Ctenostomes that encrust flat surfaces. The method of budding is, however, completely different, for the closely compacted parallel branches of the zoarium are produced by linear budding or by the production in the first instance of two divergent buds at the tip of a parent zooecium. Except at and near the centre (which is the oldest part of the zoarium) there is no organic connection between the different branches, which, at any rate near the periphery, merely lie alongside one another. In the older parts of the colony it is clear that the production of divergent buds in the position indicated has been frequent but that they, or rather the branches produced from them by linear budding, have become closely pressed together and therefore parallel, not apparently having the power of raising themselves from the basis to which they adhere. Thus the method of budding differs from that of such forms as *Membranipora* and *Hislopia* in that lateral buds are never produced, while there is no single zooecium from which the branches radiate outwards as in *Flustrella* and many other encrusting forms. Indeed, it seems probable that each apparent colony is not really a single zoarium but rather the result of budding on the part of a group of statoblasts or embryos from each of which branches have been produced in one or in two directions. In *Plumatella tanganyikae*, although compact flat zoaria are often found, it is always possible to see that their branching is fundamentally bilateral and probably arises from the fact that the two first polypides produced from a single statoblast or embryo have diverged from one another before fixation was completed. In *P. testudinicola*, on the other hand, each colony appears to have arisen from a group of separate but closely adjacent individuals, the branches of which have been forced to diverge by mutual pressure. It is, however, difficult to be quite sure of this without studying young growing zoaria, which I have not seen, as the central part of old zoaria is always in a more or less decayed condition.

My specimens of the new species were taken in March, and it is evident that the vegetative phase of their life-cycle was practi-

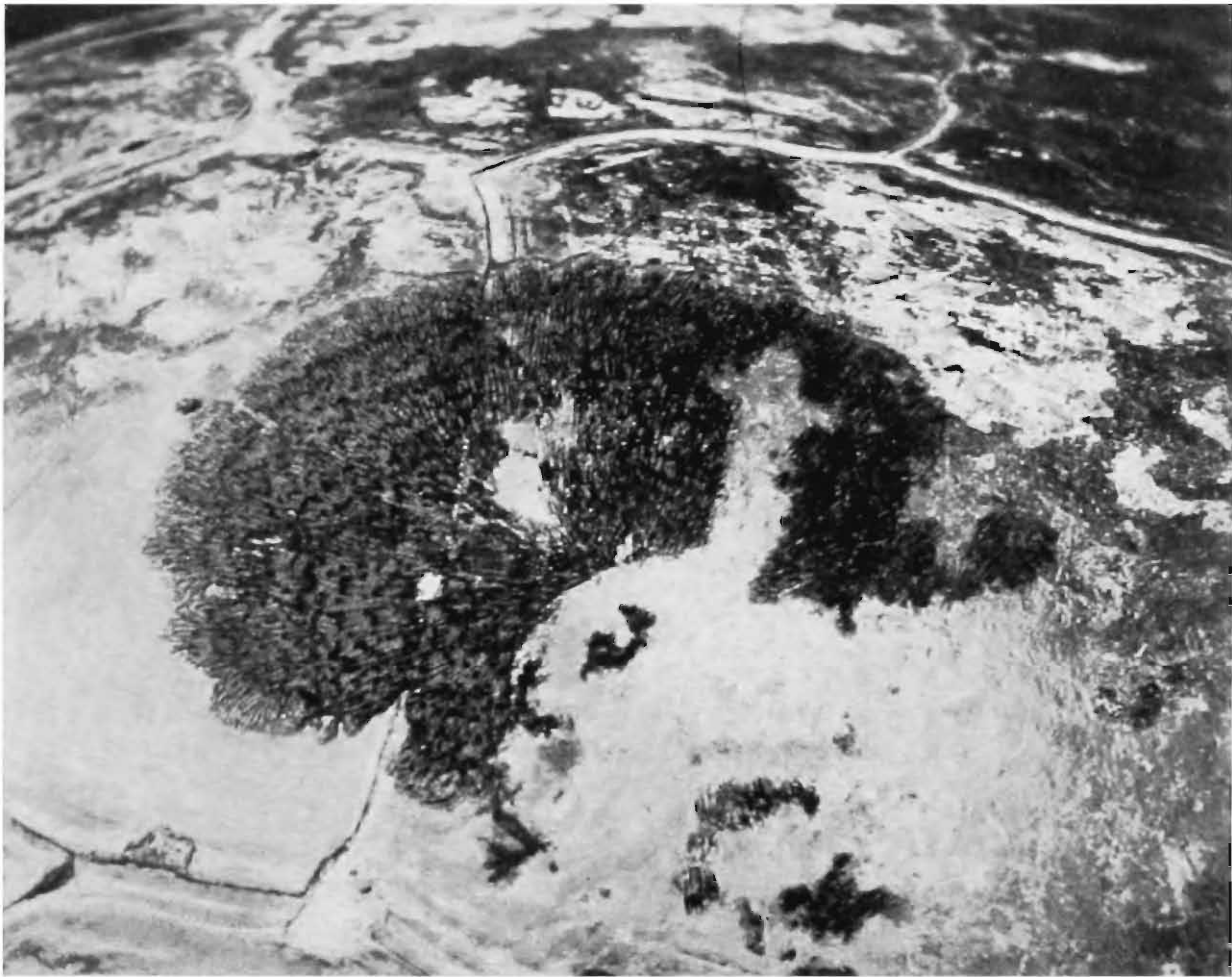
cally complete, statoblasts being produced in large numbers. *P. testudinicola*, like so many other Indian representatives of the Phylactolaemata, would appear, therefore, to be essentially a cold-weather form. On *Hardella thurgii* the zoaria grew over those of *Hislopia lacustris* and the zooecia were much less regular in their arrangement than when they were alone. The smooth shell of *Kachuga lineata* seemed, on the other hand, to encourage the production of the regularity and parallel growth so characteristic of the branches of the species.



EXPLANATION OF PLATE XIII.

Photographs of the type-specimens of *Plumatella (Afrindella)*
testudinicola on the carapace of *Kachuga lineata*.

- FIG. 1.—The whole zoarium (*nat. size*).
,, 2.—The central part of the same zoarium (*enlarged*),
showing statoblasts (s) *in situ*.



1.

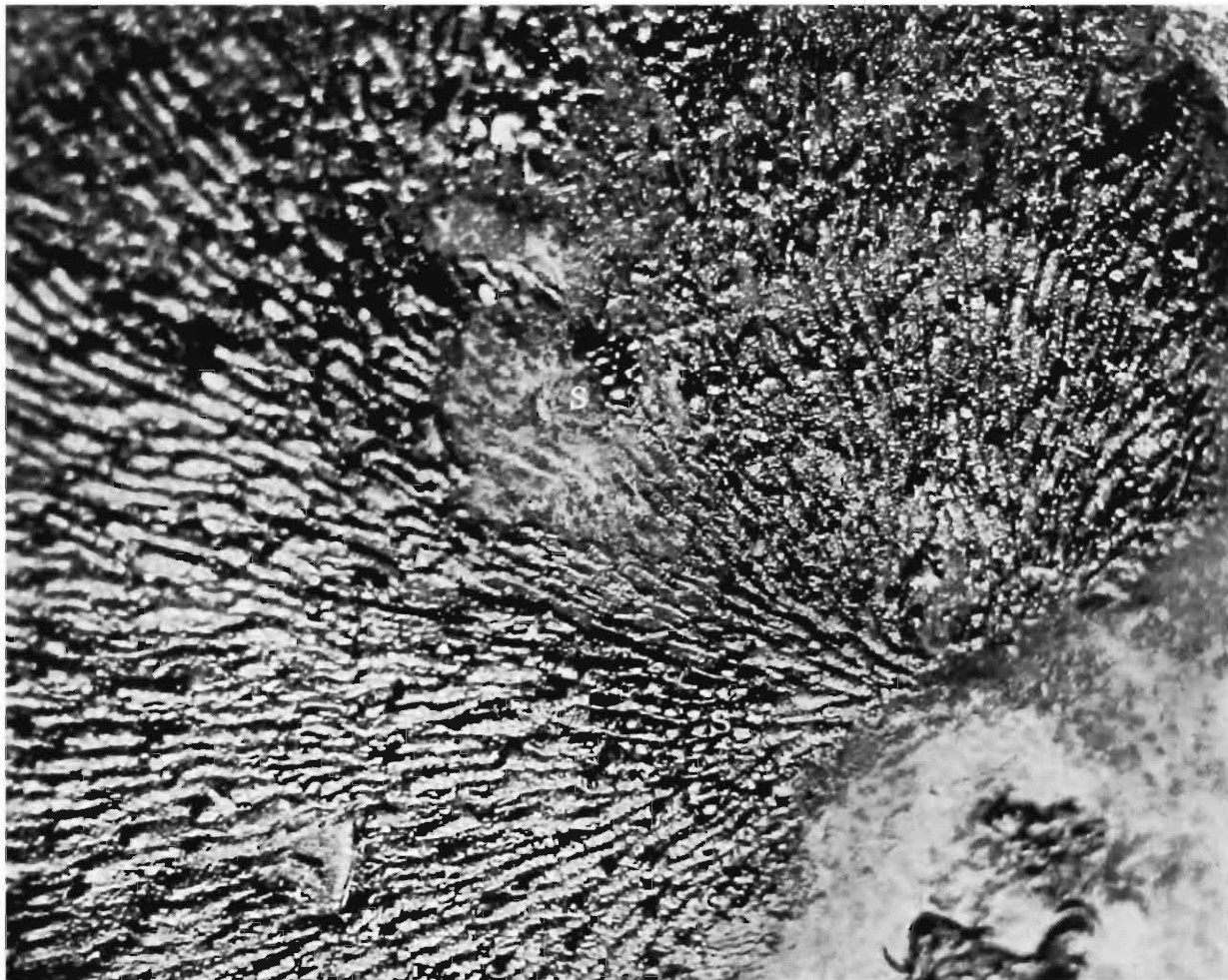


Photo by N. Annandale.

2.

XVI THE INDIAN MUD-TURTLES (TRIONYCHIDAE)

By N. ANNANDALE, D.Sc., F.A.S.B., Superintendent,
Indian Museum.

(Plates V—VI.)

The main object of the present paper is to supplement Mr. G. A. Boulenger's admirable account of the Indian Chelonia published in the volume on Reptilia and Batrachia in the "Fauna of British India." It is now twelve years since this volume appeared and although additions to our knowledge of the Trionychidae since that date have not been very numerous or important so far as India is concerned, the fact that its author had not access to the bulk of the large collection accumulated in the Indian Museum by the late Dr. J. Anderson and his contemporaries and successors rendered certain omissions unavoidable.

I have been able, moreover, to institute special inquiries into the distribution of certain species and races and have received assistance in so doing from several naturalists in different parts of India, especially from Dr. J. R. Henderson, Superintendent of the Madras Museum, and from my colleague Mr. B. L. Chaudhuri, who has supplied me with valuable information.

One species and two subspecies not recognized by Mr. Boulenger in the "Fauna" are here described. The species belongs to the genus *Trionyx* and is interesting because it represents this genus in a geographical area in which information about its distribution was peculiarly scanty.

This *Trionyx* was described, it must be confessed inadequately, by Dr. Anderson, who named it *T. nigricans*. It inhabits a tract of country intermediate between the Brahmaputra river-system and the Arrakan streams in which a Burmo-Malay species of the genus first makes its appearance. I have found it necessary, moreover, to recognize the races of *Emyda* that occur in Chota Nagpur and Orissa on the one hand and in Ceylon on the other as distinct subspecies. The name *intermedia* is here proposed for the former race, while Gray's "*ceylonensis*" is available for the latter.

LIST OF THE INDIAN TRIONYCHIDAE.

1. *Dogania subplana* (Geoffr.). Mergui, Malay Peninsula, Sumatra, Sinkep I., Java, Borneo, and the Philippines.

- | | | |
|------|-------------------------------------|--|
| 2. | <i>Trionyx gangeticus</i> , Cuvier. | The river-systems of the Indus, the Ganges and the Mahanaddi. |
| 3. | „ <i>leithii</i> , Gray. | The rivers of western, central, and northern India. |
| 4. | „ <i>hurum</i> , Gray. | The lower reaches of the Ganges; the Brahmaputra as far east as its entry on the plains. |
| 5. | „ <i>nigricans</i> , Anderson. | Chittagong. |
| 6. | „ <i>formosus</i> , Gray. | The Irrawaddi, the Sittang and the Salween. |
| 7. | „ <i>phayrei</i> , Theobald. | Arrakan, Pegu, Tenasserim, the Malay Peninsula, Sumatra, Java, and Borneo. |
| 8. | „ <i>cartilagineus</i> (Boddaert). | Pegu, Tenasserim, Siam, Cambodia, the Malay Peninsula, Sumatra, Borneo and Java. |
| 9. | <i>Pelochelys cantoris</i> (Gray). | The lower Ganges system, Burma, the Malay Peninsula, Annam, S. China, Borneo, Sumatra, the Philippines and New Guinea. |
| 10. | <i>Chitra indica</i> (Gray). | The Ganges and Irrawaddi system, as far as the base of the Himalayas in the former. |
| 11. | <i>Emyda granosa</i> (Schoepff). | The valleys of the Indus and the Ganges; the Arrakan Coast. |
| 11a. | „ „ <i>intermedia</i> , nov. } | Chota Nagpur; the Central Provinces; Orissa and the north-east of the Madras Presidency. |
| 11b. | „ „ <i>vittata</i> , Peters. } | The greater part of the Bombay Presidency (including Cutch); the whole of the Madras Presidency except the north-eastern part; Travancore. |
| 11c. | „ „ <i>ceylonensis</i> , Gray. } | Plains of Ceylon. |
| 11d. | „ „ <i>scutata</i> , Peters. } | The valleys of the Irrawaddi and the Salween. |

From the above list it will be seen that the Trionychids of the Indian Empire fall naturally into three groups, if considered from a geographical point of view:—(1) those of the Indo-Gangetic and Brahmaputra river-systems; (2) those of the valleys of the rivers of Peninsular India, and (3) those of Burma.

The exact limits of these areas are, however, not strictly observed, for while the typical form of *Emyda granosa*, a characteristic Indo-Gangetic race, ranges in a south-easterly direction as far as the Arrakan Coast, the common Indo-Gangetic *Trionyx* (*T. gangeticus*) is apparently not only replaced in Arrakan by

T. phayrei but also separated from that species in Chittagong by *T. nigricans*, in many respects an intermediate form. Very little information is as yet available about the exact distribution of the South Indian species of *Trionyx*, but we now know that an Indo-Gangetic species (*T. gangeticus*) occurs in the Mahanaddi.

Both the southern race of *Emyda granosa* (subsp. *vittata*) and the northern or typical form have been found to be different from that which occurs in the Central Provinces and Chota Nagpur and inhabits even the valleys of rivers such as the Kasai and the Barakar which actually reach the sea through the Hughli estuary, south of the Hughli itself.

The Burmese forms are either endemic or found also in the Malay Peninsula, except the monotypic genus *Chitra* which has only been found in the Ganges and the Irrawaddi. *Trionyx formosus* is only known from the Irrawaddi, the Salween and the Sittang; *Emyda granosa scutata* only from the valleys of the two former rivers, while *Dogania subplana* and *Trionyx cartilagineus* are typical Malayan forms. *T. phayrei*, on the other hand, in all probability originated in the hills of Arrakan and has made its way southwards into the Malay Peninsula and certain islands of the Malay Archipelago and eastwards into Indo-China.

Only one of the Indian Trionychids has a really wide geographical range in both the Malayan and Indian sub-regions, namely *Pelochelys cantoris*. This appears to be a somewhat scarce species wherever it occurs, although it has been found both in the lower reaches of the Ganges and in New Guinea, as well as in many intermediate localities.

In preparing these notes I have not thought it necessary to give detailed reference to all the works that have appeared before or since the publication of Mr. Boulenger's volume in the "Fauna." To do so in respect to previous works is needless except in a few instances, whereas a full bibliography of recent references can be extracted from Dr. E. Siebenrock's "Synopsis der rezenten Schildkröten" (Zool. Jahrbucher, Jena, 1909). I have referred to this most useful work throughout simply by the author's name with the page number added.

Genus DOGANIA, Gray (1844).

Siebenrock, p. 605.

This genus, which is not recognized by Mr. Boulenger (at any rate in the "Fauna") as distinct from *Trionyx*, has the whole series of costal plates separated by neurals, instead of having the last pair of costals in contact in the middle line. The plastron¹ is also less fully ossified than in *Trionyx* in a restricted sense, and the branchial skeleton differs in that the basihyoid bones are in close contact in the middle line.

Only one species, which is widely distributed in Malaysia and occurs in the coastal districts of Burma, is known to exist.

¹ Siebenrock, S. B. K. Akad. Wiss. Wien, CXI, pp. 817—8, fig. 2, 1902.

The branchial skeleton of this genus is less fully ossified and less complex than in some genera of the family. I have been able to find specific differences in it in some species. The basal part consists in the adult of three pairs of bones, a pair of basihyals in front, followed by two pairs of basibranchials. The basihyals are widely separated by a cartilaginous plate in which small irregular ossifications sometimes occur; their external margins are somewhat protuberant anteriorly but do not form regular horns. The basibranchials are in close contact in the middle line; the large cornua are articulated to prominent condyles situated on their external margins. The hypobranchials are well developed. They are articulated to the posterior border of the posterior basibranchials. The ceratobranchials and pterygo-branchials are sometimes represented by cartilage, sometimes ossified.

An examination of the fine collection accumulated in this museum by the late Dr. John Anderson renders it necessary to reinstate one species (*T nigricans*) inadequately described by him and since ignored by most writers on the Chelonia. All the recognized Indian and Burmese species are represented in the Indian Museum, but *T leithii* and *T cartilagineus* only by young specimens. We possess the types of the following described species :—

T buchanani, Theobald. (= *T hurum*, Gray). No. 1090 (skeleton). Proc. As. Soc. Bengal, 1874, p. 78.

T nigricans, Anderson. Nos. 1898 and 735 (skeletons). Ann. Mag. Nat. Hist., (4) XVI, 284 (1875).

Mr. Boulenger suggests in his "Catalogue of the Chelonians, etc. in the British Museum" (p. 243) that at least some species of *Trionyx* are dimorphic, the two phases differing in the form and structure of the jaw and their characteristic features being produced, in the case of the individual, by the method of obtaining food adopted at an early age.

So far as the Gangetic species are concerned I have been unable to obtain any evidence that this is so. Two distinct species, the skulls of which are different at all ages, occur together, namely *T gangeticus* and *T hurum*. The former has a blunt, the latter a sharp snout; and the youngest skulls can be distinguished with ease by the length of the symphysis of the lower jaw. I have examined many hundreds of living individuals, as well as a large series of skulls, and have never come across a specimen that was in any way intermediate between the two species in structure; while only one specimen of *T hurum* (No. 16627) had some resemblance to *T gangeticus* in colour, or rather differed so widely in this respect from normal individuals of its own species that its superficial appearance was reminiscent of *T gangeticus*, although it lacked the characteristic head-markings of that species.

A not uncommon abnormality in the Indian species is an upward curvature of the vertebral column that results in the carapace, instead of being flat, assuming a conical form and actually in some instances being deeper than it is broad. The presence of a deep groove on the middle line of the carapace is another common abnormality.

The nature of the food of the members of the genus is apparently a disputed point. So far as my own observations go, they are practically omnivorous, at any rate when living in a semi-domesticated state. In the Malay Peninsula certain individuals (probably of *T cartilagineus*) haunt rivers in the vicinity of villages and act as scavengers. The specimens of *T formosus* that are kept in the Arrakan Pagoda at Mandalay feed readily on curry and rice and those of (?) *T hurum* that live in somewhat similar conditions in a tank attached to one of the temples at

Puri in Orissa, eat sweetmeats made of parched rice and palm-sugar. In such conditions they grow very tame and come to feed when called. Those at Puri are popularly believed to be the descendants of a man named Gopal who offended Jugger-naut; they are summoned by the priests by this name, to which they answer sometimes—but by no means always—by appearing on the surface and swimming towards the edge of the tank.

The distribution of the Indian species of *Trionyx* is a matter of considerable interest but one in need of further elucidation, especially in respect to the species that occupy the rivers of western and southern India. There can be no doubt that one species (*T. gangeticus*) occurs both in the Indus and the Ganges, but whether this is the only form that will be found in the former river we do not know. Whether *T. leithii* is to be found in all the rivers of western, central and northern India we do not know. What species occur, if any do occur, in the rivers that water the southern and south-western parts of the Madras Presidency, and whether any species occur in Ceylon are questions that I have been unable to solve.

In the Gangetic delta, and I believe in the other parts of India, *Trionyx* is regarded as an important article of diet. Very large numbers are caught, chiefly in the Khulna district, for the Calcutta market and are sent to town by train. They are captured in nets in autumn, when the rivers begin to sink, and are stored in the vicinity of Calcutta in small ponds, their fore and hind feet being sewed together and a hole, to which a string is attached, bored in the cartilaginous part of the disk. In this condition they live for many months. The only species I have actually seen treated in this way are *T. hurum* and *T. gangeticus*, but I understand *Chitra indica* is dealt with in a similar manner.

Key to the Indian species of *Trionyx*.

1. Two neural plates between the first pair of costals.
 - (A) A strong longitudinal ridge on the mandibular symphysis; coloration of adult very dark. *T. nigricans*.
 - (B) The longitudinal ridge on the mandibular symphysis feebly developed or absent.
 - a. Mandibular symphysis produced in front, its length being much greater than that of the orbit; at least four large and conspicuous ocelli as well as a dark reticulation on the disk of the young, that of the adult dark. *T. hurum*.
 - a¹. Mandibular symphysis not much longer than the orbit.
 - a. Disk pale, with radiating dark lines but no ocelli in the young; inner margin of mandible ridged.. . . . *T. gangeticus*.

- a'* Disk of young with four ocelli; inner margin of mandible without a ridge. *T leithii*.
11. A single neural plate between the first pair of costals; a strong longitudinal ridge on the mandibular symphysis.
- A. Epiplastra widely separated immediately in front of the entoplastra. *T formosus*.
- B. Epiplastra in contact in front of the entoplastra.
- a. Plastral callosities feebly developed, finely sculptured.. *T phayrei*.
- a¹. Plastral callosities well developed, deeply sculptured.. *T cartilagineus*.

The above key is based on the one given by Mr. Boulenger on pp. 10 and 11 of his volume in the "Fauna," but has been modified to include the species omitted by him.

A table of measurements of the skulls of this genus and of *Dogania* preserved in the Indian Museum is given at the end of this paper.

2. *Trionyx gangeticus*, Cuvier (pl. v, figs. 1, 1a, 2).

Boulenger, Fauna, p. 12: Siebenrock, p. 596.

DISTRIBUTION.—The Indus, the Ganges, the Mahanaddi and their tributaries; probably also the Brahmaputra system. Mr. Boulenger is wrong in suggesting that this species does not occur in the Indus, for specimens from Karachi are identical, at any rate so far as head-markings and skull-characters are concerned, with those from Lower Bengal. The species, although not so abundant in the Calcutta market as *T hurum*, is sold for food in considerable numbers, being brought from different places in the Gangetic delta, especially from Khulna.

SPECIMENS :—

	BENGAL.	
	Calcutta.	Purchased.
1805 (no skull)		
1808 „	„	„
1806 (skl.)	„	
1080-3 : 1089 (skulls)	„	„
78-9 (skull)	„	„
3870 (skulls)	„	„
1720-2 (stuffed)	„	„
1724 „	„	„
1716 „	„	„
1893 (carapace & skull)	„	Dr. J. Anderson.
1895 (skl.)	„	„
1052-3 (skulls)	Ganges.	„
1054 „	„	?
288 (spirit)	Hughli.	?
879 (32 b. A. S. B.)	Calcutta.	E. Blyth, Esq.
881 (32 d. A. S. B.): juv.	„	„

881 (32 d. A. S. B.): juv.	Calcutta.	<i>E. Blyth, Esq.</i>
882 (32 e. A. S. B.)	„	„
883 (32 f. A. S. B.)	„	„
884 (32 g. A. S. B.)	„	„
1084-6 (skulls)	„	„
16750-1 (skl.)	Probably from Khulna Dist.	<i>Dr. N. Annandale & B. L. Chaudhuri, Esq.</i>

UNITED PROVINCES.

1810 (carapace): juv.	Allahabad.	<i>E. Atkinson, Esq.</i>
1729 (stuffed)	„	<i>J Cockburn, Esq.</i>
468 (spirit)	„	„
285 („)	„	„
286 (head in spirit)	„	„
756 (skull)	„	„
1732 (stuffed)	Agra ?	<i>Dr. Stoliczka.</i>
1727 „	Agra.	„
1728 „	„	<i>Riddell Museum, Agra.</i>

SIND.

1835-6 (skulls)	R. Indus, Karachi.	<i>Karachi Museum.</i>
3869, 3871-2 (heads in spirit)	„	„

Very old individuals lose the characteristic markings to a greater or less extent, sometimes becoming of an almost uniform pale olive-green all over the dorsal surface of the head and body. The ventral surface is never dark. The iris varies in colour from emerald-green to golden yellow.

The bony carapace of the largest specimen I have seen measures 48.5 cm. in length by 53.4 cm. in breadth. So far as I am aware, there are always two neural plates between the first pair of costals. The presence or absence of a callosity on the entoplastron is not correlated, either in this species or in *T. nigricans*, with age or sex. In some small individuals it is present, while in other much larger and evidently older ones no trace of it can be found. The median projection of the hyoplastra,¹ except in very young individuals, is double and comparatively short and stout, disappearing altogether in very large specimens, in which the two hyoplastra are in contact or almost in contact in the middle line for the greater part of their length. The sculpture on the sternal callosities is very deep and strong. The skull becomes much broader and blunter with age. The hypobranchials (fig. 1) are long and comparatively slender. In old individuals they are followed at the distal end by four or five short flattened oval bones, but in the young these are represented by cartilage.

¹ Cf. Siebenrock, S. B. K. Akad., Wiss. Wien, CXI, p. 280, fig. 3.

3. *Trionyx leithii*, Gray.

T. leithii, Gray, P. Z. S. 1873, p. 49, fig. 3. *T. gangeticus*, *id.*, *ibid.*, pl. viii.

Boulenger, Fauna, p. 12 Siebenrock, p. 597.

DISTRIBUTION.—The limits of distribution of this form are very imperfectly known. It was described from Poona in the Western Ghats and was taken by the late Colonel Beddome in the Nelambar River, which is also in the Malabar zone. Mr. Boulen-

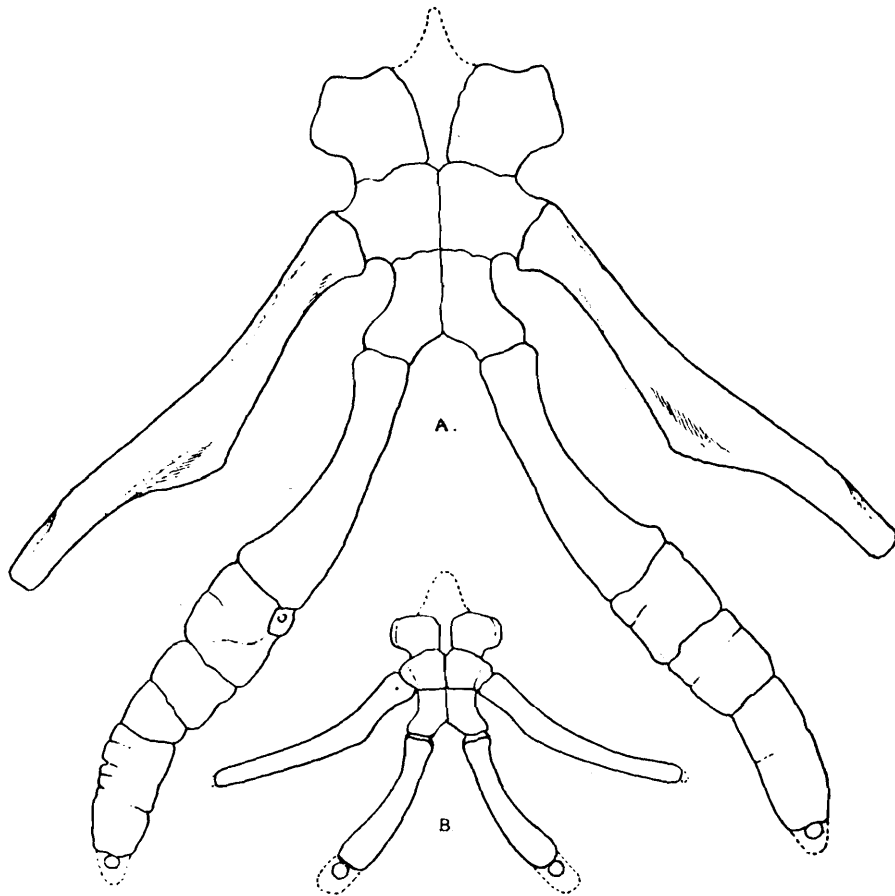


FIG. 1.—Branchial Skeleton of *Trionyx gangeticus*, $\times \frac{2}{3}$.
A, of adult ; B, of young.

ger states that the species occurs in the Kistna River and that the figure of it reproduced by Gray in 1873 as representing *T. gangeticus* was a copy of a drawing of specimens from Fatteghar.¹ The late Dr. W. T. Blanford obtained specimens in the Upper Mahanaddi system and in the lower reaches of the Godavari.

SPECIMENS :—

16503 (spirit) : juv.

?

?

¹ There are two places of this name in N.-W. India, one on the R. Ganges, the other in Patiala State and within the limits of the Indus system.

- 1731 (stuffed: skull } Hasdo R. (tributary Dr. W T Blanford.
 separate): juv. } of the Mahanaddi,
 Bilaspur district,
 Central Provinces.
 522 (spirit: skull } Godavari valley. „
 separate): juv. }

The only specimens in our collection that can be assigned to this species are young individuals. A figure of the plastron of the largest is reproduced below (fig. 2).

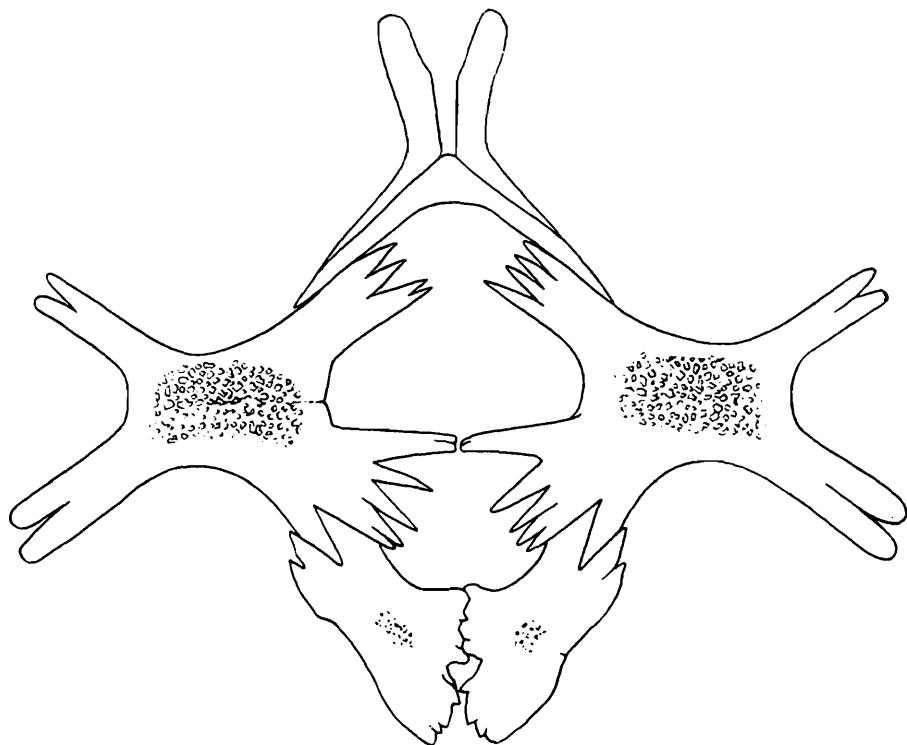


FIG. 2.—Plastron of *Trionyx leithii* (young), $\times \frac{2}{3}$.

4. *Trionyx hurum*, Gray (pl. v, fig. 3).

Boulenger, Fauna, p. 13, fig. 5 (young) : Siebenrock, p. 597.

DISTRIBUTION.—The lower reaches of the Ganges; the Brahmaputra as far north and east at the point at which it debouches on the plains. The species is said to occur also in Indo-China,¹ and in the Malay Peninsula,² but the latter locality rests on insufficient evidence. Although *T gangeticus* makes its way as far north as the base of the Nepal foot-hills and as far west as Karachi, I have been unable to obtain any evidence that *T hurum* is found much above Rajmahal. Moreover the only specimen (No. 10627) I have seen that was actually taken in Bengal outside

¹ Mocquard, "Les Reptiles de l'Indo-China" (*La Revue coloniale*, 1907, p. 13).

² See Flower, P. Z. S. 1896, p. 861, and 1899, p. 620.

the Gangetic delta was so peculiar in coloration that it may well represent a distinct local race. Specimens from Assam are perfectly typical in coloration. I have seen a consignment of over 500 individuals from Khulna being unloaded at the railway station. The "fishery" takes place mainly in October.

SPECIMENS:—

BENGAL.		
1050 (skull)	Calcutta.	<i>Dr. J. Anderson.</i>
1920 (skl.)	"	"
1797 (skl. deformed)	"	"
1049 (skl.)	Ganges.	"
1047 (skull)	Calcutta.	<i>Purchased.</i>
270 (skl.): juv.	"	"
1796 (skl.)	"	"
1784 (stuffed)	"	"
6846 (spirit): juv.	"	"
271-2 "	"	"
1090 (Skl.) Type of <i>T</i> <i>buchanani</i> , Theob.	"	"
16752 (skl.)	Gangetic delta.	<i>Dr. N. Annandale.</i>
292 (spirit): juv.	R. Hughli.	<i>Purchased.</i>
287; 289-91 (spirit): juv.	"	?
273-4; 276 (spirit): juv.	Calcutta.	<i>Dr. W. Theobald.</i>
16627 (Skl.)	{ Oodhua nallah, R. Ganges, near Rajmahal.	<i>B.L. Chaudhuri, Esq.</i>
283; 660 (spirit)	Kaligunge.	<i>W. Dodgson, Esq.</i>
16505 (head in spirit)	Dacca, E. Bengal.	<i>H. E. Stapleton, Esq.</i>
5578 (spirit)	{ Nattore, Rajshahi Dist., E. Bengal.	<i>T. R. Doucett, Esq.</i>
ASSAM.		
659 "	{ Nazir, N. of the Naga Hills, E. Assam.	<i>J. M. Foster, Esq.</i>
303 "	"	"
402-4 "	Sibsagar.	<i>S. E. Peal, Esq.</i>
11373 "	{ Dilcoosh, N. E. Assam.	<i>J. Ingles, Esq.</i>

In this species the coloration of the dorsal surface normally grows darker and more obscure with age, although the ventral surface is dark in the young and only assumes its uniform pale colour in half-grown individuals. Buchanan (Hamilton) in his collection of drawings now preserved in the Asiatic Society of Bengal's library figured three stages as distinct species. The first of these drawings (No. 52) is labelled *Testudo ocellata* and represents the young in which four large ocelli and a bold reticulation of black lines are conspicuous on the dorsal surface of the

disk. The second (No. 54), which is labelled *Testudo hurum*, represents an older individual in which the ocelli have become obsolescent, the ring of bright reddish yellow which surrounds the central dark spot having faded and the spot itself having increased greatly in size, while the reticulate lines have multiplied and become more vermicular in character. The third drawing (No 53) evidently represents a much larger specimen; it is labelled *Testudo chhim*. The whole of the dorsal surface of the disk has darkened and only small and somewhat obscure yellowish spots represent the pale ground-colour of the juvenile disk. The ventral surface is represented as dark olive faintly speckled with a pale shade in the first figure and uniformly pale in the others. The coloration of the head varies somewhat in the adult as regards the relative proportions of the yellow and the dark green areas. The former colour usually predominates on the snout and on the sides of the head behind the mouth and the latter on the post and inter-orbital regions, forming a more or less close and dense reticulation. In the young the two colours are more definitely separated. In old individuals traces of dark radiating lines can sometimes be detected on the edge of the disk, while that of the young is usually spotted minutely with yellow. The iris is greyish.

The specimen from near Rajmahal to which allusion has already been made was altogether abnormal in coloration. It was a half-grown individual with a disk measuring 27.6 cm. in length. The whole of the dorsal surface was of an almost uniform pale olive, green on the head and neck and greyer on the limbs than on the disk, which showed no trace of ocelli—markings of which traces can usually be detected in even larger individuals. The disk, however, had an obscure mid-dorsal stripe crossed by five cross-bars, all of a slightly darker shade than the ground-colour. The posterior part of the upper surface and sides of the head was obscurely clouded with dark olive. The whole of the ventral surface was pale and the iris was pinkish white. Fortunately a record of the colours of this specimen, which is preserved as a skeleton, was kept in the form of rough water-colour sketches and a cast of the fresh specimen was made and painted accordingly.

The snout does not become much blunter or the head broader with age in this species. In some very old individuals, however, the nasal aperture is, on the skull, considerably broader than the inter-orbital space, but this appears to be due, judging from the rugosity of the bones, either to senility or to disease. The hypobranchials (fig. 3) are comparatively short and broad; even in aged individuals they bear at the distal end only a cartilaginous plate containing a small ossicle.

The size reached by this species is not so great as that commonly attained by *T. gangeticus*. The largest individual I have seen was a male recently purchased in Calcutta and said to have come from Khulna. Its dorsal disk measured 60 × 40.9 cm. and its bony carapace 41.6 × 40.9 cm., the disk being rather narrower than usual.

Specimen No. 1094, an articulated male skeleton, is the type of Theobald's pseudo-species *T. buchanani*. It presents a very large male only slightly smaller than the one to which I have just referred, the bony carapace measuring 38.4 mm. in length and being distinctly broader than long.

The structure of the carapace and sternum of *T. hurum* is closely similar to that found in *T. gangeticus* except that the two

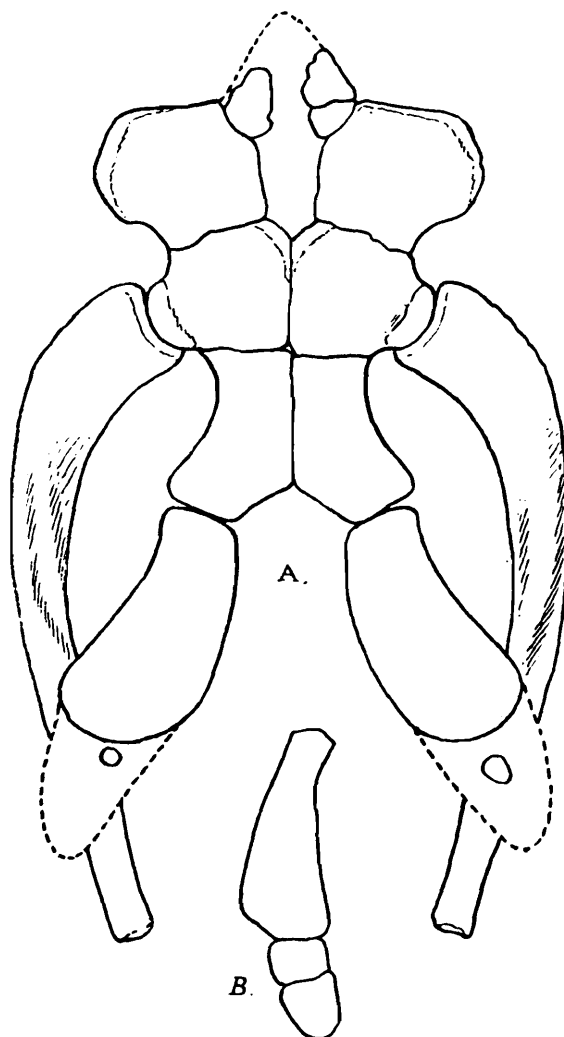


FIG. 3.—Branchial skeleton of *Trionyx hurum* and *T. formosus*.

A, complete apparatus (nat. size) of adult *T. hurum*.

B, hypobranchial, etc. of *T. formosus* (nat. size).

hyoplastra approach one another at a rather earlier stage and that their median processes are slighter and always single although distinctly bifid at the tip.

A not uncommon abnormality, noticed in both young and old individuals, is the presence of three neural plates between the first pair of costals. This is due to the separation of a small bone, sometimes quite symmetrically, from the central part of the anterior border of the first normal neural plate.

5. *Trionyx nigricans*, Anderson (pl. v, fig. 5).

Anderson, Ann. Mag. Nat. Hist., (4), XVI, p. 284 (1875).

The first pair of costals are separated by two neural plates. The posterior paired bones of the plastron are provided with well-developed callosities on which the sculpturing is only a little less strong than in *T. gangeticus*, and in some individuals there is also a callosity on the entoplastron. The hyoplastra do not meet in the middle line and are strongly divergent posteriorly, although they are relatively larger than in *T. phayrei*; their median process is single, short, stout and blunt, indistinctly bifid at the tip. The epiplastra are narrowerly separated or actually in contact in front of the entoplastron.

The skull is moderately broad, the snout a little longer than the diameter of the orbit; the interorbital width is greater than that of the nasal fossa and the postorbital arch is about one-third as wide as the orbit; the zygomatic arch is horizontal, less distinctly curved than in *T. phayrei*.

The alveolar surface of the upper jaw bears low median and internal longitudinal ridges. The lower jaw has a strong longitudinal ridge on the symphysis, which is a little longer than the orbit; there is no internal alveolar ridge.

Anderson describes the external characters as follows:—

“Carapace rather flattened on the back, with the vertebral groove ill-defined anteriorly, but well marked posteriorly. Nuchal swelling broader than in *T. gangeticus*, but not prominent, the carapace on either side being flattened. Alae of plastron well defined, projecting equally beyond the carapace. Nuchal flap narrow, and covered with rather large nodose folds; and the hinder portion of the cartilaginous margin of the carapace with little nodosities. The rugosities of the osseous carapace coarser than in *T. gangeticus*.

The under surface of the thighs and tail and of all the soft parts, including the head and neck, covered with little papillae. No trace of rugosities on the axygos plate of the plastron visible through the skin.

The tail in the female does not reach to the margin of the cartilaginous portion of the carapace.

Colour of the carapace dark blackish plumbeous, with a tinge of olive due to the presence of blackish spots, among which are inter-mixed many rusty brown spots, which overlies as it were the black spots. The head, neck, and upper surface of the limbs are almost black; the upper lip in its two posterior thirds is white; and there is a great white blotch over the ear.

The area between the neck and the four legs is whitish; and there are some white spots on the margin of the carapace. The head is reticulately spotted; and there is a distinct infrapraeorbital band, and a trace of another above the eyes; but the head is so black that these markings are difficult to distinguish. The under surface of the head and neck is almost black; and the

plastron is densely spotted with blackish purple, especially over the bones, and the tail is similarly marked. The claws are yellow."

DISTRIBUTION.—With one exception the specimens of this species are labelled as being from Chittagong in the extreme south-eastern corner of the old Province of Bengal. The one exception is labelled as being from Calcutta, but this locality is probably incorrect and in view of the fact that large numbers of Trionychids are imported into this city for food, carries in any case very little weight unless supported by independent evidence. It should therefore be ignored, unless it can be substantiated by the capture of specimens in the Gangetic delta, the probability being that *T. nigricans* is a species intermediate in habitat, as it is in structure, between *T. gangeticus* and *T. phayrei*.

SPECIMENS:—

BENGAL.

1918 (skl.)	Chittagong Tanks	<i>A. L. Clay, Esq.</i>
754 (skl.)	" "	"
1908 (skl.)	" "	"
1898 (skl.)	} Types.	"
735 (skl.)		
no skull)		
1849 (skl.)	" Calcutta "	<i>Dr. J. Anderson.</i>

T. nigricans may be stated in general terms to resemble *T. phayrei* in the structure of its skull and mandible and *T. gangeticus* in that of its carapace and plastron. In coloration, however, it evidently differs from both and neither its skull nor its plastron agrees precisely with that of the species which they respectively recall. All the specimens appear to be adult and both sexes are, to judge from Anderson's labels, represented. The bony carapace of the largest measures 40.3 cm. in length by 46.7 cm. in breadth.

6. *Trionyx phayrei*, Theobald (pl. v, fig. 4).

Anderson, P.Z.S. 1871, p. 154, fig. (plastron): Boulenger, Fauna, p. 14: Flower, P.Z.S. 1899, p. 620: Siebenrock, p. 598.

DISTRIBUTION.—Arrakan, Pegu, Tenasserim, the Malay Peninsula, Sumatra, Java (*Max Weber*) and Borneo. In Arrakan this species occurs in mountain streams and Flower states that he found a specimen in a similar situation in Johore. As Mr. H. C. Robinson has pointed out to me, the locality "Penang" must be accepted with caution, for there is a Chinese temple on the island in which tortoises from many different parts of the Malay Archipelago are kept.

SPECIMENS:—

755 (skull and plastron)	" Penang "	<i>Dr. J. Anderson.</i>
1094 (stuffed: skull separate)	Arrakan	(<i>Purchased</i>).

Both these specimens present fully adult individuals and have already been referred to in published works. No. 1094 is the one mentioned by Theobald on p. 15 of his "Catalogue of Reptiles in the Museum of the Asiatic Society of Bengal" as *T guntherii*, Gray; while the other (No. 755) is all that remains of the specimen described in detail by Anderson in 1871.

I was at first inclined to think that neither could belong to the species described by Theobald as *T phayrei*, because of the broadness of the skulls (fig. 4) and of the fact that the callosities

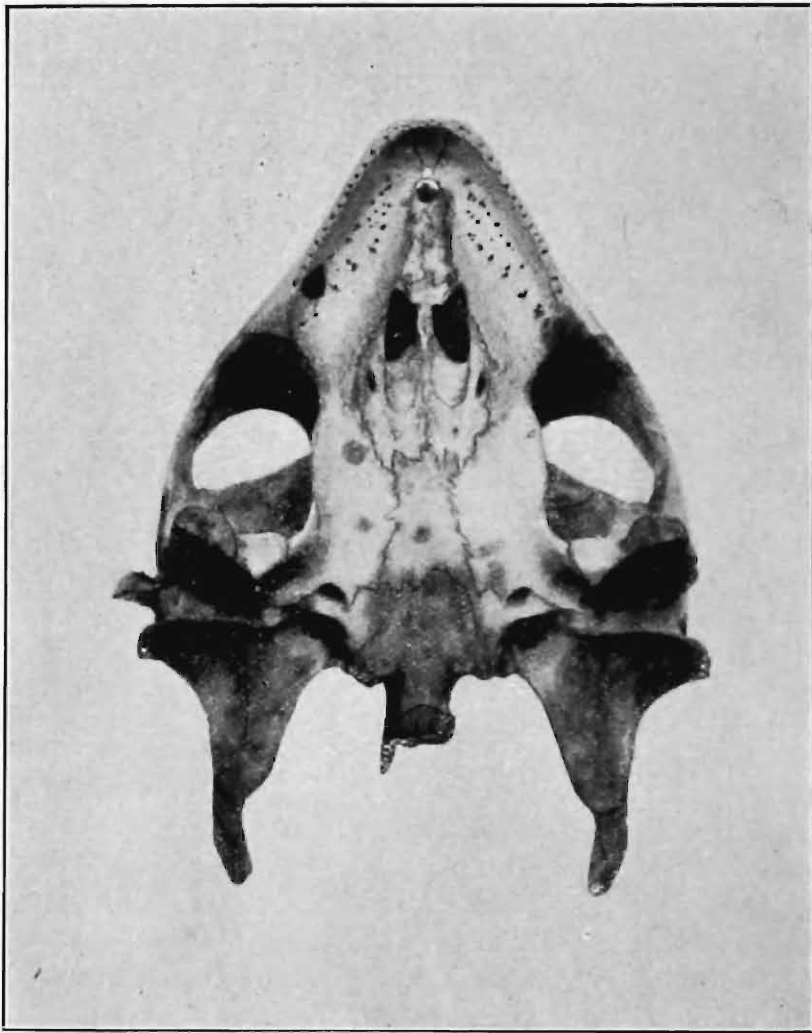


FIG. 4.—Adult skull of *Trionyx phayrei* from below (reduced).

of the plastron are distinctly though not deeply sculptured. It is, however, probable that these discrepancies are due entirely to the fact that most of the specimens hitherto examined have not been fully adult, for parallel if not quite as great differences may be noticed between the skulls of half-grown and of full-grown individuals of *T gangeticus* as those that evidently exist between the skull figured by Gray under the name *T jeudi* (and by Boulenger in his British Museum Catalogue (p. 252, fig. (6) under that of *T phayrei*) and those now before me. It is evident, moreover,

that Anderson in describing and figuring the plastron of his specimen did not remove the outer integument, which still adheres to the bone, and that in consequence he believed the surface to be smoother than actually was the case. As a matter of fact it is more nearly smooth than that of any Indian species, although by no means devoid of sculpturing.

The bony carapace of specimen No. 1094 measures 40.3 cm. by 50.6 cm.; that of No. 755 was, according to Anderson, slightly smaller. The median processes of the hyoplastra in this species are single, slender and pointed. They are never bifid at the tip.

T. phayrei is connected with *T. gangeticus* through *T. nigricans*, from which it differs chiefly in having only one neural plate between the first pair of costals. The skull is also broader than that of *T. nigricans*, in fully adult individuals.

7. *Trionyx formosus*, Gray (pl. v, fig. 6).

Boulenger, Fauna, p. 14: Siebenrock, p. 598.

DISTRIBUTION.—The Irrawaddi, Sittang and Salween Rivers. In the Irrawaddi this species is found near the Chinese frontier, as well as in the lower reaches. Numerous individuals, many of which are deformed, are kept in a small pond at the Arrakan Pagoda in Mandalay. I take it they belong to this species. It is very possible that statements regarding the occurrence of *T. hurum* in the Malay Peninsula actually refer to *T. formosus*, but the latter species has not been definitely recorded from any Malay locality.

SPECIMENS:—

BURMA.		
1786 (skl.)	Moulmein	Maj. Sladen.
277-8 (spirit)	Mandalay	
634 (skull)	Bhamo	Maj. Lowndes.
1837 (skl. juv.)	Burma	Dr. J. Anderson.
1063 (skull)	„	Hon. A. Eden.
605 (skl.)	„	Maj. Sladen.
685 (skl.)	Irrawaddi	Maj. Lowndes.
687 (spirit)	„	Hon. A. Eden.
1051 (carapace and palastron)	„	Dr. F. Stoliczka.
766 (skl.)	Burma	Hon. A. Eden.

This appears to be a comparatively small species. The bony carapace of the largest specimen in the collection measures only 27.4 × 26.5 cm.; its skull appears to be fully adult. In this specimen there are actually two neural bones between the first pair of costals, but the suture is asymmetrical and there can be no doubt that the condition is abnormal. In most cases the median process of the hyoplastra is short, single and rather stout, its

apex being bluntly pointed. In one skeleton, however, the right process is double.

The branchial skeleton (fig. 3, p. 163) resembles that of *T. hurum*, but the distal bones of the posterior process are more fully ossified, the hypobranchial being followed by two distinct bony plates of moderate size.

8. *Trionyx cartilagineus* (Boddaert).

Boulenger, Fauna, p. 15: Siebenrock, p. 599.

DISTRIBUTION.—Pegu, Tenasserim, Siam, Cambodia, the Malay Peninsula, Sumatra, Java, Borneo. This is evidently a Malayan species which has made its way into Lower Burma. It appears to be scarce in Pegu and Tenasserim but to be the common species of the Malay Peninsula.

SPECIMENS :—

BURMA.

2632 (spirit: skull
separate): juv. R. Irrawaddi . *Dr. W Theobald.*

MALAY PENINSULA.

13207 (spirit) : juv. .. Perak . Dr. J. Anderson.

Both of the above specimens are very young. Their skulls, which I have had removed, show the specific characters quite clearly.

Genus PELOCHELYS, Gray (1864).

Boulenger, Fauna, p. 15: Siebenrock, p. 606.

This genus is closely allied to *Chitra* but may be readily distinguished therefrom by the large and prominent orbits, which occupy a less anterior position on the skull. The plastron and carapace are very similar in the two genera. *Pelochelys* is another monotypic genus but has a much wider range, so far as we know, than *Chitra*.

9. *Pelochelys cantorii*, Gray.

DISTRIBUTION.—The lower reaches of the Ganges, (?) Assam, Burma, Indo-China, Siam, the Malay Peninsula, Borneo, the Philippines and New Guinea. *P. cantorii* appears to be a scarce species in all the localities in which it is found. I have not seen a single fresh specimen, and the two old ones in our collection are probably immature.

SPECIMENS :—

BENGAL.

1781 (skl.)	R. Hughli, Calcutta	<i>Dr. J Anderson.</i>
886 (33 a. A.S.B.).	, ,	?

Genus CHITRA, Gray (1844).

Boulenger, Fauna, p. 16: Siebenrock, p. 608.

This genus, of which only one species is known, is easily recognized by the elongate appearance of the skull, the eyes being situated close to the snout, and the complex form and unusually complete ossification of the branchial skeleton. The plastron¹ and carapace do not differ materially from those of *Trionyx*. The photographs reproduced on plate vi show clearly the general structure and proportions of the branchial skeleton, although its position relative to the skull is perhaps a little distorted. The basal part consists of four pairs of bones either sutured in the middle line or narrowly separated. Those of the most anterior pair (fig. 2, 1) are in close contact with one another for the greater part of their length as well as being firmly sutured to the next pair. They are roughly triangular in shape and probably represent the basihyal element, although they are not produced into horns at the sides. Behind them follow three other pairs of bones which may be taken to be the basibranchial; those of the first pair are smaller than those of the two posterior pairs and remain separated in the middle line even in old individuals. Those of the next pair are transverse in shape and form a median suture; they support the greater cornua, which are articulated to their sides. These bones are comparatively stout and long and are not expanded dorso-ventrally; they bear very large and well-developed muscular impressions near the proximal end of their external margin. The posterior processes are of great size and considerably expanded in the lateral plane, their ossification being unusually complete. Each consists of three broad bones fitted together by serrated sutures. The first of these is much the longest of the three and probably represents the hypobranchial and ceratobranchial fused together. In this case the second bone would be the epibranchial and the third the pterygobranchial. The former is a short plate of bone, the latter, although no broader at its outer margin, is bluntly produced towards the ventral margin in such a way that it is more than twice as broad within as it is without. The whole process curves inwards and upwards towards its fellow. In the large specimen mentioned below the length of the bony hyoid apparatus is nearly as great as the skull; the basal part measures 9 cm., each horn 11 cm., and each posterior process 13 cm. in length.

10. *Chitra indica* (Gray) (pl. vi, figs. 1, 2).

DISTRIBUTION.—The Ganges and Irrawaddi river-systems, as far as the base of the Himalayas in the former. The species is not uncommon in the Gangetic delta and large individuals can often be bought in the Calcutta market, in which, however, they are less abundant than *T. hurum* and *T. gangeticus*.

¹ Siebenrock, S.B.K. Akad. Wiss. Wien, CXI (1), p. 833, fig. 12, 1902.

SPECIMENS:—

BENGAL.

1776; 1113 (skl.)	. Calcutta.	<i>Purchased (Dr. J. Anderson.)</i>
3543	„ { Zoological Gardens, Calcutta.	<i>Peer Bux.</i>
1046 (skull)	R. Hughli, Calcutta	?
1055	Dacca, E. Bengal	<i>Dr. Wise.</i>
16753 (skl.)	Probably from Khulna	<i>B. L. Chaudhuri, Esq.</i>

UNITED PROVINCES.

483 (spirit): juv...	Allahabad	<i>J Cockburn, Esq.</i>
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Chitra indica is apparently the largest of the Indian Trionychids. The bony carapace of the largest specimen examined measures 52.3 cm. $\times$ 59.7 cm. The length of its skull (pl. vi, figs 1, 2) measured from the tip of the snout to that of the articular condyle is 17.8 cm., and the greatest breadth 10 cm. The carapace may be distinguished from any purely Indian species of *Trionyx* by possessing only one neural bone between the first pair of costals. The epiplastra are more widely separated from one another than in *T. hurum* and *T. gangeticus* and the anterior part of each is shorter than in most species of *Trionyx*. There are three or four processes on the inner margin of each hyoplastron.¹

Genus EMYDA, Gray (1831).

Boulenger, Fauna, p. 49: Siebenrock, p. 590.

A consideration of this genus, which probably occurs only in the Indian Empire and in Ceylon, raises questions of considerable taxonomic and geographical interest. As a genus it is easily distinguished from all other Trionychids of the Oriental Region by the fact that the hind limbs are protected by cartilaginous flaps or valves which can be closed over them on the ventral surface. Mr. Boulenger recognizes three species in the "Fauna," but expresses a doubt as to whether two of them are really distinct. After examining a large series of skeletons and specimens in spirit and seeing living individuals in different parts of India, I find it possible to recognize only one species with several local races or subspecies.

The branchial skeleton resembles that of *Trionyx* but differs in having the basihyals in close contact, the lateral margin of each basihyal produced into a blunt horn, the posterior margin of the posterior basibranchials deeply emarginate and the hypobranchials (with which the ceratobranchials are perhaps fused) very long and slender.

¹ Siebenrock, S.B.K. Akad. Wiss. Wien, CXI (1), p. 845, fig. 18, 1902.

The peculiar structure of the carapace and plastron of this genus, in which the soft parts can be more completely protected than in any other Indian genus of the family, may perhaps be correlated with a peculiarity in habits. *Trionyx* usually inhabits rivers and appears to be active at all times of the year, but *Emyda* lives in ponds and lakes and undergoes, at any rate in northern India, a considerable period of hibernation. Specimens were brought me in February at Purulia which had been dug from the mud in the basin of a dried pond, while the individuals which inhabit the Museum tank in Calcutta disappear for the whole of the cold weather. Not only can the characteristic cartilaginous flaps of the plastron close tightly over the hind limbs, but the anterior part of the carapace is flexible, owing partly to the fact that the nuchal plate is not as a rule united to the first pair of costals; it can be bent down to meet the anterior margin of the plastron in such a way that the retracted head and fore limbs are completely concealed, while the posterior part of the disk, including the marginal bones, can be bent down in a similar manner to protect the thighs and tail.

The typical form of *E. granosa*, although it rarely leaves the ponds in which it lives, is fond of sunning itself on logs or stones projecting above the surface of the water. It is extremely timid and difficult to approach. I have taken a young specimen of the South Indian form (*vittata*) at the edge of a pond among weeds.

11. *Emyda granosa* (Schoepff).

The distribution of this species cannot be considered apart from the question of the characters whereby its local races are separated. So far as it is possible to judge from the collection before me, three local races occur in India, one in Burma and one in Ceylon. They are:—

- (1) Indian races:—*E. granosa* (typical form), subspecies *intermedia*, nov., and subspecies *vittata*, Peters.
- (2) Burmese race:—Subspecies *scutata*, Peters.
- (3) Ceylon race:—Subspecies *ceylonensis*, Gray.

(1) The *forma typica* is confined in India proper to the valleys of the Indus and Ganges, but it probably occurs in Assam and certainly does so on the coast of Arrakan.

The subspecies *intermedia* occurs in the valleys of the Barakar and Kasai rivers, which reach the sea, just south of the Ganges, through the Hughli estuary, and in those of the Mahanaddi and the Godavari. Politically its range extends through Chota Nagpur, the Central Provinces, Orissa and the north-eastern part of the Presidency of Madras.

The subspecies *vittata*¹ is found in the Madras Presidency, over the greater part of which it ranges, occurring on the Mysore

¹ Siebenrock (p. 591, footnote) states that the Vienna Museum possesses a specimen of this race which appears to have come from Celebes, but the evidence as regards its *provenance* is not satisfactory.

plateau at an altitude of at least 3,000 ft. and also at sea level on the coast. It also occupies the greater part of the Bombay Presidency, including Cutch.

(2) The Burmese race (*scutata*) is only known from the valleys of the Irrawaddi and the Salween.

(3) The Ceylon race (*ceylonensis*) is confined to the plains of that island.

A. *Forma typica*. The granulations on the carapace and more especially on the plastral callosities are small, even and regular and are not arranged in concentric curves. The head and the carapace, at all ages, are of a dark olivaceous shade conspicuously spotted with yellow. There are usually 14 bony marginal plates situated round the posterior part of the carapace. The entoplastral callosity is never very large and the xyphoplastral callosities are never in contact for the whole of their length, invariably diverging from one another above. The median process of the hyoplastra is long and slender.

B. *intermedia* (pl. vi, fig. 3). The granulations of the plastral callosities are coarser and more irregular, the granules being larger but not arranged definitely in concentric curves. The head of the young is very obscurely marked; the carapace is deep olive-green with obscure paler markings. The head of the adult bears very conspicuous longitudinal dark lines; its carapace is dark olive-green with a darker vermicular reticulation. The entoplastral callosity is of moderate size and the two xyphoplastral callosities are never in contact for the whole of their length. The marginal and the median hyoplastral process are as in the preceding race.

C. *vittata*. The granulations of the plastral callosities are still coarser than in *intermedia* and the granules tend to be arranged in concentric curves. The head of the young bears longitudinal dark lines, but the carapace is without markings at any age. In older individuals the dark lines on the head tend to disappear, the colour being an almost uniform

dark brown. In other characters this race resembles *intermedia*.

D. *scutata*. The granulations of the plastral callosities resemble that of the *forma typica*, but the pale markings on the head and carapace are completely absent. In the young the carapace bears obscure dark spots, which tend to form a reticulation in the adult. The entoplastral callosity is very large. The marginal bones never fuse together; all are small and there are usually 18 present. The median hyoplastral process is very short and the xyphoplastral callosities are often in contact for their whole length.

E. *ceylonensis*. This race is closely allied to *vittata*, from which it is distinguished by the great relative size of the entoplastral callosity, by the facts that the xyphoplastral callosities are in contact for their whole length and that the marginal bones show a greater tendency towards fusion (only 12 being usually present), and by the extreme shortness in the adult of the median xyphoplastral process. The carapace of the young is obscurely spotted with a dark shade and there are black longitudinal lines on the head. The adult as a rule appears to be devoid of definite markings.

The only differences between these races lie in coloration, in the sculpturing of the plastral callosities, in the degree of ossification attained by the plastron, and in the number of posterior marginal bones that normally fuse together in the adult. Except coloration and plastral sculpturing none of these differences can be called constant, and even in coloration and sculpturing a certain amount of variation occurs. It may therefore be well to discuss each character separately.

To deal with coloration first: I should state that while I have seen a considerable number of living individuals of the typical form of the species and of the races *intermedia* and *vittata*, I have only been able to make a detailed examination of fresh material in the case of the two former and have not seen living individuals of either the Burmese or the Ceylon race. Specimens preserved in spirit, however, even for many years, as a rule show at least traces of the characteristic markings, except that the dorsal reticulation of the race *intermedia* disappears completely.

Moreover, Dr. J. R. Henderson has been kind enough to send me notes on the natural colours of the Madras race (*vittata*) at different stages. These notes confirm observations made on specimens preserved in spirit.

The spots on the dorsal disk of the Indo-Gangetic race are variable in size, number and arrangement but are perfectly distinct even in the largest individuals. Sometimes the larger spots have dark centres and resemble irregular ocelli. The markings on the head are much more regular. A large pale spot covers the greater part of the snout and of the interorbital region, being interrupted in the latter by a circular or nearly circular dark spot. There are two smaller pale spots beneath each eye and another above the angle of the mouth. A broad pale stripe runs obliquely backwards from below the eye towards the tympanic region and two longitudinally oval spots, sometimes united to form a V-shaped mark, form an angle above it, the anterior spot starting from the posterior upper border of the orbit. Sometimes the oblique stripe is broken up into two or more spots. There are also two or three smaller pale spots on each side of the back of the head. So far as can be judged from specimens preserved in spirit, those from Calcutta agree closely with those from Akyab on the one hand and Karachi on the other.

The pale spots on the back of the young of the race *intermedia* are very obscure and could not be recognized except in fresh specimens. The dark reticulation on the back of the adult is much more distinct but fades gradually in spirit. The dark lines on the head are, however, much more persistent. They are also conspicuous on small specimens of the Ceylon race (*ceylonensis*) that have been in spirit for many years.

The races of *Emyda granosa* fall into two groups as regards the sculpturing on the plastral callosities; in one group (consisting of the typical form, *intermedia* and *scutata*) the granules are much more regular, more uniform in size and more widely distributed on the surface of the bone than they are in the other, in which they tend to run together and to be arranged in concentric curved lines. The second group consists of *vittata* and *ceylonensis*. This difference is best observed in young individuals. The size of the entoplastral callosity is correlated to some extent with the degree of ossification attained by the other bones of the plastron. When the callosity is very large the xyphoplastra are always in close contact for the whole of their length on the inner margin. These characters, however, vary greatly in all races and it is only by examining *fully adult* individuals that satisfactory results can be obtained.

The following measurements, all of which are taken from the skeletons of adult females, show at any rate the large size of the entoplastral callosity in the adult of the Ceylon race. There is, however, considerable variation in the size of this callosity in specimens from India, although it is never nearly so large as it is in the race *ceylonensis*.

	<i>Calcutta.</i>	<i>Madras.</i>	<i>Ceylon.</i>
Length of carapace	22·8 cm.	22·5 cm.	24·5 cm.
Breadth	21·0 „	20·4 „	19·0 „
Length of entoplastral callosity	2·2 „	2·5 „	5·0 „
Breadth	2·5 „	1·7 „	5·5 „
Length of xyphoplastral callosity	5·3 „	5·0 „	5·7 „
Breadth	3·3 „	3·5 „	3·5 „

In measuring the carapace the length of the marginals is omitted and the longest measurement of the callosities that can be obtained in a straight line is given.

The relative size of the anterior marginals is due in the first instance to the fusion or non-fusion of several bones. The full number of marginals appears to be eighteen, nine on either side. In all the Indian races, and also in the Ceylon race, several of the most anterior of these bones normally fuse to form a single plate, the fusion taking place at a comparatively early age. Many irregularities, however, occur and it is often the case that the number of bones which have fused on one side is not the same as that of those which have fused on the other. Moreover, the pattern of the granules on the ventral surface often shows the line in which fusion has occurred, even in old individuals. Especially in the Ceylon race, moreover, the bone fused by the fusion of the first three marginals tends to increase greatly in width as the animal grows old. In the Burmese race (*scutata*) no such fusion normally occurs, but it is noteworthy that in a half-grown individual from Akyab which exhibits all the other characters of the typical *granosa* the marginals remain separate as in *scutata*, although in a slightly larger individual from the same locality the first three bones on either side are completely fused.

Emyda granosa (Schoepff).

BENGAL.

875-7 (stuffed):	} Calcutta and neighbourhood.	} Purchased; Dr. J. Anderson; E. Blyth, Esq.; Medical College.
13470-1 (carapace)		
1714: 1772 (skl.)		
1027-32 (plastra)		
242-3, 226-8, 239, 13380,	} Ditto	} Purchased; Dr. J. Anderson; E. Blyth, Esq.; W. Theobald, Esq.; O. L. Fraser, Esq.; Dr. J. T. Jenkins; C. Swarries, Esq.; D. Cunningham, Esq.
213-6, 218, 233-5, 237-8,		
220, 4229 32, 370-1,		
16501, 240-1 (spirit)		
1034-42 (skulls)		
	Calcutta or N. W. Provinces	?
1824 (skull)	Jessore	C. Tweedie, Esq.
1023 (skl.)	Sunderbunds	O. L. Fraser, Esq.

SIND.

3878-80 (spirit)	R. Indus, Karachi	<i>Karachi Museum Ex.</i>
3377 „	Jempir	„ „ „

BURMA.

244-5 (spirit)	Akyab	<i>Deputy Commissioner, Akyab.</i>
12627-9 „ : juv.	Jergo I., Off Arra- kan Coast.	<i>Indian Marine Survey.</i>

Emyda granosa intermedia, Annandale.

CHOTA NAGPUR AND ORISSA.

1663, 1665, 1669-71, 1673-5, 1677-80, 1688, 1686, 1689, 1694 (skl.)	} Hazaribagh.	<i>Lt.-Col. Boddam.</i>
250 (spirit)		
1662, 1664, 1666-7, 1672, 1676, 1681-2, 1692-3 1685 (skl.)	} Chota Nagpur	<i>Col. Dalton.</i>
1733-41 (plastra)		
1024, 1683 (skl.)	Singhboom	<i>H Hayes, Esq.; Lt.- Col. Boddam.</i>
257-61, 294 (spirit)	„	<i>H. Hayes, Esq.</i>
246 (spirit)	Surjuga	<i>Dr. V Ball.</i>
251-3 „	Ranchi	<i>Col. Dalton.</i>
16694 (skl.)	Chaibassa.	<i>Rev. A. Logsdail.</i>
405-7 (spirit)	Sambalpur.	<i>Dr. V Ball.</i>
12568 „	Dharma	<i>C. H. Dreyer, Esq.</i>
16764 „ TYPE.	{ Near Purulia, Man- bhum Dist.	<i>Dr. N. Annandale</i>
16765 „		

CENTRAL PROVINCES.

249 (spirit)	Raipur	<i>Dr. W T. Blanford.</i>
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MADRAS PRESIDENCY.

15990 (spirit)	{ Gopkuda I., Lake Chilka, Ganjam.	<i>Museum Collector.</i>
15991 (skl. & skull)		
520-1 (spirit)	Godavari River	<i>Dr. W T Blanford.</i>

Emyda granosa vitata, Peters.

MADRAS PRESIDENCY.

13497 (spirit)	{ Coconada, Coro- mandel Coast.	<i>— Mairguy, Esq.</i>
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263-5 (spirit)	Travancore	Prince Rama Varma.
254-6 ,, }	Madras	Madras Museum.
1022 (skl.) }		
16689 (spirit): juv.	Bangalore (3,000 ft.)	Dr. N. Annandale.

BOMBAY PRESIDENCY.

1660 (skl.): 1043 (skull)	Cutch.	Dr. Stoliczka.
247-8 (spirit): 566 ,,	Goa	Purchased; Dr. J Anderson.
1774 (skull)	Sind	Dr. W T Blanford.

Emyda granosa ceylonensis, Gray.

280-2 (spirit)	Ceylon	Dr J. Anderson.
1025-6 (skl.)	,,	Dr. Kelaart.
1043 (skull)	Colombo	Dr. J Anderson.

Emyda granosa scutata, Peters.

1705-7 (skl.)	Burma	Hon. A. Eden.
783 (skull)	,,	,, ,, ,,
266-7, 269, 3885, (spirit): juv.	,,	Hon. A. Eden, Maj. Sladen, Dr. W Theobald, Dr. F. Stoliczka.
268 (spirit): juv.	Moulmein, Lower Burma.	Dr. W T Theobald.
1708 (skl.)	Bhamo, Upper Bur- ma	Capt. Lowndens.
1709 ,,	Mandalay, ,, ,,	Maj. Strovers.

Lydekker (Pal. Ind. III (ser. x), p. 197 (43), 1886) states that *Emyda vittata*, Peters, occurs as a fossil in the Siwalik deposits of the Punjab and suggests that the Indo-Gangetic form (*granosa*) had not been produced when these beds were formed.

The shell he figures as that of the former, however, resembles the race *ceylonensis* (which he did not distinguish from *vittata*) in having the xyphoplastral callosities in contact for the whole of their length, agreeing in other respects well enough with *vittata*. It is not improbable that it actually represents a form from which both of the southern races have been evolved. The other fossil remains figured by the same author appear to have belonged to forms that were both less highly specialized and considerably larger than the modern ones. They show, however, that in Post-Tertiary times two types of plastral sculpturing had already become fixed. The North Indian and Burmese races may be descended from *Emyda sivalensis* or *E. palaeindica*, and there are indications that *scutata* possibly represents the latter species. If it could be proved that the different races of the one surviving species were derived from comparatively recent fossil forms that were specifically distinct from one another, it would be permissible

to cite them as instances of convergence produced by isolation, the ancestors of different species isolated by some means from one another having, in the absence of enemies and the presence of a liberal supply of food, tended to revert in general structure to their common but long extinct ancestor, while retaining certain unimpor-

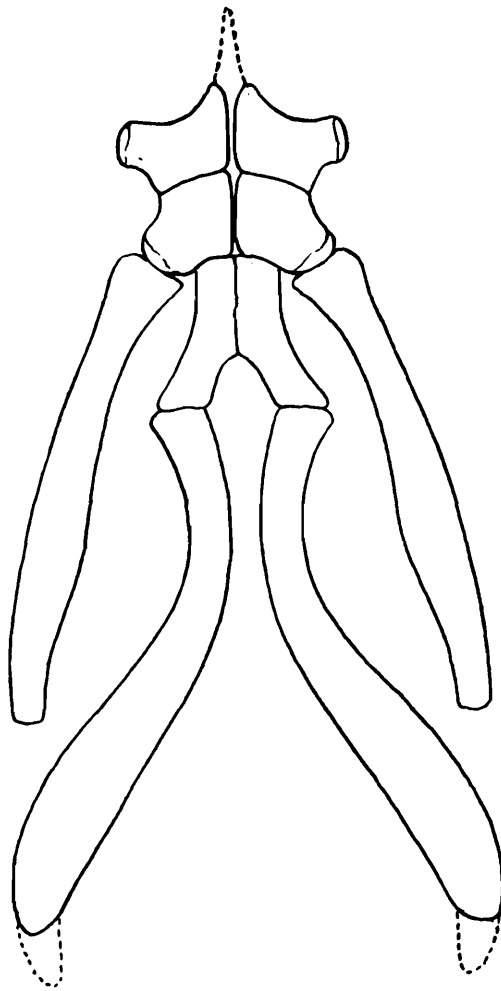


FIG. 5.—Branchial skeleton of *Emyda granosa*, $\times 2$.

tant distinctive features. Theoretically it would be difficult in that case to regard such forms as local races of one species, but in practice this seems at present to be the only possible course to adopt, if we are to pay any attention to geographical considerations in distinguishing between subspecies and varieties. (See Annandale, Fauna Brit. Ind.—Freshwater Sponges, etc., p. 18, 1911.)

Species.	Sex.	Reg. Nos.	Length.	Breadth.	Orbit.	Snout.	Inter-orbital width.	Nasal aperture (width).	Post-orbital Arch.	Mandibular Symphysis.
<i>T. gangeticus</i> , Cuv.	..	1893	134 mm.	96 mm.	22 mm.	36 mm.	17 mm.	19 mm.	12 mm.	20 mm.
"	..	1080	127	94	21	35	16	20	13	19
"	♂	78	123	95	20	34	16	20	11	13
"	..	16751	118	88	20	32	15	19	12	18
"	♂	79	117	86	21	32	16	21	9	18
"	♂	756	118	87	18	33	15	17	11	18
"	..	1081	113	84	19	33	13	18	9	18
"	..	1835	111	92	20	34	15	18	12	20
"	..	1089	102	75	18	30	13	15	9	13
"	..	1054	104	75	17	29	11	16	9	..
"	..	1082	92	68	15	26	12	14	8	14
"	♀	1083	92	63	17	25	9	14	7	12
"	..	1084	89	62	16	23	9	13	6	15
"	..	1052	88	62	16	23	10	15	7	15
"	..	1085	74	51	14	18	7	11	5	..
"	..	3870	84	58	14	22	8	12	5	..
"	..	1051	88	60	16	23	10	14	6	13
"	..	1086	77	52	14	19	7	11	5	11
"	..	1727	68	48	14	17	7	10	3	11
"	..	16750	60	41	12	15	6	9	4	10
<i>T. hurum</i> , Gray.	..	16752	129	87	21	38	16	19	14	30
" ¹	♂	1090	125	87	23	37	18	18	13	..
"	♂	1050	100	62	16	29	12	13	7	23
"	..	1920	88	58	16	28	11	11	7	22
"	♀	1047	83	49	14	24	11	10	7	20
"	..	1049	70	41	13	20	9	9	6	15
"	..	16627	72	43	13	19	9	10	4	16
<i>T. nigricans</i> , Andr.	..	1894	126	93	21	34	20	18	10	24
"	..	1898	125	90	21	32	16	17	10	22
"	♀	754	105	82	19	21	13	15	8	21
"	..	1908	104	74	18	28	12	15	8	19
"	♀	1918	?	74	18	28	15	14	9	?
"	..	1731	40	26	9	9	3	5	2	6
<i>T. formosus</i> , Gray.	..	1787	88	67	17	25	13	12	9	18
"	..	1786	89	60	15	25	13	11	8	21
"	..	605	87	56	16	24	12	11	7	?
"	♂	1063	79	54	13	20	11	10	6	17
"	..	634	59	42	12	16	7	8	4	13
<i>T. phayrei</i> , Theob.	♂	755	140	114	25	39	21	16	12	27
"	..	1094	?	128	25	42	21	20	13	26
<i>D. subplanus</i>	..	661	32	22	7	8	2	4	1	5
"	..	13488	70	52	7	17	5	8	1	10

¹ Type of *T. buchanani*, Theob.

1912.]

N. ANNANDALE: *The Indian Mud-Turtles.*

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ADDENDA.

The following specimens have been added to the collection or assigned to their proper position since the foregoing paper went to the press :—

TRIONYX GANGETICUS (p. 157).

Bengal.

16791 (skl.)	.	Oodhua, near Rajmahal.	<i>B. L. Chaudhuri,</i> <i>Esq.</i>
16791 ,,	.	R. Mahanaddi, Sambalpur	,,
16712 ,,	.	,, Cuttack	<i>Mrs. L. de Monte.</i>

Central Provinces.

1087-8 (skulls : } juv.) }	Nasdo R. (tributary of the	<i>Dr. W.T. Blanford.</i>
	Mahanaddi), Bilaspur district.	

TRIONYX HURUM (p. 160).

16781 (skl : skin of head in } spirit). }	Oodhua, near Rajmahal.	<i>B. L. Chaudhuri,</i> <i>Esq.</i>
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This specimen agreed fairly well in coloration with the one (16627) from the same locality described on p. 162 but was rather darker.

EMYDA GRANOSA INTERMEDIA (p. 172).

Orissa.

16911 (skl.)	R. Mahanaddi, Cuttack.	<i>Mrs. L. de Monte.</i>
16785-6 (spirit.) ..	,, Sambalpur.	<i>B. L. Chaudhuri,</i> <i>Esq.</i>

Specimen No. 16785 is melanic, the whole of the dorsal surface being of an almost uniform black while the ventral surface is strongly tinged with dark pigment.

EXPLANATION OF PLATE V

MANDIBLES OF INDIAN SPECIES OF *Trionyx*.

Figs. 1, 3, 4, 5 reduced ; 1a, 2, 6 natural size.

FIG. 1, 1a, 2.—*Trionyx gangeticus*.

1, 1a. Old and young individuals from the R. Ganges ;
2. Young individual from the R. Mahanaddi.

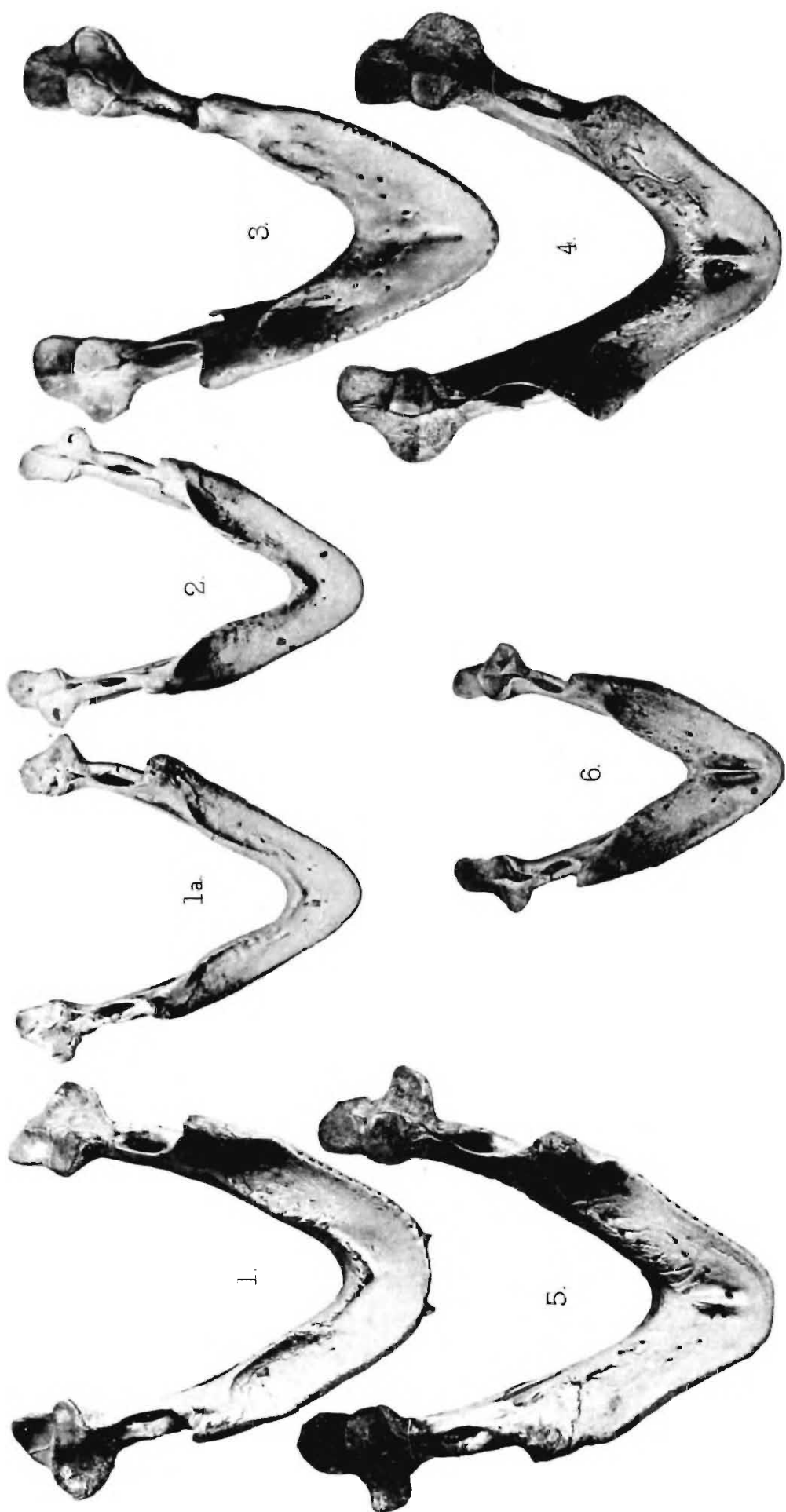
FIG. 3.—Adult of *T. hurum* from the Gangetic delta.

FIG. 4.—Adult of *T. phayrei* from Arrakan.

FIG. 5.—Adult of *T. nigricans* from Chittagong.

FIG. 6.—Half-grown individual of *T. formosus* from Burma.

[The small projections at the tip of the jaw represented in fig. 1 are artificial.]



Mandibles of Indian Species of Trionyx.

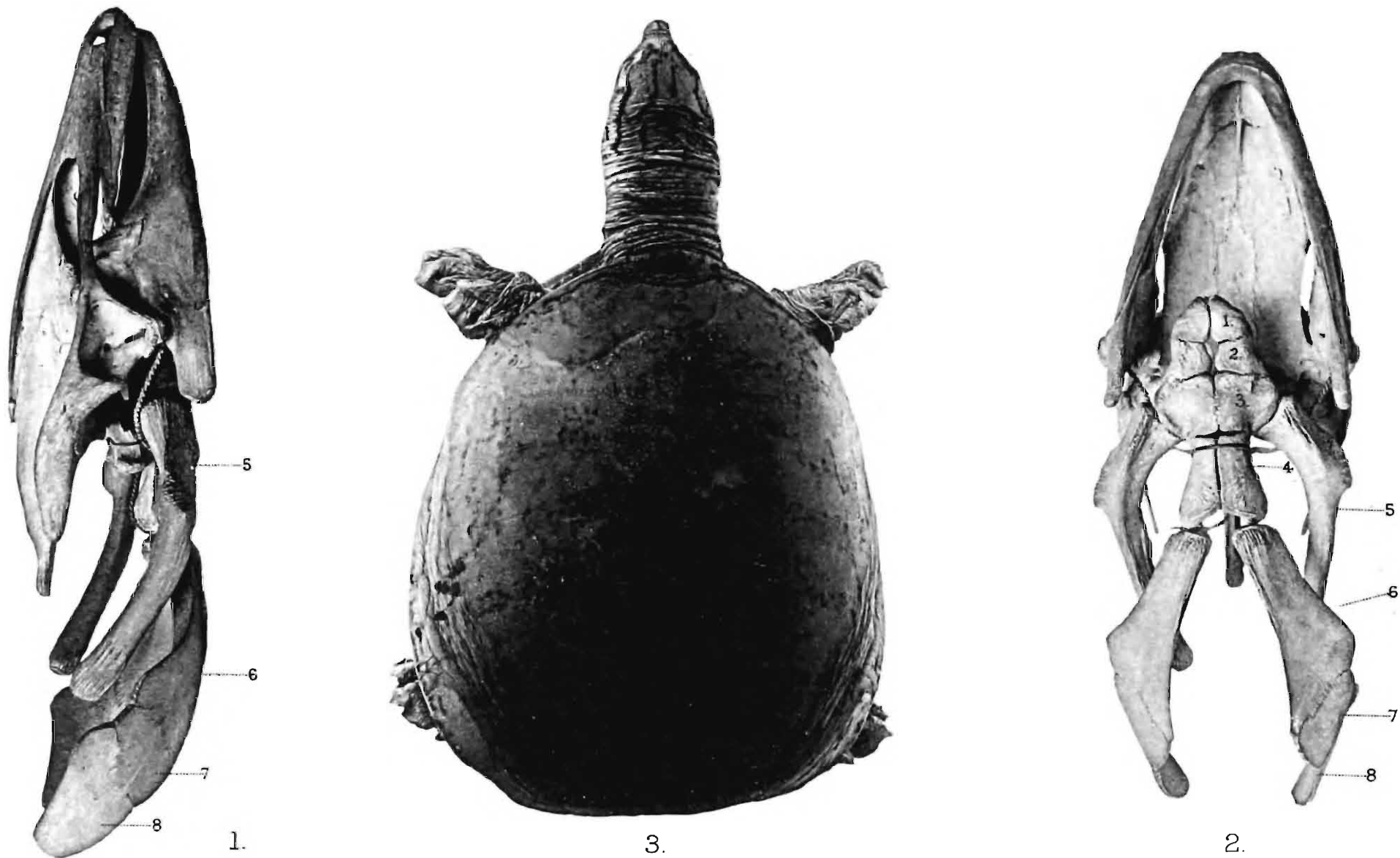
EXPLANATION OF PLATE VI.

All figures reduced.

FIG. 1, 2.—Skull and branchial skeleton of *Chitra indica*.

1. basihyal; 2, 3, 4. basibranchials; 5. greater cornu;
6. hypobranchial and ceratobranchial fused; 7. epibranchial;
8. pterygobranchial.

FIG. 3.—Type specimen of *Emyda granosa* subsp. *intermedia*.



Figs. 1, 2. *Chitra indica*. Fig. 3. *Emyda granosa intermedia*, subsp. nov.

XVII ON THE ANATOMY OF *ATOPOS*
(*PODANGIA*) *SANGUINOLENTA*
(STOLICZKA, M.S.).

By EKENDRANATH GHOSH, L.M.S., B.Sc., Assistant Professor
of Biology, Medical College, Calcutta.

(Plates xxv-xxvii.)

INTRODUCTION.

The present article is based on several specimens of a slug collected more than forty years ago by the late Dr. F. Stoliczka in Penang¹ and at present in the possession of the Indian Museum. They have been placed at my disposal through the kindness of Dr. N. Annandale for anatomical investigation. Although left in alcohol for so many years, the animals were still in such a good condition as to allow me to make out the anatomical features in full detail with a few exceptions only. Having access to Simroth (12) and Collinge's (3, 4, 5, 6) publications, I took the opportunity of comparing the anatomy of other species of *Atopos* (of which *Podangia* is a subgenus) with that of the present species. As the animals had not been lately identified, it was necessary for me to consider the external characters fully and in minute detail, including the coloration. Unfortunately the colours of the animals have probably faded through long immersion in alcohol, but I have described them as they are at present.

Before passing on to the anatomy at once I shall try to find out the positions of the animals and the genus to which they most probably belong.

The specimens were placed in the family of Vaginulidae (Veronicellidae, Gray), order Pulmonata, under the name of *Veronicella sanguinolenta* by Stoliczka.² In 1891 Simroth in his admirable monograph (12) defined a new genus *Atopos* which he established for three species of *Vaginula*, Latrille,

¹ Apparently he obtained the specimens in the "more wild and deep ravines of the north-western part of the island." (Journ. As. Soc. Bengal (2) XLI, p. 261 (1872).

² Stoliczka probably referred to these specimens in his paper on the mollusca of Penang (1873), but he only named them in MS. Collinge in "A CHECK LIST OF THE SLUGS," published by Cockerell and himself (3), writes on page 223 "*Atopos pulverulentus* apparently includes a specimen in the British Museum from Penang (Theobald), marked '*V. sanguinea*, Stol.' It has the body beautifully marbled with black and grey, the sole pale orange-tinted. Length about 54 mm. Bluntly keeled." No date is assigned to *A. pulverulentus*, Benson, on page 195 of the same paper and I am unable to trace the description.

which is considered to be identical with *Veronicella*, Blainville (17). He also described the anatomy of these three species.

The genus *Atopos* is mainly defined by the following characters:—

The body is thickest at the junction of the anterior one-third and posterior two-thirds, with a median keel on the dorsal surface of the mantle (notum); the transverse section of the body forms an isosceles triangle with a short base (formed by the foot); the female generative aperture is situated close to the anus and the renal and respiratory apertures in the groove between the mantle and the sole, a little behind the male generative aperture (although a little distant from it); the male generative aperture is situated behind the right lower tentacle.

Simroth also separated a few other species of *Vaginula* and placed them in a new genus which he named *Prisma*. The genus is characterized by the body of the animal being prismatic in transverse section.

Before the publication of Simroth's paper (12), Heude founded another genus *Rathousia* for *Vaginulus sinensis*, the name of which he changed to *R. leonina*. The characters of the genus *Rathousia* are briefly as follows:—

The animals are elongated, limaciform; the mantle is not slimy; the upper tentacles are long; the lower tentacles are bifid; the posterior end of the foot is pointed, and extends beyond the mantle. The male generative aperture is placed behind the right lower tentacle. The female generative aperture rather approaches the male one, and is placed a little behind it, the anus and the excretory and respiratory apertures are placed close to the female generative aperture.

Later on, Heude united the genera *Atopos*, *Prisma* and *Rathousia* to establish a separate family Rathousiidae, characterized by a keeled mantle, male and female generative apertures distant and the anal and respiratory apertures placed near the female opening, in contradistinction to the absence of a keel, the position of the female generative aperture on the right in the middle of the body and that of the anal and respiratory apertures nearly at the posterior end of the body in the family of Vaginulidae (7, 11).

In 1900 Babor (2) established a new subgenus *Podangia* for *Atopos schildii* which differs from other species of *Atopos* in the following characters. The body of the animal is slender and high, with a distinct head separate from propodium. The foremost part of the notum is bent over the head covering it as a hood. The ommatophores (upper tentacles) are short, thick and distinctly annulated. Under each ommatophore is a crescent-shaped flap of integument produced into a process on each side and blended with the lower tentacle and the integument on the side of the mouth. The surface of the mantle is uniformly granulated with scattered tubercles in addition. The sole is small, with finely wrinkled border and with numerous

compact lobes. The groove between the foot and the mantle is shallow. The snout is elongated, with a small triangular mouth.

Taking the above characters into consideration, it seems to me that the animal belongs to the subgenus *Podangia*,¹ and as the colouring of the body differs from that of *P. schildii* it may be provisionally designated as *Atopos (Podangia) sanguinolenta*.

EXTERNAL CHARACTERS (pl. xxv, figs. 1 & 2).

GENERAL. The animal is elongated, limaciform. The body is compressed from side to side and is tapering to a point at the posterior end. The height and width of the animal is greatest at about one-fourth the length from the anterior end. The surface of the mantle is granulated uniformly and it also bears small scattered tubercles in addition. The tubercles are more numerous on the lateral aspect specially towards the margin of the mantle. The keel in the middorsal line is prominent but rounded. The margin of the mantle (perinotum) is sharp, wrinkled and inflexed. The foremost part of the mantle is bent over the head to form a hood-like covering. The anterior border of the hood is slightly notched. The posterior end of the mantle extends well beyond the foot. There is no distinct snout, the mouth being placed in a depression on the ventral aspect of the head. The head is distinctly separate from the propodium. The ommatophores are short, thick, and cylindrical, and are marked with annular wrinkles, they seem to be non-retractile (i.e. non-invaginable), as in all the specimens examined they were protruded to their full lengths although a little bit contracted. The lower tentacles are short, contractile and are each connected at the base with a flap of integument (precephalic flap) beneath. Each precephalic flap is a continuation forward of the head from the ventral aspect and is separated from its fellow of the opposite side by a long narrow gap extending behind to a little in front of the mouth. The anterior border of the flap is thin and convex; the outer border is broadly S-shaped, being concave in front and convex behind; the antero-external angle is pointed and the antero-internal rounded (pl. xxv, fig. 4). The anterior end of the foot is truncated and is produced in front to form the propodium. The posterior end of the foot is narrow and pointed and it does not extend beyond the mantle border. The margin of the foot is produced into a thin rim. The sole is wrinkled irregularly with small

¹ The colouring of *P. schildii*, as described by Babor (2), is as follows:—The dorsal surface of the mantle (notum) is dark brownish grey; the foremost part of the mantle which forms a hoodlike covering of the head is of course pale. The head and foot are hazel-nut brown in colour.

The anatomy of *P. schildii* having been compared with that of *A. semperi* and *Rathouisia* in a few lines only, is of little use for the determination of the species.

lobules. The foot is separated from the mantle border by a shallow groove.

COLORATION.—The dorsum of the mantle is now reddish buff with dots and blotches of purplish black; of the tubercles some are of the same colour as the blotches. The lateral surface of the mantle is purplish black above, forming a broad longitudinal band with irregularly sinuous margins and of about one-third the height of the notum in width; this band is continuous with that of the opposite side round the anterior hood-like portion of the mantle; below there is another bluish black band with irregular margins, this is also continuous with that of the opposite side round the anterior end of the mantle by a narrower band of the same colour. The margin of the mantle (perinotum) is yellowish grey, with bluish black dots just below the band above. The ommatophores, lower tentacles and the dorsal surface of the precephalic flap are slaty blue. In life the colour of the dorsal surface of the mantle was probably bright red and the lower lateral band was probably dark blue.

MEASUREMENTS.—The animals having contracted in different degrees, and having been distorted by long immersion in alcohol, it is very difficult to get an accurate measurement to be of any use afterwards. Still it was thought best to note down the different measurements of all the specimens so as to form an idea of an average dimension. The length is taken along the midventral line after straightening the animal but without stretching it. The figure thus obtained was then compared with that resulting from measuring the animal along the midventral line in the distorted condition, and it was seen to be practically the same in both the cases. Another measurement is also taken along the keel from end to end. The width of the notum is taken to be the longest distance between the two lateral surfaces of the animal, and this is found to correspond generally to the junction of the anterior one-fourth and the posterior three-fourths of the body. The height of the notum is the longest perpendicular distance between the keel and the margin of the notum.

The measurements are given below in a tabulate form; they are all taken in centimetres.

Number of specimens.	1	2	3	4	5	6
Length along the venter ..	7·8	7·6	7	6·9	6·9	6·4
Length along the dorsum ..		10·9	9·1	10·2	9	8·8
Width of the notum	1·1	1·0	1·0	1·0	1·0	1·0
Height of the notum	1·4	1·3	1·2	1·3	1·2	1·2
Width of the foot	·7	·6	·65	·65	·6	·5
Distance of the male genital aperture from the anterior end of the foot ..	·3	·3	·3	·3	·3	·3
Distance of the female genital aperture from the anterior end of the foot ..	1·3	1·3	1·25	1·3	1·3	1·2
Length of the ommatophore ..	·3	·2	..	..	·2	·2
Length of the lower tentacle	·15	·15	..	..	·15	·15
Length of the cephalic flap ..	·4	·3	..	..	·3	·3
Width of the flap ..	·3	·3	..	..	·3	·3

ANATOMY.

I. BODY WALL (pl. xxv, fig. 3).

Minute structure.—The body wall consists of the following layers :—

- (1) The *epidermis* consists of a single layer of epithelium. The cells of the epithelium are columnar in shape and are placed side by side except at their extreme narrow ends of attachment, where they are a little separated from each other. The free borders of the cells are refractile and striated, but it is doubtful whether they are ciliated. The protoplasm is granular and is marked with faint longitudinal striations. The nuclei are large and oval, and are placed in the middle of the cells. The attached narrow ends of the cells probably contain brown pigment granules in some places. Between these epithelial cells are scattered fine ducts of unicellular

glands which are sometimes placed so close to the surface of the body that the epithelial cells over them become more or less flattened and displaced sidewise.

- (2) The *dermis* or corium consists mainly of connective tissue with a few muscle fibres and unicellular glands. The glands are large flask-shaped cells generally placed beneath the epithelial layer. The cell-content consists mainly of the secreted materials with a little protoplasm and a small nucleus at the base. Immediately beneath the epithelial layer the connective tissue consists of large bundles of white fibres placed nearly at right angles to the surface and of smaller bundles which are branched off from the vertical ones and are spread horizontally in all directions. The fibres ultimately form a close network in the interstices of which lie the connective tissue cells. These are round, oval or fusiform cells with large nuclei. Some of these and others with branching processes contain brown pigment granules, which are densely placed beneath the epidermal layer. Beneath this are one or two layers of several muscle fibres scattered irregularly. The deeper layers of connective tissue consist of loosely arranged bundles of white fibres with a few yellow fibres and numerous connective-tissue cells. These cells are free from pigment granules.

II. RESPIRATORY SYSTEM (pl. xxv, fig. 5).

The pulmonary chamber is much atrophied; it forms a small oval sac lying in the anterior-third of the body beneath the right lateral wall of the mantle. It extends almost to the junction of the mantle with the foot below and stops short of the middle line above. The pulmonary chamber seems to open to the interior by an aperture placed at the antero-lateral corner to the right; the aperture is placed just behind the anus. The pericardium extends obliquely on the roof of the pulmonary chamber from the right antero-lateral towards the left postero-lateral corner. The kidney lies on the roof at the back. The roof of the pulmonary chamber is closely adherent to the inner surface of the mantle.

III. VASCULAR SYSTEM (pl. xxv, fig. 5).

The *pericardium* lies obliquely on the roof of the pulmonary chamber. The dorsal wall of the pericardium seems to be closely adherent to the body-wall.

The *ventricle* is placed in front of the auricle. The ventricle is a thick-walled pyriform sac with the ventral surface flattened

and the dorsal one convex. The *auricle* is thin-walled and is smaller than the ventricle.

Minute structure of the ventricle.—The ventricle is surrounded by a single layer of columnar epithelium. The muscles are arranged in various directions. The cavity of the ventricle is irregular and is traversed by numerous strands of muscle fibres. There is no epithelial lining in the cavity.

The *aorta*, just after its origin from the anterior end of the ventricle, divides into two; one passes forwards to the buccal bulb, while the other curves backwards and passes beneath the ventral aspect of the albumen gland closely applied to it, and seems to enter into the substance of the ovary; it also gives origin to several small vessels which supply the albumen gland.

The *pulmonary artery* (8) lies along the left side of the kidney, before it ends in the auricle; it receives numerous vessels from the kidney.

IV KIDNEY (pl. xxv, fig. 5).

The kidney is a flattened triangular body lying on the roof of the pulmonary chamber at the back. In position it lies just over the accessory digestive gland to the right. The surface of the kidney is provided with a network of vessels which open into the pulmonary arteries. The margins of the kidney are thinned out and is continuous with the membranous wall of the pulmonary chamber. The ureter could not be traced.

In *A. strubelli* (10), the pulmonary chamber is a more or less round sac with the heart placed transversely and kidney to the left extending over more than half of the pulmonary chamber.

Minute structure.—The kidney consists of a mass of tubules which converge to open into the ureter which seems to lie along the right (?) side of the kidney. The tubules are long and wavy with wide lumen. They are all placed side by side with thin layers of intervening connective tissue. The wall of the tubules consists of a single layer of polyhedral cells placed on basement membrane. The nuclei of the cells are oval, and are placed at the bases of the cells.

The sections of kidneys from two specimens show numerous cystic bodies contained in the cells of the tubules. These cystic bodies, which are doubtlessly parasitic, seem to be the oocysts of a sporozoon. They are mostly round or oval, although many are irregular in shape. The wall seems to consist of a thick layer of cuticle which did not allow the staining fluid to penetrate into the interior. The cysts contain from one to six spores with distinct round nuclei. The spores are spherical, or faceted when there are more than one in a single cyst. The oocysts were too little advanced to show the formation of sporozoites. This sporozoon seems to belong to the genus *Klossia* (fam. Polysporocystidae, order Coccidiidea).

V. DIGESTIVE SYSTEM (pl. xxv, figs. 6-13, and pl. xxvi, figs. 14-16).

(i) The *buccal bulb* forms a tubular or elongated conical proboscis lying in a muscular sheath when retracted. The sheath opens on the ventral aspect of the head to form the mouth. The wall of the sheath is continuous behind with the wall of the buccal bulb just in front of the opening of the oesophagus into the latter.

(ii) The buccal bulb is continuous behind with a thick-walled conical sac which forms the *radula sac*. Collinge (3) describes the buccal bulb as divided into two portions lying respectively in front and behind the opening of the oesophagus. The radula sac is surrounded by a distinct muscular sheath.

The *radula* (pl. xxv, figs. 11-13) is a wide ribbon-like structure which does not seem to extend far forwards in the proboscis. The teeth are arranged in V-shaped rows with the apex of v directed backwards. There is no central. The lateral teeth are uniform in shape except the two median ones which are slightly different from others. There is no marginal. There are never less than 19 teeth on each side of the middle line. Each tooth is unicuspid and presents a shallow cup-like process in the middle.

The teeth of the radula in *A. strubelli* (10) are similar to those of the present species except that there is no cup-like process in the former.

(iii) The *salivary glands* could not be found in the specimens dissected. They were described in several species of *Atopos* by Collinge (3, 4) and Simroth (12). Each gland was described to consist of a glandular mass and a long duct opening into the buccal bulb just behind the attachment of the muscular sheath on the ventral aspect. In *A. sarasini* (4), the two glands unite to form a single mass, although the two ducts are separate.

(iv) The *oesophagus* (pl. xxv, fig. 6) is a narrow tube arising from the dorsal surface of the buccal bulb behind the proboscis-sheath in the middle line or a little to its left. It then takes a U-shaped curve the bend of which is directed to the left. The tube then curves to the right, and down the side and ventral aspect of the anterior end of the radula sac to the mid ventral line, and then sharply turns forwards for some distance beneath the proboscis-sheath. It again turns backwards and passes beneath the short intercerebral connective to the undersurface of the digestive gland into the cavity of which it opens a little in front of the junction of the anterior one-third and posterior two-thirds of its length.

In *A. maximus* (3), the oesophagus passes to the left and then takes a U-shaped curve to pass beneath the radula-sac, it then passes backwards and to the left beneath the intercerebral connective to the under surface of the digestive gland and opens into it at a point about one-fourth the length of the gland from the anterior end. In *A. sarasini*, the oesophagus takes a similar sigmoid curve, but passes to the right at first and

then to the left. In *A. leuckarti* and *A. strubelli*, it ends in the anterior end of the digestive gland.

Minute structure (pl. xxv, fig. 10).—The oesophagus consists of the following coats from without inwards:—

- (1) A thin layer of connective tissue consisting of a few white fibres and elongated fusiform connective tissue cells. Just beneath this layer are seen two nerves (oval in transverse section) passing along the sides of the ventral surface of that portion of oesophagus which passes backwards from beneath the intercerebral commissure to the digestive gland.
- (2) Alternate layers of longitudinal and transverse muscle-fibres with loose connective tissue intervening between them. The fibres do not form continuous bundles, but are arranged irregularly. The fibres of different layers often communicate with one another. The bundles become smaller and smaller as we pass inwards. The longitudinal fibres become predominant on the inner side and form several longitudinal folds, generally nine in number, which project into the cavity of the tube.
- (3) The mucous membrane consists of a single layer of columnar epithelium. The cells seem to be ciliated.

(v) *The digestive gland, mid-gut gland or liver* (pl. xxv, figs. 6 and 8) is a large elongated conical (or fusiform) body wide and rounded in front, but tapering and pointed behind. It occupies more than the posterior two-thirds of the body. In front it lies in connection with another small gland, the accessory digestive gland, and it is connected at its hinder end to the terminal body-wall by strands of connective tissue. The outer surface of the gland is smooth, but presents some transverse fissures. The inner surface is raised into numerous folds and papillae which increase the absorbing surface to a great extent. The wall of the gland is thick, and the gland is circular in transverse section.

In *A. strubelli* and *A. semperi* (10), the outer surface of the gland is finely lobulated but the inner surface is smooth and circular in transverse section. In both the gland is of dark colour and is conical in shape. In *A. leuckarti* (10) the gland is irregularly lobed and presents a process to the left from near the anterior end.

Minute structure (pl. xxvi, figs. 14, 15).—The whole gland is surrounded by a thin layer of connective tissue (consisting of white fibres and connective-tissue cells). This ensheathing layer gives off numerous strands which converge and pass inwards to form the core of numerous papillae and folds which project into the cavity of the gland. These strands consist of connective-tissue fibres with a few muscle cells. These strands are surmounted by a single layer of cells which are placed side by side without any interspace between them. The cells are arranged to form

tubular spaces (simple tubular glands) between the contiguous connective tissue strands. Each space communicates with the cavity of the digestive gland by a wide mouth. The epithelium consists of elongated ciliated cells with the nuclei placed at the base. Numerous goblet cells are found between these ciliated cells. The bases of many of these ciliated cells are occupied by a number of amoeboid (?) corpuscles with large round nuclei.

The *accessory digestive gland* (pl. xxv, figs. 6, 8) is a small triangular body lying in front of the digestive gland. The ducts of this gland open into the intestine as the latter passes forward from the left side of the gland. In the drawing of the alimentary canal of *A. maximus* (5) ducts of two other glands (not represented in the figure) are shown to open into the digestive gland. Hence it might be inferred that the above gland opens into the digestive gland. No such glands seem to be present in *A. strubelli*, *A. semperi*, and *A. sarasini* (4.) The process from the digestive gland in *A. leuckarti* seems to be homologous with the accessory gland.

Minute structure (pl. xxvi, fig. 16.)—The gland is surrounded by a connective tissue-sheath. It consists of a large number of lobules held together by connective tissue. Each lobule consists of a group of irregularly polyhedral cells closely apposed to one another, although fine channels (with walls composed of connective-tissue cells only) are often found passing between the cells. The protoplasm of most of the cells is coarsely granular and is stained red with eosin. These are undoubtedly zymogen granules. The nuclei are oval or rounded, and are obscured in many cells by these granules. A small proportion of cells have clear protoplasm with finer granules and more distinct nuclei. The gland is richly supplied with blood vessels which are placed inside the lobules. They generally form bundles in the middle of the lobules.

(vi) The *intestine* is a stout but thin-walled tube arising from the left side of the digestive gland towards the ventral aspect and close to the opening of the oesophagus. It forms a U-shaped loop lying embedded on the dorsal surface of the gland and then passes along the left side or on the dorsal aspect of (figs. 6, 18) the accessory gland, over the groove on the albumen gland and vagina obliquely to end in the anus, which lies on the right side in the groove between the foot and the overhung margin of the mantle closely behind the female genital aperture.

In *A. strubelli* (10) and *A. leuckarti* (10), the intestine seems to be directly continuous with the oesophagus at the anterior broad end of the midgut gland, which opens into the gut by a wide aperture at the junction of the two. In *A. sarasini* (4) the intestine forms a M-shaped loop lying embedded in the wall of the gland and comes out from its anterior end. The oesophagus is continuous with the intestine with a wide aperture (at the junction) which communicates with the cavity of the midgut gland.

Comparing the alimentary canal of these slugs with that of the more typical groups of pulmonates, *e.g.* the land snails, it should be observed that in the present animal there is no distinct dilatation of the midgut in the form of stomach quite distinct from the liver, which opens into the gut by small ducts in contradistinction to the separate stomach and liver in the land snails. Here the stomach might be considered to have become incorporated with the cavity of the gland, the wall of which presents numerous tubular glands homologous with a separate digestive gland.

VI. REPRODUCTIVE SYSTEM.

As in other pulmonates, the male and female genital organs are united in the same individual. There is some difference in opinion about the connection between the male and female organs at their proximal ends. Simroth's (10) descriptions and figures of the genital organs of his three species show that there is a common hermaphrodite gland from which are given off the vas deferens and oviduct; this condition then corresponds to the second of three types of genital ducts described by Lang (8). Collinge (3, 4), however, could not find out any connection between the two in his specimens. Although I found the two organs separate from each other I have a good deal of doubt about the validity of Collinge's view for the reasons noted below. On examining under the microscope the stained sections of the organ which corresponds to what Collinge described as ovary, I observed spermatozoa in different stages of development to my full satisfaction in addition to immature ova. As I had only old spirit specimens to dissect, it occurs to me that the so-called ovary is really a hermaphrodite gland the fine vas deferens of which I could not trace. As the hermaphrodite and albumen glands lie over the penial sheath it seems to me that the vas deferens, being very fine and small, gets torn as the above glands are lifted up from their position and are separated from the penial sheath. Still as I could find out no connection between the two organs in the several specimens I dissected, I leave the question for further consideration in future.

(I) MALE GENITAL ORGANS (pl. xxvi, fig. 20).

(1) A fine thread-like tube (pl. xxvi, fig. 20a) opening into the posterior end of the penial sheath near the attachment of the retractor muscle of the penis. It lies along the left side of the penial sheath and the stout tube in front, and extends to near the external opening of the right Simrothian gland. The same arrangement is seen in both *A. maximus* and *A. sarasini* described by Collinge (4) who called the tube vas deferens. Considering the anatomy of the genital organs of other pulmonates, this tube seems to be homologous with the flagellum. This has

been described in *Helix pomatia* and other pulmonates of the same family (7, 8).

Minute structure (pl. xxvii, figs. 27 and 28).—The tube is composed of the following coats from without inwards :—

- (1) A thin layer of connective tissue.
- (2) A layer of longitudinal muscle-fibres.
- (3) A layer of circular muscle-fibres.
- (4) A submucous coat of connective tissue (with a few muscle-fibres) raised into a number of longitudinal folds, generally ten, projecting into the lumen.
- (5) A single layer of columnar epithelium with numerous goblet cells (secreting cells).

(2) The *penial sheath* consists of two portions:—(1) A stout hollow spindle-shaped structure giving attachment to the retractor muscle at its proximal end; (2) a stout tubular structure arising from the distal end of the first portion and ending in the external aperture at the base of the right lower tentacle.

Minute structure.—The tubular portion consists of alternate layers of longitudinal and transverse muscles arranged irregularly. The wall is thrown into large longitudinal folds, the core of which is formed mainly of longitudinal muscle fibres. The presence of these large folds shows the great extensibility of the penial sheath. The epithelium consists of a single layer of cubical (or short columnar) cells.

(3) The *penis* is a more or less cylindrical structure lying in the proximal portion of the penial sheath when retracted. The penis is attached to the sheath at the proximal end and is traversed by a fine channel continuous with the lumen of the tube described above, and opening into the tip by a small aperture.

(4) The *retractor penis muscle* is a short thick band extending from the inner side of the body wall on the right, a little behind the female genital aperture, to the proximal end of the penial sheath and penis.

(5) The *Simrothian glands* (pl. xxvi, figs. 19, 20a) are two tubular structures, one on each side, opening on the outer side of the lower tentacles, the right one being placed close to the male genital aperture. Each gland can be divided into four portions—(1) a long stout tubular portion coiled in various ways; (2) a short narrow portion, also tubular in structure, coiled closely; (3) an elongated slightly curved conical portion continuous with the second one at the tapering end and ending in the next in a broad base; (4) a very short narrow tube with a small cylindrical process from the outer side.

The structure of the Simrothian glands in *A. maximus* and *A. sarasini* resembles closely that of the present species except that there is no distinct fourth portion and the process arises from the proximal end of what corresponds to the third division

in the present species. There is no left Simrothian gland in *A. sarasini* (4).

Minute structure.—First portion (pl. xxvi, fig. 24).—The wall consists of the following layers from without inwards :—

- (1) A thin layer of connective tissue forming a sheath round the tube.
- (2) A layer of large granular cells more or less cylindrical in shape and with large nuclei placed on one side; they are arranged radially and obliquely, being attached to the first layer at their outer ends and to the next by the inner. In a transverse section one finds several oblique sections of the cells. These seem to be muscle-cells.
- (3) A layer of muscle-fibres arranged longitudinally.
- (4) A layer of transversely arranged muscle-fibres.
- (5) A layer of submucous tissue. It forms numerous folds projecting into the lumen. Small muscle-fibres can be traced into it from the fourth layer.
- (6) The mucous membrane consists of a single layer of columnar epithelium.

Second portion (pl. xxvii, fig. 26).—The different layers are :—

- (1) An outermost layer of connective tissue.
- (2) A thick transverse layer of muscular fibres intermingled with white and yellow fibres.
- (3) A single layer of cubical cells with round nuclei. The epithelium is not folded.

Two or more loops of this portion of the tube may be held together in connective tissue.

Third portion (pl. xxvii, fig. 25).—The various layers are :—

- (1) A layer of thick longitudinal muscle-fibres—the individual fibres are separated by connective tissue.
- (2) A thin transverse layer of muscle-fibres; some of these are continued into the folds of submucous tissue.
- (3) A submucous coat of loose connective tissue thrown into ten or twelve folds.
- (4) The mucous membrane consists of a single layer of columnar cells with oval nuclei.

(6) The external aperture of the male genital organ seems to be situated on the inner side of a triangular process between it and the base of the right lower tentacle.

(II) FEMALE GENITAL ORGANS (pl. xxvi, figs. 17, 18).

(1) The *hermaphrodite* gland is a large lobulated body lying closely apposed to the posterior end of the albumen gland. The dorsal surface is marked with a longitudinal groove for the

intestine. The ventral surface is concave and rests on the penial sheath.

Minute structure (pl. xxvi, fig. 21).—The gland is composed of a number of lobules held together by connective tissue, which forms a thin sheath round the whole gland and also extends between the adjacent lobules. Each lobule is oval in shape and gives rise to a duct of its own which unites with others from the adjacent lobules to form the main duct of the gland. The lobular ducts could be distinctly followed to the oviduct by the naked eye. Each lobule consists of a single layer of flattened epithelium supported on a thin layer of connective tissue (forming the wall), with a central cavity filled with mature ova and spermatozoa. Each lobule gives origin to both ova and spermatozoa from its wall.

In the formation of an ovum, a cell of the wall enlarges and becomes fusiform in shape; its free surface is covered by a single layer of flattened cells continuous with those of the wall of the lobule. When mature the ovum seems to lie free in the cavity of the lobule.

The cells which ultimately form the spermatozoa seem to divide into a number of round cells (primary sperm-mother cells) which become aggregated on the surface of conical or round projections into the cavity of the lobule from its wall. In a section of the lobule one will see several projections, the centre of which consists of a mass of protoplasm with a large nucleus. The primary sperm-mother cells are arranged on the surface of the projections. What seems to occur is the proliferation of an epithelial cell so as to form a mass of round cells on the surface of one which grows more rapidly than others and forms the supporting cell. The protoplasm of this cell is highly granular, and it has got no distinct cell-wall. The primary mother cells seem to divide again to form groups of secondary sperm-mother cells for by careful examination of stained sections under the microscope one will find a second set of smaller cells grouped in a similar way and still attached to a supporting cell. The nuclei of these secondary sperm-mother cells become gradually elongated to form the head of the spermatozoa. The different stages of the change in shape of the round nucleus to a rod-shaped body could be easily followed in stained sections. The protoplasm of the cell then elongates to form the tail of the spermatozoon. The mature spermatozoa then separate from these papillae and lie freely in the cavity of the gland in bunches.

The mature *ovum* (pl. xxvi, fig. 22) is completely surrounded by a single layer of flattened cells (with distinct nuclei) attached end to end. The protoplasm is coarsely granular. The large nucleus lies in the centre and presents a conspicuous nucleolus.

The mature *spermatozoon* (pl. xxvi, fig. 23) consists of a hook-shaped head and a long fine tail. The head is curved and pointed at the tip, but broad and rounded at the base. It is also curved twice before it ends in the tail, which is many times longer than the head.

(2) The *albumen gland* is an elongated body with the posterior end flattened and attached to the ovary. The anterior end is narrow. The upper convex surface of the gland is smooth, but present numerous transverse fissures. It is indented with a longitudinal groove for the intestine. The inner surface is concave and presents a depression for the penial sheath over which it lies.

Minute structure (pl. xxvii, fig. 29).—The gland is composed of a number of lobules bound together loosely by connective tissue. Each lobule is formed by a group of tubular acini, each of which seems to end in a duct which unites with others to form a main duct opening into the oviduct. Each acinus is enclosed by a basement membrane. Inside it is the epithelium consisting of a single layer of polyhedral cells with large round nuclei placed towards the base. The inner free borders of the cells are broken and jagged. The inner two-thirds of the cells are filled with coarse granules. The cavities of the acini are filled with the secreted material which is stained deep blue with hæmatoxylin. The ducts of the acini are lined with columnar epithelium.

(3) The oviduct is a thin-walled tube passing through the substance of the albumen gland and emerges through its anterior extremity to end in the vagina.

Minute structure (pl. xxvii, figs. 30, 31).—The wall consists of a thin outer layer of connective tissue which is continued into the centre of the longitudinal folds projecting into the lumen. Inside this layer is a coat of connective tissue cells with a few fibres between them. These are also continued into the folds and surround the central strands of connective tissue. The mucous membrane consists of a single layer of ciliated columnar epithelium.

(4) The vagina is a stout tubular structure slightly curved with the convexity downward and to the right. The upper surface presents a groove for the intestine.

(5) The receptaculum seminis is an oval body with a fairly long tubular stalk opening into the middle of the vagina on its side.

(6) The female genital aperture in which the vagina ends, lies in the groove between the foot and right mantle border at a distance from the anterior end of the body already noted in a tabular form.

VII. NERVOUS SYSTEM (pl. xxvii, fig. 32).

The nervous system is of euthyneurous type. The ganglia are closely united to form a mass round the oesophagus. The cerebral ganglia are closely connected to each other by a short thick intercerebral commissure. The cerebro-pedal and cerebro-pleural connectives are united to form a short thick band on each side. The buccal ganglia are placed on the ventro-lateral aspect of the hinder end of the proboscis-sheath at the junction with the radula-sac. The stomato-gastric connectives are long

The pedal and viscero-pleural ganglia of both sides are closely connected to each other to form a reniform mass. The aperture for the oesophagus is very small.

VIII. PEDAL GLAND (pl. xxvii, fig. 33).

Is a tubular structure lying beneath the central nervous system on the dorsal aspect of the foot. The external aperture of the gland lies in the middle line in the groove between the head and propodium.

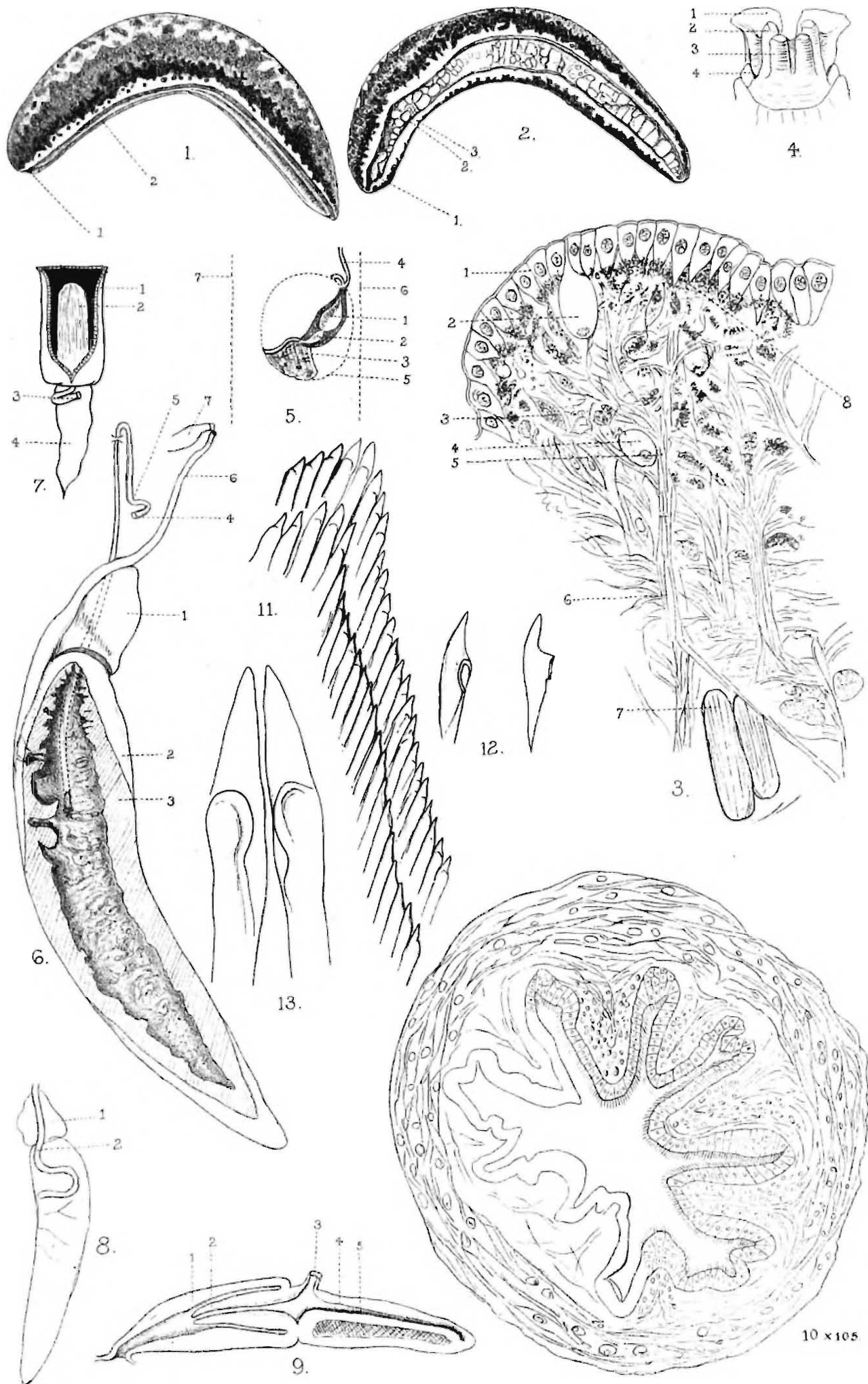
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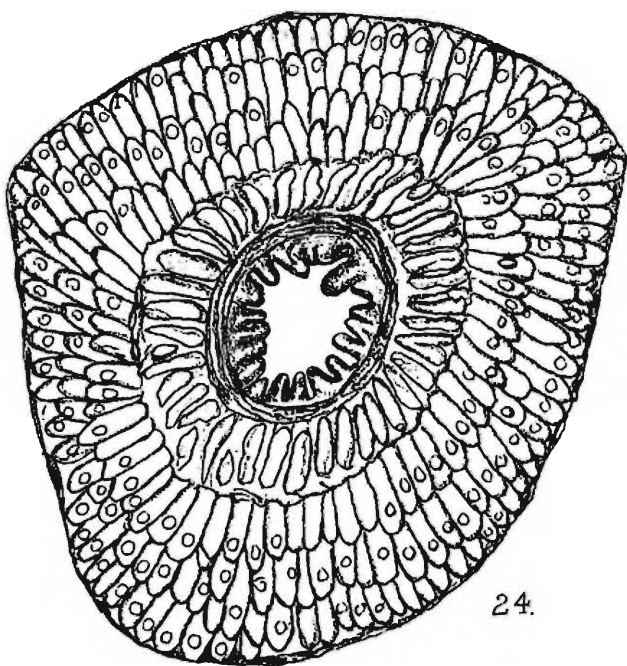
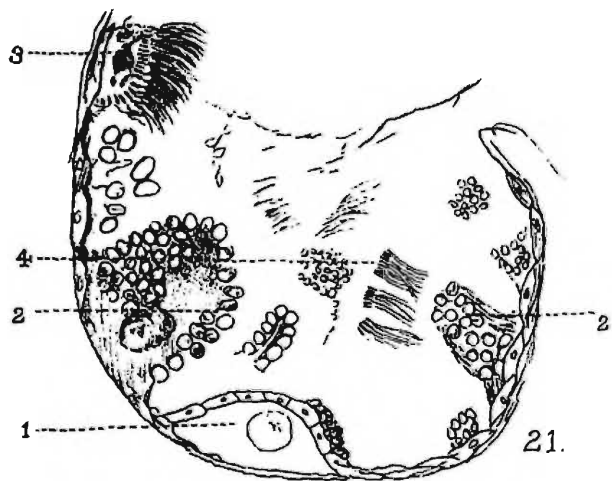
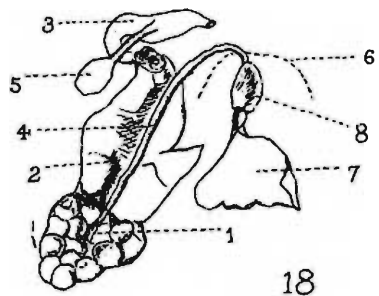
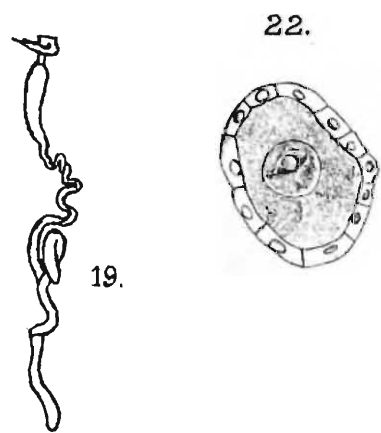
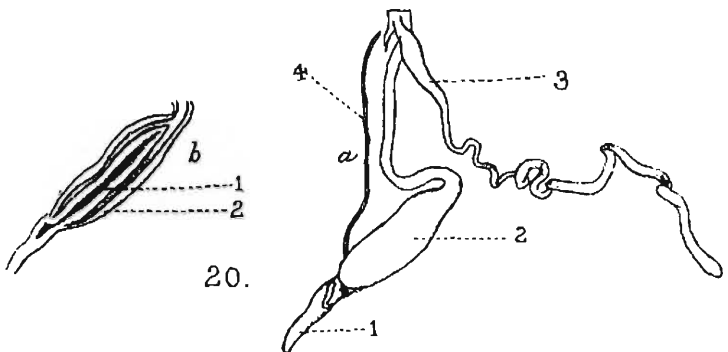
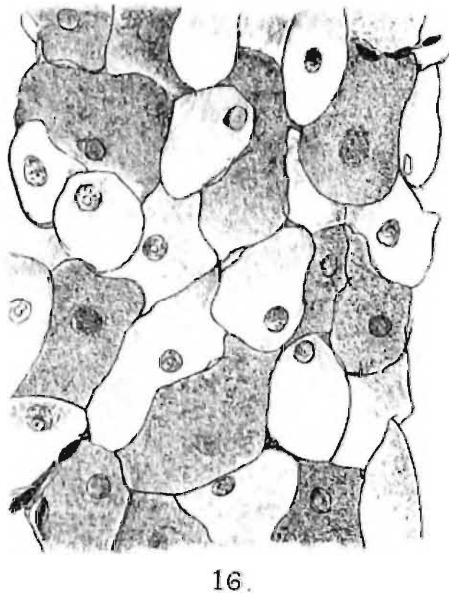
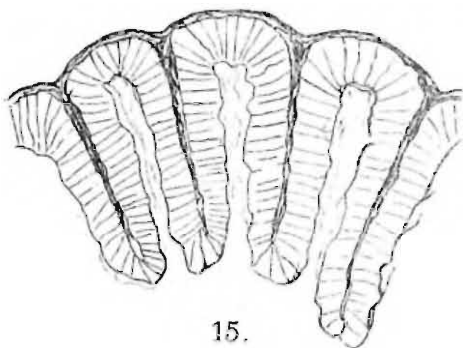
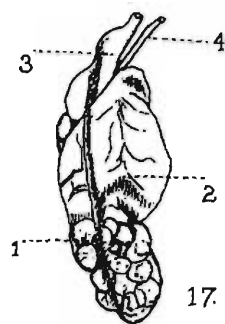
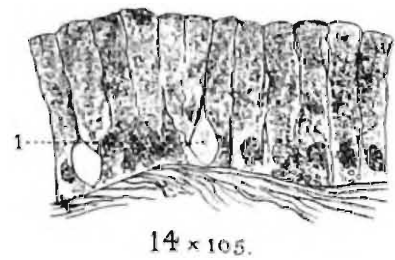
EXPLANATION OF PLATE XXV.

- FIG. 1.—*Atopos sanguinolenta* (nat. size): 1, male genital aperture; 2, female genital aperture.
- „ 2.—Ventral view (nat. size): 1, male genital aperture; 2, female genital aperture; 3, anus.
- „ 3.—Section of the bodywall, $\times 460$; 1, epidermis, 2, unicellular gland; 3, pigment-containing connective tissue cell; 4, connective tissue cell (without pigment); 5, 6, vertical strands of white fibres; 7, muscle-fibre; 8, subepidermal pigments.
- „ 4.—Head (dorsal view), $\times 4$; 1, precephalic flap; 2, lower tentacle (left); 3, ommatophore (left); 4, opening of the left Simrothian gland.
- „ 5.—Pallial chamber, $\times 1\frac{1}{2}$; 1, ventricle; 2, auricle; 3, kidney; 4, aorta; 5, boundary of the pallial chamber; 6, position of the right lateral border of the mantle; 7, position of the mid-dorsal line (of the mantle).
- „ 6.—Portion of alimentary canal, $\times 2$; 1, accessory digestive gland; 2, digestive gland; 3, wall of digestive gland cut open to show the internal cavity; 4, cut end of oesophagus; 5, oesophagus; 6, intestine; 7, vagina.
- „ 7.—Buccal mass, $\times 2$; 1, proboscis-sheath; 2, proboscis; 3, a portion of oesophagus; 4, radula-sac.
- „ 8.—Digestive gland of another specimen, $\times 1$; 1, accessory digestive gland; 2, intestine.
- „ 9.—Longitudinal section through the buccal mass, $\times 3$; 1, proboscis-sheath; 2, proboscis; 3, opening of oesophagus; 4, radula-sac; 5, radula.
- „ 10.—Transverse section of oesophagus, $\times 105$.
- „ 11.—Portion of radula showing teeth, $\times 60$.
- „ 12.—Two lateral teeth of radula, $\times 105$.
- „ 13.—Two median teeth of radula, $\times 255$.



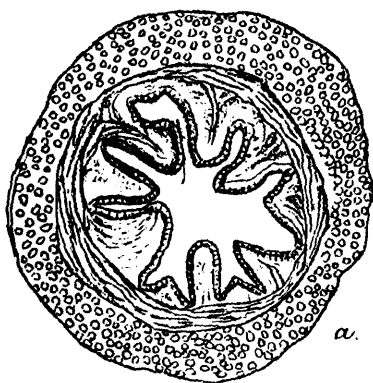
EXPLANATION OF PLATE XXVI.

- FIG. 14.—*Atopos sanguinolenta*, portion of epithelial layer of digestive gland, $\times 105$; 1, goblet cell.
- „ 15.—A transverse section of the wall of digestive gland (diagrammatic).
- „ 16.—Section of accessory digestive gland, (stained with eosin and haemotoxylin), $\times 255$.
- „ 17.—Female genital organs (dorsal view), $\times 2$; 1, hermaphrodite gland; 2, albumen gland; 3, vagina; 4, visceral artery.
- „ 18.—Female genital organs, etc. (ventral view, with vagina unfolded), $\times 2$; 1, hermaphrodite gland; 2, albumen gland; 3, vagina; 4, visceral artery; 5, receptaculum seminis; 6, anterior limit of pallial chamber; 7, kidney; 8, ventricle.
- „ 19.—Left Simrothian gland, $\times 2$.
- „ 20a.—Male genital organs, $\times 2$; 1, retractor penis muscle; 2, penial sheath; 3, right Simrothian gland; 4, flagellum.
- „ 20b.—Longitudinal section of penis and penial sheath, $\times 2$; 1, penis; 2 penial sheath.
- „ 21.—Section of hermaphrodite gland, $\times 124$; 1, ovum; 2, sperm-mother cells; 3, developing spermatozoa; 4, free mature spermatozoa.
- „ 22.—Section of a mature ovum, $\times 124$.
- „ 23.—A mature spermatozoon, $\times 756$.
- „ 24.—Transverse section of the first portion of the right Simrothian gland, $\times 50$.



EXPLANATION OF PLATE XXVII.

- FIG 25a.—*Atopos sanguinolenta*, transverse section of the third portion of the right Simrothian gland, $\times 50$.
- „ 25b. A portion of the epithelial lining of the third portion of the Simrothian gland, $\times 460$.
- „ 26.—Transverse section of the second portion of the right Simrothian gland, $\times 50$.
- „ 27.—Transverse section of flagellum, $\times 255$.
- „ 28.—Portion of the wall of flagellum (transverse section).
- „ 29.—Section of albumen gland, $\times 255$.
- „ 30.—Transverse section of oviduct, $\times 30$.
- „ 31.—Portion of a fold of oviduct as marked in fig. 30, $\times 255$.
- „ 32.—Nervous system, $\times 4$; 1, cerebral ganglion (right); 2, right viscero-pleural ganglion 3, otocyst; 4, right pedal ganglion; 5, right pedal nerve ($\frac{1}{10}$ th of the length).
- „ 33.—Pedal gland, $\times 2$.



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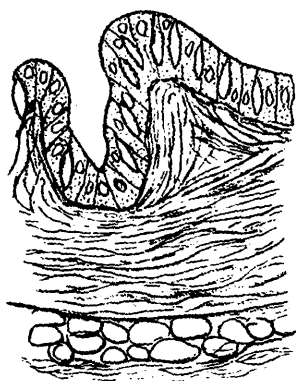
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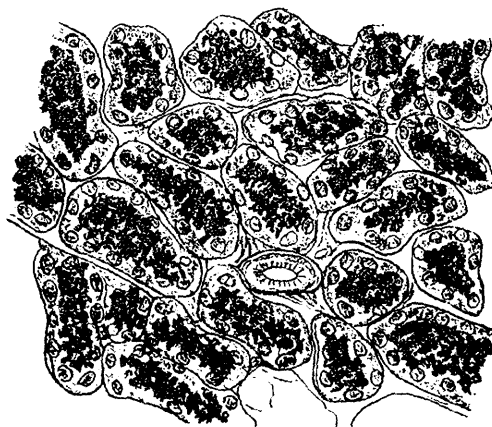
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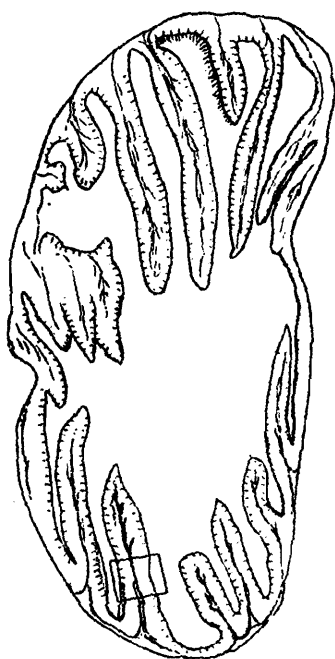
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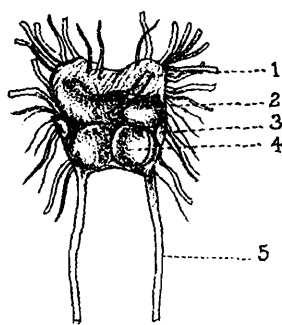
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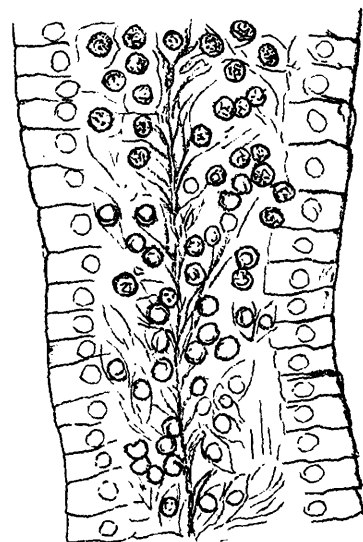
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XVIII NEW CESTODES FROM INDIAN FISHES.

By JAMES HORNELL.

(Plates ix—x.)

- I.—PROSTHECOBOTHRIUM UROGYMNI, n. sp.
- II.—BALANOBOTHRIUM TENAX, n. gen. et sp.
- III.—TETRARHYNCHUS ANNANDALEI, n. sp.

(1). PROSTHECOBOTHRIUM UROGYMNI, n. sp.

(Pl. ix, figs. 1—3).

Two specimens of this fine cestode were obtained from the spiral valve of a male *Urogymnus asperrimus* (Bl. Schn.), trawled in 9 fathoms on the north end of the Periya Par, one of the Ceylon Pearl Banks in the Gulf of Manaar, February 1908.

When alive the larger of the two measured 25 cm. in length, shortening to 14 cm. at death. The species is closely related to *P. dujardini* (van Beneden), differing therefrom chiefly in its much greater size, the great elongation of the neck and the superior development of the suckorial loculi of the bothridia.

The scolex is furnished with four elongated sessile bothridia. Each is sub-lanceolate in outline, divided into three distinct loculi by two transverse muscular costæ. The most anterior loculus is considerably the longer being equal to the combined length of the two posterior ones. In life the mobile edges of the bothrium curve inwards and all three loculi are distinctly seen as deep sucker-like cavities; in this latter characteristic the present species exhibits a marked divergence from Diesing's type of the genus where the bothridia are described as undivided, each having a suckorial appendage at its posterior extremity. Johnston's description of the same species (*P. dujardini*) necessitates a modification of the original generic diagnosis as he describes each bothrium as "really divided into three loculi by two transverse curved costæ," adding, however, that the most anterior loculus "is not apparently concave." The distal portion of each bothrium possesses a tongue-like mobility enabling it to twist and turn in search of a new holding when the living worm is dislodged from its attachment within the host's intestine. The tips of the bothridia may then be seen projecting prominently and at a considerable angle from the neck.

In anterior view the scolex appears sub-quadrangular, the thickened anterior extremities of the bothridia forming the four angles; as seen in figure 2 the bothridia extend some distance towards the centre of the "head," by their slight prominence forming a distinct cruciform depression upon the apical surface. The thickened anterior extremity of each bothrium bears a pair of double hooks; each consists of two sub-equal slightly curved long and slender prongs fused together by their bases. The curve in each prong is double—a light divergent curve from its fellow and a somewhat abrupt or right-angled curve on the under side whereby its holding power in attachment is increased. The acute-angled apex of the base of each double hook is approximated to that of its fellow in the same pair. The prongs project considerably and overhang slightly the anterior margin of the proximal bothridial loculi. In colour the hooks are dark brown and in appearance are chitinous. No accessory suckers or acetabula are present, thus differentiating this genus from the otherwise closely allied *Calliobothrium*.

The neck is very long and slender; about 0.4 mm. broad. The proglottides are extremely numerous and always markedly broader than their length. The width of the great majority, 0.75 to 0.9 mm., is characteristically almost twice as great as the length; a few at the posterior extremity as they ripen become somewhat more elongate and narrower. The lateral edge of the proglottides is slightly curved, the posterior margin very slightly produced and overlapping the front edge of the next succeeding. The genital pores are lateral. The general appearance and proportions of the strobila thus approximate closely to what is seen in *P. trygonis*, Shipley and Hornell.

It is noteworthy that the stomach contents of the host which yielded this cestode consisted (with the exception of a fragment of a Nemertine) of a great mass of one or more species of *Amphioxus*; there were hundreds of individuals in the mass. Other parasites present were *Tylocephalum uarnak*, Shipley and Hornell, in great numbers, a single specimen of *Tetrarhynchus ætobatides*, and numerous individuals of an undetermined Nematode.

The dimensions of the host were:—

Length of body to base of tail	3 ft. 1 in.
Breadth of disc	3 ft. 0 in.
Length of tail	1 ft. 8 in.

The diagnosis of *P. urogymni*, n. sp., is as follows:—Long slender cestode. Head elongated, twice as long as broad, armed with four large sessile, elongated and regularly disposed bothridia, each sub-lanceolate and trilocular with mobile edges and posterior tip; anterior extremity of each bothrium tumid, armed with a pair of double dark brown chitinous hooks. Prongs of each hook slender, equal, curved in two planes, the tips projecting beyond the anterior margin of the proximal loculus.

Neck very long and slender, proglottides very numerous, lateral margins lightly curved, posterior slightly overlapping, usually twice as broad as long, except a few of the most posterior. Length when alive up to 25 cm. Breadth of head under 1 mm.; of typical proglottides, 0.75 to 0.9 mm.

Habitat:—The large intestine of *Urogymnus asperrimus* (Bl. Schn.).

The characteristics of the genus *Prosthecobothrium* may now be amended as follows:—

Scolex with four elongated sessile bothridia divided by transverse costæ into three loculi; no accessory suckers on the anterior margins of the bothridia; a pair of double hooks on the anterior margin of each bothrium.

BALANOBOTHRIUM, n. gen.

Scolex acorn-shaped, consisting of a bulbous head surrounded at the base by a cup-shaped mobile membranous collar; a pair of very minute two-pronged uncini situated at four equidistant points on the upper circumference of the head, a minute acetabulum above each pair of uncini. Neck extremely short. Strobila ligulate, the proglottides short and wide.

(2). BALANOBOTHRIUM TENAX, n. sp.

(Pl. ix, figs. 4-6 and 8-10, and x, figs. 7, 11, 12).

This species has been found on two occasions in Indian seas, the first in 1905, when I found several small and immature ones attached to the spiral valve of a *Stegostoma tigrinum* (Gmel.) trawled on the Ceylon Pearl Banks; the second, in the intestine of an individual of the same host trawled in the Bay of Bengal by the Bengal Government Fishery Steamer "Golden Crown." Those obtained by the "Golden Crown" are much the larger and appear to have reached full development. In the dead condition they attain a length of 32 to 33 cm., three of the five specimens being within this range; the other two are shorter, 18 cm. and 21 cm. respectively. Two of the largest are headless. The scolex consists of a bulbous sub-conical head contracted suddenly at the base to a very short and slender stalk from which a delicate membranous upturned cup-shaped collar is given off. In life the bulbous region of the scolex is wholly embedded within a sac-like diverticulum of the surface membranes of the host's intestine. This diverticulum hangs freely within the cavity of the intestine, its base greatly constricted. The os of its free end is minute and encircles closely the constricted base of the parasite's head bulb. In this way the head of the cestode is so firmly held that in removing the worm it is impossible to withdraw it uninjured from the sac and it becomes necessary to tear or cut away the sac at its junction with the intestine. In life the wide collar below the base of the head bulb functions as a suckorial bothrium, enfolding

and clasping the wall of the distal half of the intestinal diverticulum, so that a double purchase is assured—the diverticulum enveloping the parasite's head and the collar of the latter in turn enfolding the distal half of the hollow intestinal outgrowth (pl. x, fig. 11).

When freed from its adventitious envelope, the head is seen to be capable of considerable change of form and it is probable that by its alternate elongation and contraction it functions as a burrowing or penetrating organ, aided by the suckorial action of the bothridial cup which simultaneously anchors the worm securely in position. To supply the means of contraction well-marked muscle fibres pass from the constricted stalk and spread out over the walls of the head. The musculature of the encircling bothrium is weak, but radial and circular fibres appear to be present.

The head is armed in a peculiar manner with four pairs of minute two-pronged hooks situated at four equidistant points well anterior to its widest circumference. In the small and immature specimens obtained in Ceylon the two prongs of each hook are unequal and strongly recurved and rise from a common horizontal base, the larger from one extremity, the smaller from midway between the two ends. Opposite the base of the larger spine is a minute blunt spur-like process. In the large and fully adult specimens from the "Golden Crown" the common basal bar is stouter and wider and no "spur" is to be seen. So minute are these uncini that they cannot be seen until the head be mounted and examined microscopically and then a $\frac{1}{8}$ th-inch objective is required to see the structure clearly. A low fleshy ridge runs backwards from the insertion of each pair of uncini, while immediately anterior to the interspace between the members of each pair is a minute acetabulum (pl. ix, fig. 8).

No definite neck region is present. Closely set grooves of incipient segmentation are apparent immediately behind the scolex; they gradually become more and more definite till the segments appear as distinct proglottides. These attain a maximum breadth of 4 mm. anterior to the terminal chain of ripening proglottides; in this region the length of each proglottis is approximately 0.8 mm. The mean breadth of a proglottis in the second and third quarters of the body may be stated at from five to six times that of its length.

The breadth of the strobila increases very gradually and with perfect regularity from 1.3 mm. in the anterior region to 4 mm. which it attains at the region where the proglottides begin to show a change of form, owing to the development of the gonads, about 3 cm. from the posterior extremity in the largest individuals examined. Thereafter the proglottides tend to decrease in width and become more elongate, but in none does the length become equal to the breadth. The ovaries are large and coarsely lobulated, arranged as a rosette of radially disposed pear-shaped lobes in the centre of the proglottis.

The genital apertures are lateral and placed well forward towards the anterior margin; the disposition is very irregularly alternate in series, that is, those pertaining to a number of consecutive proglottides, from two to six in number, may all open on the same side, to be succeeded by a number which open consecutively on the opposite side.

Both surfaces of the strobila are closely marked by transverse striæ; the lateral margins are almost straight, and there is no overlapping; sometimes the posterior lateral margin may be slightly salient and pointed.

The diagnosis of this species is as follows:—

Scolex consisting of a bulbous sub-conical head encircled at the base by a cup-like bothridial collar. Four pairs of minute two-pronged uncini disposed at equal intervals around the circumference of the head-bulb; the prongs are sharply bent at mid-length and borne upon a common horizontal bar; in young specimens a spur-shaped projection occurs opposite the base of the outer and longer prong.

No definite neck. Strobila ligulate, long and stout, 33 cm. in dead condition. Narrow at anterior end, 1.3 mm., increasing slowly and uniformly in width till it attains 4 mm. in front of the region of ripening proglottides.

Proglottides short, five to six times broader than long in the wide region posterior to mid-length; ripe proglottides characteristically short and length never greater than breadth. Grooves of segmentation apparent immediately behind bothridial collar. Cuticle striated transversely with minute furrows.

Ovaries arranged centrally in a rosette of large pear-shaped lobules. Genital pores lateral, opening well forward and anterior to mid-length; disposition irregular, in alternate consecutive series of from 2 to 6 on the same side.

Habitat:—The large intestine of *Stegostoma tigrinum* (Gmel.), Bay of Bengal and Gulf of Manaar.

The *type* specimens of this species are deposited in the Indian Museum, Calcutta, No. ZEV ⁴⁸²⁸₇.

(3). TETRARHYNCHUS ANNANDALEI, n. sp.

(Pl. x, figs. 13-15a).

Associated with the specimens of *Balanobothrium tenax*, n. sp., described above from the gut of *Stegostoma tigrinum* (Gmel.) were two mature Tetrarhynchids. These both measure 3.6 cm. in length (dead).

The head or scolex is well proportioned and about 8 mm. long. Anteriorly it has two well-developed simple bothridia of lappet form, 2 mm. in length by 1.6 mm. in breadth. They are somewhat fleshy in appearance, the border thickened and elevated and slightly emarginate on the posterior edge. Behind the bothridia, the head becomes slender, cylindrical and neck-like, 0.7 mm. wide;

this section is slightly longer than the bothridia. In this region the proboscical tubules are seen in a prepared specimen to be long and closely coiled, predicating considerable length of the proboscides when extended (they are almost entirely withdrawn in both specimens examined). The posterior region of the head, containing the contractile proboscical sacs, is characterized by its great relative length which equals the combined lengths of the bothridial and duct regions. It is also slightly wider. The four muscular sacs occupy the whole of this posterior head region; the fibres in their walls are arranged as usual in two sets crossing each other obliquely but in these species the criss-cross appearance so produced is particularly distinct and well marked.

Each of the four proboscides emerges from the summit of a minute perforated papilla situated near the anterior bothridial margin. Each bothrium bears two of these papillæ, separated from one another by a considerable interval.

None of the proboscides was sufficiently everted to enable the arrangement of the hooks to be clearly made out. The majority of them are of a sabre-like curve, distinctly stout and apparently laterally flattened. All are not of the same size, and there appears to be a certain variation in the proportions of these spines, some being shorter and more slender. A few extremely minute sharply curved stout hooks, strongly beaked, and with a large base (pl. x, fig. 15a) are also present.

Immediately posterior to the contractile bulbs the worm increases abruptly though slightly in diameter to form a stout cylindrical neck; its surface is wrinkled transversely by a few irregular weak groovings. Its diameter is greatest anteriorly, gradually narrowing till it merges at a distance of one and a half its greatest diameter into the regularly segmented anterior region of the strobila. At first the segments are wider than long and the lines of division difficult to see; after the fifth they become square in lateral view and then gradually increase in length till they attain a length of twice their width. No overlapping occurs and the lateral margins are parallel except in those where the genital pore is developed.

The proglottides number about 25. The last seven are remarkable for the enormous development of the genital pore, in this closely agreeing with *T. macroporus*, Shipley and Hornell, which appears to be a closely allied species. In the present species, the pore is guarded by two great salient tumid lips. In all cases the pores are lateral, but their arrangement is very irregular. In the individual figured (pl. x, fig. 13), of the seven maturing segments, wherein pores are present, we have first one segment (the most anterior of the set) where the pore is on the right side as figured; in the three next succeeding the three pores follow each other consecutively on the opposite side (left) while in the terminal three proglottides, there is again a group of three pores following each other consecutively but this time it is on the right side, giving a formula of R 1, L 3, R 3.

The following measurements are from a specimen preserved in alcohol:—

	Millimetres.
Extreme length	36.00
Length of scolex without neck	8.00
Length of bothridia	2.00
Breadth do.	1.60
Length of region of coiled proboscis sheaths	2.00
Breadth do do	0.70
Length of contractile bulbs	3.80
Breadth of this region.	1.00
Length of neck	1.75
Breadth of neck at anterior end	1.25
Do. posterior end	1.00
Length of a mature proglottis	1.75 to 2.00
Breadth do. including genital eminence	1.20

This Tetrarhynchid is closely allied to *T tenuicolle*, Rudolphi, and to *T macroporus*, Shipley and Hornell. From the former it is sharply divergent in the much greater length of the contractile proboscidian bulbs, while from the latter it is equally sharply marked off by the form of the bothridia which is simple and entire in *T annandalei*, whereas in *T macroporus* each is divided into halves. The proboscis hooks in the latter appear also to be shorter and stouter and it is stated that there is practically no neck. In both the latter species the relative proportions of the two regions of the head are nearly the same and there is also approximation in the number and general form of the proglottides and in the great prominence of the lips of the genital pore.

Diagnosis of *T annandalei*:—

Length 3.6 cm. Head cylindrical, and fairly long, about 8 mm. Bothridia two, lateral, longer than broad, slightly emarginate on the posterior edge and with a raised and thickened margin. Proboscides four, long, and strongly armed with curved hooks, the majority long and sabre-shaped, fairly stout; a small number of very minute recurved forms with elongated base also present.

The proboscis sheaths long and arranged in closely set spirals; this region of the head including with it the part overlaid by the bothridia is about equal in length to the posterior section containing the contractile sacs. *The latter region is characteristically of great relative elongation* and is slightly wider than the anterior head region. The sacs are cylindrical, with the oblique decussation of the muscle fibres well marked. Neck short, one and a half times as long as wide; greatest breadth seen in this worm occurs in the anterior part which increases in width abruptly immediately behind the contractile sacs. Neck wrinkled slightly transversely.

Proglottides about 25. Anteriorly they are wider than long, but soon become square and then rapidly elongate and in the matur-

ing ones length is twice the breadth. The lateral margin parallel, and none of the proglottides overlap. Cuticle sometimes faintly ringed but this may be a *post mortem* effect.

Last five or six proglottides remarkable for enormous development and prominence of the genital pore. This is lateral and situated at beginning of posterior third of the marginal length of each proglottis. Position of the pores are alternate in consecutive groups, usually in alternate series of 3, *e.g.*, right 1, left 3, right 3.

Habitat:—Intestine of *Stegostoma tigrinum* (Gmel.), Bay of Bengal.

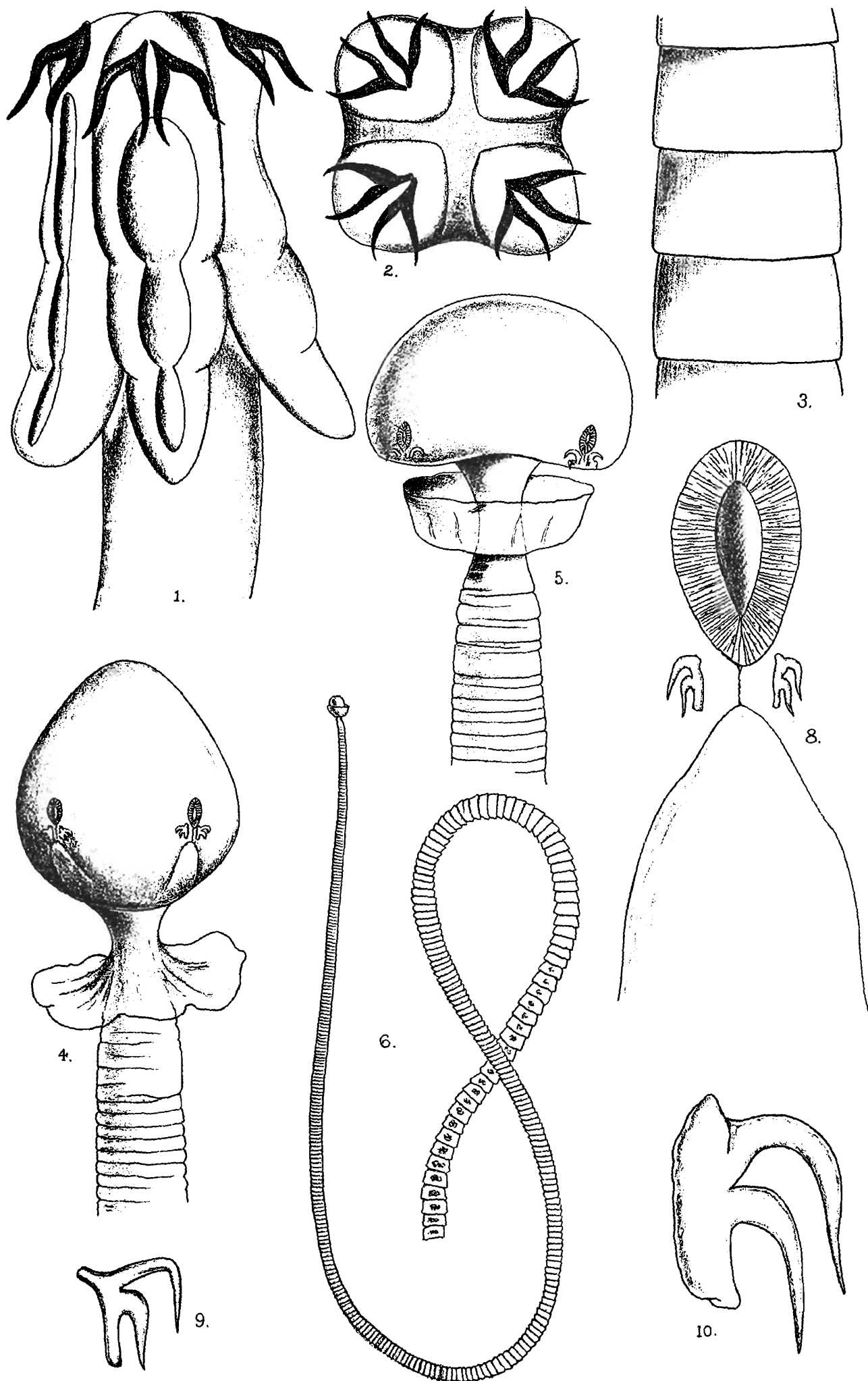
Type specimen in the Indian Museum, Calcutta, No. ZEV $\frac{5929}{7}$.

I have pleasure in naming this elegant form after Dr. Annandale who has done so much to extend our knowledge of Indian Marine Zoology.



EXPLANATION OF PLATE IX.

- FIG. 1.—*Prosthecobothrium urogymni*, n. sp.
Lateral view of head, $\times 50$.
- „ 2.—Head of the same, viewed from the anterior aspect,
 $\times 55$.
- „ 3.—Outline sketch of proglottides of the same from
median region of body, $\times 40$.
- „ 4.—*Balanobothrium tenax*, n. gen., n. sp.
Lateral view of the head of an immature individual
showing collar turned back. Sketched from life.
- „ 5.—A second view of the same, to show another form
frequently assumed when alive.
- „ 6.—A fully mature individual of the same species.
Natural size.
- „ 8.—View showing the relative positions of each pair
of uncini with the minute acetabulum anteriorly
and the tumid ridge posteriorly, $\times 200$.
- „ 9.—An uncinus from a young individual of the same
species.
- „ 10.—An uncinus from an adult individual, $\times 800$.



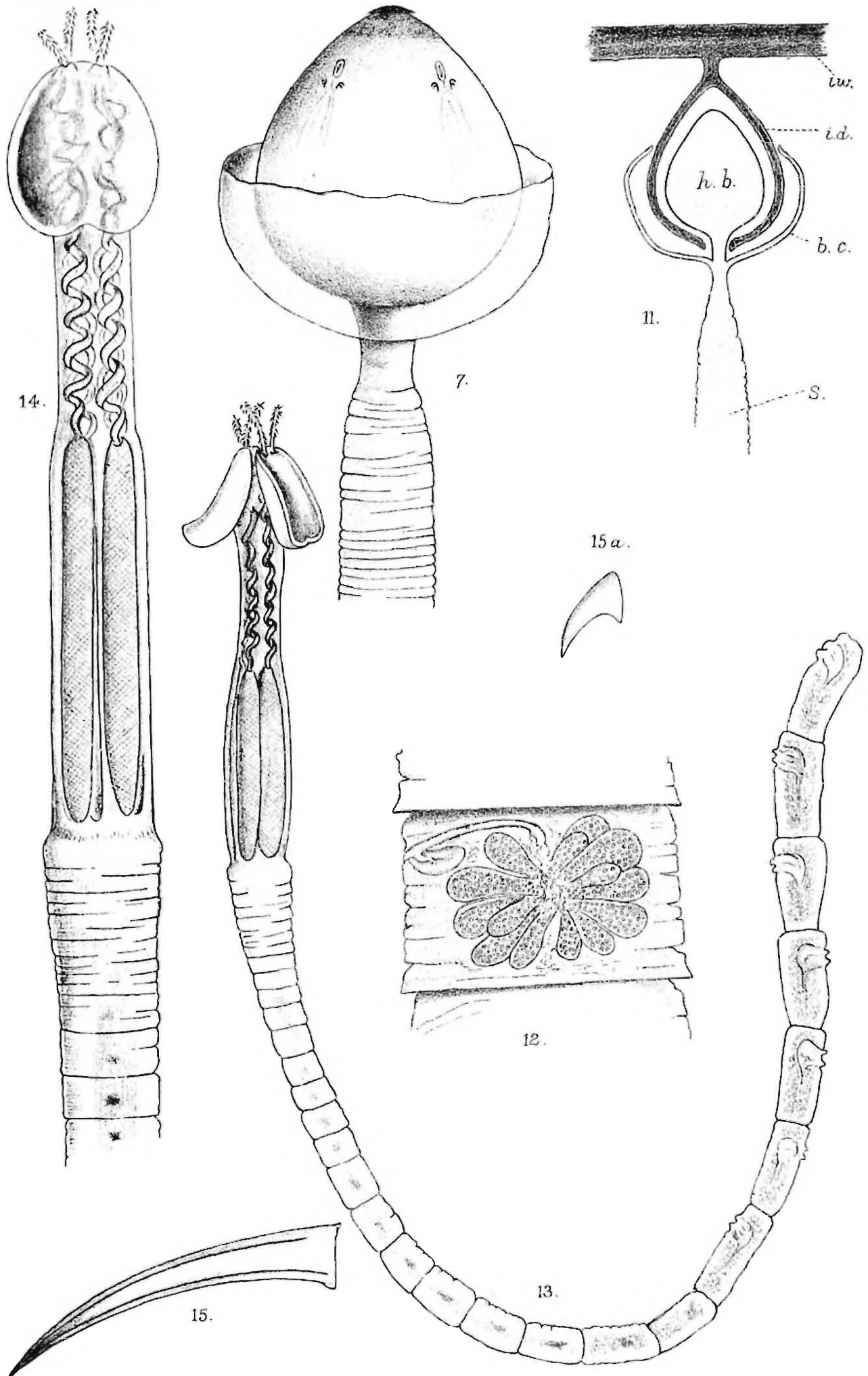
Dorothy L. Hornell del.

A.C. Chowdhary, lith.

1.2.3. *Prosthecobothrium urogymni*, n.sp. 4.5.6.8.9.10. *Balanobothrium tenax*, n.sp.

EXPLANATION OF PLATE X.

- FIG. 7.—*Balanobothrium tenax*, n. gen., n. sp.
View of head; the collar shown transparent to exhibit the base of the head bulb, $\times 17$.
- ,, 11.—Diagram of a vertical section through the head of the same species when contained within a sac formed by an outgrowth from the intestine of the host, *i.w.*, wall of the intestine; *i.d.*, saccate diverticulum from inner wall of intestine; *h.b.*, head bulb of the cestode; *b.c.*, its bothridial collar; *s.*, anterior end of strobila.
- ,, 12.—A ripening proglottis from the same species showing the rosette-like ovary with vagina and penis sheath anteriorly on the left, $\times 11$.
- ,, 13.—*Tetrarhynchus annandalei*, n. sp., $\times 8.3$.
- ,, 14.—Head of same, $\times 16$.
- FIGS. 15 & 15a.—Same. Hooks of proboscis, highly magnified.



Dorothy L. Hornell, del.
13. 14. 15. 15a. *Tetrarhynchus annandalei*, n. sp.

A. C. Chowdhary, lith.
7. 11. 12. *Balanobothrium tenax*, n. sp.

MISCELLANEA

POLYZOA.

THE OCCURRENCE OF ENTOPROCTA IN INDIAN WATERS.—On the stems of specimens of the Hydroid genera *Bimeria* and *Tubularia* collected at Port Canning on March 10th, 1912, I find a minute entoproctous polyzoon that appears to be specifically identical with Busk's *Barentsia* (or *Ascopodaria*) *discreta*, a species originally found at Tristan da Cunha in 100 to 150 fathoms by the "Challenger" Expedition (Busk, *Zool. Rep. "Challenger,"* vol. xvii, part L (Polyzoa II), p. 44, pl. X, figs 6—12), but recently recorded from Ceylon by Miss L. Thornley, apparently from shallow water (Herdman's *Rep. Ceylon Pearl Fisheries*, part iv, p. 128). My specimens are much smaller than the type-specimens, the full-grown heads measuring only about 0·21 mm. in length and 0·18 mm. in transverse diameter, the same measurements as given by Busk being 0·5 and 0·4 mm. The length of the stalk and the proportions of the muscular bulb at its base vary considerably and the zoaria are colourless. Otherwise I can detect no divergence from Busk's original figures and description. Miss Thornley states that the specimens she examined were of a reddish colour. In view of the conditions under which the species was growing at Port Canning it is not surprising that it should be dwarfed, and I do not consider it advisable in the circumstances to give the phase a separate name. My specimens were found on Hydrozoa that grew on stones and logs partially embedded in dense mud at the edge of the river Mutlah. They were just uncovered by an unusually low tide. The water at the point at which they occurred contains in March about 25·46 *per mille* of saline residue.

Prof. K. Ramunni Menon has recently sent me a specimen of *Barentsia gracilis* (Sars) taken in Madras harbour. The species is common in Europe and has been recorded from the Pacific coast of N. America by Miss Robertson (*Proc. Calif. Acad. Sci.* (3) II, p. 344) and from Australian waters by Kirkpatrick (*Ann. Mag. Nat. Hist.* (6) II, p. 21, 1888).

The list of Entoprocta as yet known from Indian seas is a very short one, comprising, so far as I am aware, only three species:—

- | | |
|-----------------------------------|--|
| <i>Barentsia gracilis.</i> | Madras harbour. |
| „ <i>discreta</i> | { R. Mutlah, Port Canning, Gangetic
delta and Ceylon. |
| <i>Loxosomatoides colonialis.</i> | Brackish ponds, Port Canning. |

N. ANNANDALE.

ANNELIDS.

NOTES ON THE REARING OF LEECHES IN MAWAI, BARA BANKI DISTRICT, UNITED PROVINCES.—[The leech to which the following notes refer has been identified by Mr. W. A. Harding as *Limnatis* (*Poecilobdella*) *granulosa* (Sav.)]

In this part of the country the leeches are abundantly found in ponds, streams, *jhils* and marshes but seldom in rivers.

The class of people who rear leeches are called "Chohra" and this occupation is the sole means of their livelihood. They use them for medicinal purposes; whenever any part of the human body is inflamed or its blood becomes impure the leeches are made use of to suck out the blood from the diseased part. This remedy is also prescribed with success in slight cases of blood-poisoning by native physicians.

The breeding season commences in April or May just before the beginning of the rains. The breeders pick out a few good adult specimens of leeches and put them in a new earthen pot with some pieces of a sort of black clay (called here 'hair-cleaning clay') with which people generally clean their hair, and sprinkle some water just sufficient to keep them wet. This vessel is closed and put away in a secluded corner of the house where there is no likelihood of any disturbance to the leeches. The breeders are of opinion that they do not form cocoons even if a man's shadow falls over them. This is merely putting stress on the fact that the leeches will not form cocoons if they are disturbed either by the footsteps of man or other accident. To avoid this people in certain places take the further precaution of burying the vessel containing them underground. Every alternate day the vessel is opened and some water is poured in to keep the clay wet.

In the course of a period which varies from a fortnight to a month the breeders find inside the vessel some foamy little whitish masses emitted by the leeches which within two or three days develop into oval-shaped cocoons, soft and partially transparent. As the cocoons get stiff they are carefully picked up and put into closed cups made of the clay already in the vessel. This process is kept up till all the soft cocoons have become hard and have been removed. The cups are changed every alternate day for a fortnight, when it is perceived that the young ones have developed within them. Then the shells are broken up by the breeders themselves in order to help out the weak ones which otherwise would die within the shell, not being strong enough to come out by themselves. Each cocoon contains five or six young ones.

The young ones are kept in fresh water which is changed morning and evening. This method of changing the water twice a day helps them to grow speedily. When the young ones grow sufficiently old to be able to suck blood (which is at once found out by putting a hand in the water as they rush to catch it) they are taken out and placed on some portion of his own body by the breeder, and after they have taken in a little blood they are removed and put back in the water. They are not allowed to

suck blood to their satisfaction, for if they do so they will immediately die. This process is repeated every fortnight until they grow old enough for the purpose for which they are reared. Then this new batch of leeches is divided into two lots, (1) that which is to be used for medicine and (2) that which is reserved for breeding. The latter are called 'seed leeches' and are kept in water which is regularly changed at intervals until the next breeding season sets in, during this period no blood is given to them. They are never used for money-making, for leeches once used for such a purpose are believed to lose their power of breeding.

Whenever the leeches are prescribed for medicine the *Chohra* (breeder) is sent for. He brings with him only those leeches that have not been used for two or three weeks and applies some of them to the intended part. The leeches at once begin to suck in blood with avidity, but if the blood has become mixed with pus they will immediately drop down. If it is not they will suck on till they fall down filled with impure blood, when they seem to lose all energy and look very dull and inactive. The breeder then takes these leeches one by one and pricks it with a needle just near the mouth on the middle line on the back and slowly squeezes out the blood commencing from the tail to the opening made by the needle. This, however, does not kill the leeches. When the trial is over the leeches are thoroughly rubbed by the hands which probably relieves them to some extent of the strain caused by squeezing, and restored to the water for future use.

The breeders are of opinion that the wild leeches do not breed in captivity until perhaps long used to it and it is even difficult to confine them unless they are carefully packed. Their bite when used for medicine is unbearable to the patient. This is not the case with the domesticated ones, the bite of which is comparatively less painful, much like that of an ant.

The leeches can be kept alive for many years if the water in which they are kept is occasionally changed, but those that have been used for medicine can hardly live for more than a year.

M. MOHSIN KHAN.

INSECTS.

THE HABITS OF SOME TIGER-BEETLES FROM ORISSA.—Many species of tiger-beetles, though they may have a wide geographical distribution, are curiously particular in their choice of habitat. A well-known instance of this is *Cicindela biramosa*, Fabr., which lives only on the seashore, a fact sufficiently noticeable at such a place as Puri on the Orissa coast, but much more so near Balyghai, a few miles further north. Here the sandy beach on which alone this species lives slopes sharply up for a distance of perhaps twenty or thirty yards and then ends abruptly in a low wall of sand evidently produced by the action of high tides.¹ This wall forms the outer-

¹ I have only visited the place once as yet; this was towards the end of August 1911.

most rampart of a double or treble line of sand-hills running parallel to the sea, and behind these is a flat expanse of sand extending inland to a distance of about two miles and bounded on its inner side by the Sur Lake. With the exception of the green vegetation on the shores of the lake, and of some trees round a small temple on one of the sand-hills, *Spinifex* is the only plant rising above the surface of the sand, and this does not grow luxuriantly. The vegetation is principally composed of small plants lying close on the surface of the ground; except on the beach these occur more or less abundantly over the whole sandy area not affected by the lake. There is nothing resembling the long grass which is of such importance in the well-known Southport sand-hills in England during the early stages of their formation. In spite of this, the Balyghai sand-hills present a much greater appearance of stability than do those at Southport (an appearance in keeping with the nature of the vegetation), the sand being much firmer, probably on account of greater "binding" power. The shore therefore, though sharply marked off from the country out of reach of the tide, differs but little from it in character, and the way in which the darkly coloured and consequently conspicuous *Cicindela biramosa* confines itself absolutely to the former becomes peculiarly striking and suggests that the cause of its restriction must lie either in a restriction of its food to the area between tide-marks or in some effect of the sea on the climate of this particular area. I do not remember to have seen any tiger-beetles on the sand-hills; but there are some curious long-legged heteropterous bugs living there whose appearance and mode of progression is very like that of a tiger-beetle. On the sand further inland *Cicindela cancellata*, Dej., *C. albina*, Wdm., and *C. agnata*, Flt., occur, their markings blending with the general colour of the sand in such a way as to render them almost invisible. All three species may occur together, but their relative abundance differs greatly in different places; the last-named I found particularly plentiful on bare sand not far from the shores of the Sur Lake.¹

Extensive floods occurred at about the time of leaving Balyghai and consequently the return journey to Calcutta was much impeded, and a night was spent at Cuttack on the way. By this time the floods had subsided again to a considerable extent, and among the bushes on the bank of the Mahanaddi (a big river crossed by the railway not far from Cuttack station) there were exposed at intervals little patches of firm sandy soil of not more than a few square yards extent each. On this dull soil numbers of tiger-beetles were assembled, and on more than one occasion I saw a specimen dig his jaws into the ground, from which I presume that he drew forth some food though I was unable to obtain confirmation of this. With the exception of one brightly marked

¹ Concerning the habits of the above four species see also Annandale in "Annotated list of the Asiatic Beetles in the Collection of the Indian Museum," Pt. I, pp. 13 and 28—30 (Calcutta, 1909).

specimen of *Cicindela venosa*, Koll.,¹ which was collected in the evening after dusk, the only species found in this situation were *C. angulata*, Fabr.,² *C. sumatrensis*, Herbst,³ and *C. agnata*, Flt.,⁴ and it is perhaps noteworthy that every specimen caught was of a variety with dulled markings, whereas in the longer series of the last named species collected near Balyghai most were of the brightly marked variety. Whether or not these colour differences really depend on the environment I cannot definitely say; but most of the specimens from Balyghai were certainly collected on cleaner, dryer sand of a pale colour, and a beetle of this species collected on clean yellow sand on the bank of a stream near Chakardharpur in Chota Nagpur was of the most brilliant type; whilst two specimens of *C. sumatrensis* collected at the same place were both more brightly marked than those from the muddier sand by the river at Cuttack. Above the bank of the river at Cuttack there was an open grassy area on which the floods had deposited a thin layer of slimy mud. Although continuous with the more sandy river-bank it was inhabited only by two species of tiger-beetles neither of which were to be found there. These species were *C. cognata*, Wdm., and *C. minuta*, Oliv. The latter being a small dark brown species was very inconspicuous on the mud, and evidently chooses mud-banks as its home, for on that part of the bank of the stream near Chakardharpur where the sand on which *C. agnata* and *C. sumatrensis* occurred was replaced by mud, these latter species were replaced by *C. minuta*. *C. cognata*, on the other hand, although dark coloured and not very large, was rendered conspicuous on the mud by its bluish colour, and I suspect that it normally inhabits grassy land such as this had been and would soon be again; for on such land its colour would blend excellently with its surroundings.

In conclusion I have to thank Dr. Horn for the identification of the beetles collected. Dr. Horn informs me that the tiger-beetles of Orissa are as yet but imperfectly known and suggests that all the species I collected there should be mentioned in this note. To those already referred to I have only to add *Collyris distincta*, Chd. var., on the label attached to which Dr. Horn inserts the note "palp. lab. ex parte rufis, ect." This form was abundant in a clump of trees close to the dak bungalow at Balyghai on the shores of the Sur Lake.

F. H. GRAVELY.

Schizodactylus monstrosus AS BAIT FOR BIRDS.—Perhaps the bait most commonly used by Indian bird-catchers and falconers for snaring insect-loving birds like the Roller, etc. is the mole-

¹ See Annandale, loc. cit., p. 13.

² See Annandale, loc. cit., p. 15.

³ See Annandale, loc. cit., p. 14, where it is noticed that this species replaces *C. btramosa* at a short distance from the sea at Trivandrum just as *C. cancellata*, *C. albina* and *C. agnata* do at Balyghai.

⁴ See Annandale, loc. cit., p. 13.

cricket (*Gryllotalpa*) called in the Punjab *ghū, ān*. Tethered by a thread to a peg it moves to and fro and by its restlessness attracts notice. It should however be kept in the shade as if exposed for many minutes to a fierce sun it will perish. Perhaps this is the reason that some bird-catchers prefer the great grasshopper with curved wings (*Schizodactylus monstrosus*) called *Mirag* in the Chach-Hazara district and *labāna*¹ in the Punjab. For some of the smaller insect-eating birds it must be too large and terrifying, but it is said to be hardy and to stand the sun far better than its rival for favour, the mole-cricket.

D. C. PHILLOTT.

FISH.

Macrones menoda VAR. *trachacanthus* (Cuv. et Val.)—The specimen described below was received in the Museum for identification from Mr. Kinnear of the Bombay Natural History Society nearly a year ago, and as it showed some very interesting features and was a proof against Day's charge of misprint and wrong description concerning Cuvier and Valenciennes' species *B. trachacanthus*, it was thought desirable to wait for more specimens; but this short note need not be kept back any longer.

In all essential particulars, including the proportionate length of the barbels and the remarkable filamentous prolongation of the lower lobe of the caudal fin, this fish resembles the species which Cuvier and Valenciennes described in 1839 as a new species from Bengal in their *Histoire Naturelle des Poissons*, vol. xiv, p. 419, under the name *Bagrus trachacanthus*. The character of the lower lobe of the caudal fin was thus distinctly stated on page 420: "Le lobe inférieur de la caudale dépasse l'autre de près d'un tiers et se termine en filet."

Dr. Gunther in 1864 included this species of Cuvier's in a footnote under the genus *Macrones* as one of the doubtful species (Brit. Mus. Cat. Fish, vol. v, p. 75), but it was left to Day definitely to assert that Cuvier's description was a misprint and a wrong one, especially with regard to the filamentous prolongation of the lower caudal lobe. The specimen under examination refutes the charge and is a proof positive that Cuvier's description was not a misprint.

In 1822 Hamilton (Buchanan) published the plates illustrating his descriptions of the fishes of the Ganges. Below fig. 72 of Plate i of these illustrations the name "*Mugil corsula*" occurs in print. Edward Blyth in 1858, in supplying an additional description of the fish represented by this published figure of Hamilton (Buchanan) points out that under the original drawing of this fish of which fig. 72 is a print, the name "*Pimolodus menoda*" occurs in Hamilton (Buchanan's) own handwriting. Moreover fig. 97 of Plate ix of the same set of illustrations is correctly named "*Mugil corsula*," which is described by Hamilton (Buchanan) in his *Gangetic Fishes* under the same name (p. 221, *Gangetic Fishes Text*, and

¹ In Chach *labāna* is the name for small bird.

fig. 97, Plate ix of the Illustrations). The species *Pimolodus menoda* represented by fig. 72, Plate i, was described by Hamilton (Buchanan) on page 203 of the Gangetic Fishes, additional description being supplied by Blyth in 1858 as already alluded to above. Priority of the specific name "*menoda*" was recognized also by Gunther in 1864 in the footnote on page 64 of Brit. Mus. Cat., vol. v. In spite of all this it is difficult to understand how in 1869 Dr. Day could describe this species under the name "*Macrones corsula*" (H. B.) based on Hamilton (Buchanan's) fig. 72 of Plate i of *M. menoda* and three specimens obtained from the Mahanaddi at Cuttack (Proc. Zool. Soc., 1869, p. 307). However, in this description of "*Macrones corsula*" no reference is made of Cuvier's species. But later on in the Fishes of India both the prior name *M. menoda* and Cuvier's *B. trachacanthus* are included by Day as synonyms of "*M. corsula*." In doing this he had several difficulties to encounter and explain away—the most obvious one of which he disposed of in a curious manner. Whereas Hamilton (Buchanan's) species *M. menoda* in his description (Gangetic Fishes, p. 203) and in the drawing (fig. 72 of Plate i) was represented as having the upper lobe of the caudal fin longer than the lower—the lower lobe of the same fin of Cuvier's species was described by him to be filamentous and very much prolonged. Thus the only way by which Dr. Day could fit it in with his decision that it should be considered as the same species as his "*M. corsula*" was to declare that Cuvier's description about the filamentous prolongation of the lower caudal lobe was a misprint (Proc. Zool. Soc., 1869, p. 307). The specimen which is the subject matter of this note, however, proves that Cuvier's description regarding the proportionate length of the barbels and the filamentous prolongation of the lower lobe of the caudal fin is true and could not have been due to a misprint.

It is therefore identified as Cuvier's *trachacanthus* which must be regarded as a distinct variety, if not a species—being included under Hamilton (Buchanan's) species *Macrones menoda* which through a mistake Day called "*Macrones corsula*" in the Fishes of India—the mistake being continued unnoticed in the Fauna of British India.

The specimen should therefore be identified as *Macrones menoda* (H. B.) var. *trachacanthus* (Cuv. et Val.), for which the following short description may be supplied:—

Macrones menoda (H. B.) var. *trachacanthus* (Cuv. et Val.).

Depth of body $4\frac{3}{7}$ in the length, length of head 4. Snout $3\frac{2}{7}$ in the length of head, $1\frac{1}{2}$ as long as the eye the diameter of which is $4\frac{3}{5}$ in the length of head. Barbels eight, nasal extends far beyond the hind edge of the orbit, maxillary to middle of ventral, external mandibular to the middle of pectoral fin and internal mandibular to posterior extremity of opercle. Dorsal I 7, the posteriorly serrated spine is $\frac{5}{8}$ of the length of head. Pectoral I 9, spine posteriorly

denticulated, nearly as long as the head. Ventral 6, does not reach the anal. Anal 12. Caudal 17, deeply lobed, the lower lobe being much longer than the upper and ends in a filamentous prolongation. Adipose dorsal is high and pointed, length of the base being slightly shorter than the base of the anterior dorsal fin. Colour in spirit superiorly greyish brown and inferiorly dull white. Fins stained with black.

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REPTILES.

AQUATIC TORTOISES OF THE MIDDLE GANGES AND BRAHMAPUTRA.—From enquiries from the actual catchers it appears that there are at least nine distinct species of water-tortises recognized by them in the beds of the Ganges up to Sahebgunge, the Kosi up to Jogbani (Anchra Ghat), the Mahanada in Maldah District and the Brahmaputra up to Goalpara. Of these six species* were secured during a trip to Rajmehal undertaken in March, 1912. For the identification of the tortoises I am indebted to Dr. N. Annandale.

Among the hard-shelled species four are distinguished :—

1. The *Sál* or *Sail* (*Kachuga lineata* (Gray)) grows to three feet by twenty inches, weighs 20 to 30 seers and is easily distinguished by its larger size and very smooth and oily back from the *Dhoor* which is the common medium-sized species with rough back. The *Sál* does not breed and is not found with eggs until it reaches a much bigger size than the adult *Dhoor*. Two specimens of *Sál* were secured. Dr. Annandale thinks that *Batagur baska* (Gray) is probably confounded with this species by the tortoise-catchers.

2. The *Dhoor* (*Kachuga dhongoka* (Gray)) is a smaller species than the *Sál*. It grows to sixteen inches by twelve inches and weighs eight to ten seers. It has a slightly rough back with pointed knobs in the middle line; the males are said to be very much smaller, not growing more than ten inches in length. The eggs are oval and very long, measuring 5.5×3.3 cm., and 30 to 35 are deposited at a time. Twenty-eight specimens of *Dhoor* were secured together with several eggs dug out of sand banks. Some individuals brought forth eggs while being packed. The shell of the egg is very brittle and there is a large air-space inside it, the external surface is obscurely pitted.

Both the *Sál* and *Dhoor* breed in March and deposit eggs on the sand bank of the Ganges but as they leave trailing marks behind, the hiding places of the eggs are easily discovered. Both *Sál* and *Dhoor* have long (oval) eggs, the *Sál*'s being much bigger than those of the *Dhoor*. The young ones come out in May or June. They are occasionally caught in the fine nets in the month of June or July.

3. The *Chapaut* or *Chauptuta* (*Kachuga smithii* (Gray)) is the smallest species but otherwise very similar to the *Dhoor*. It

does not grow to more than eight or ten inches in length and not more than a seer in weight. It deposits 5 to 8 eggs at a time and buries them in sand. Three specimens were secured.

4. The *Panchuria* (? *Kachuga tectum* (Gray)) similar to the *Chapaut*, is an intermediate species between the *Dhoor* and the *Chapaut*, growing to one foot in length and two seers in weight. No specimens of this species could be found on my trip.

5. The *Kala* or *Kali Kaunttha* of the Bengalis (*Hardella thurgii* (Gray)), is known as *Gaira* among the Gondris who are the expert catchers of tortoises. This species grows to two feet by fourteen inches and weighs 19 to 20 seers. The eggs of the species are not found in the sand bank on the Ganges, but are occasionally met with in the months of August and September, when the water subsides. The eggs are said to be oval. This species is also known as *Kariha* (or *Kariyaon*) among the Teors and Binds on the Kosi side. One specimen was secured.

Of the soft-shelled water-tortoises four species are recognized by the catchers.

6. The *Kataha* or *Kattha* of the Gondris and *Palaiya* of the Binds (*Trionyx gangeticus*, Cuvier) is a roundish low species growing to four feet by three feet and weighing two to three maunds. It brings forth round eggs which are found in the mud after the subsidence of the floods. The eggs are perfectly spherical, measuring 2.3 cm. in diameter. Some eggs were secured on a previous trip. This species is said to be good to eat. One specimen was obtained.

7. The *Keora* of the Gondris (*Trionyx hurum*, Gray) is a smaller species than the *Kataha*. It weighs twelve to fourteen seers, grows to sixteen inches by twelve inches in the disk, and brings forth round eggs. It is said to be very bad eating owing to its rank smell. One specimen was secured on this trip, and another on a former occasion near Rajmahal. Both are unusually pale in colour, lacking to a large extent the characteristic markings of the species. Dr. Annandale thinks it probable that they represent a local race distinguished from the typical one by a more uniform coloration and possibly by being smaller. In any case no structural difference likely to be constant can be detected.

8. The biggest of these soft kinds is the *Sim* (*Chitra indica* (Gray)) which grows to five feet in length of disk and weighs six to seven maunds. Like the *Kataha* it is to be found in the Kosi and also at Kustea and occasionally at Chilmari. It does not bite but disables its victim by blows, often injuring fishing boats by the impact thereof. It is bad and coarse eating. No specimen was secured, but there can be little doubt from the fishermen's description that *C. indica* is the species referred to under the above name.

9. The *Abhua* (*Emyda granosa* (Schoepff)), which is also known as *Matia* because it is supposed to subsist on earth, is a smaller species than the *Kataha*. In winter they are found peeping out of mud holes in the banks. It is said to be numerous

near Kánsàt (Maldah) and in the Gumani River (Murshidabad). It grows to one foot in length. No specimen was secured but there can be little doubt that the identification is correct.

The Santals, the great patrons of tortoise-consumption, recognize only two kinds. One is called *Lepra*, under which name falls *Kattha*, *Keora*, *Sim* and *Abhua* of the Gondris and the other *Hurum*, under which Santali name fall the *Dhoor*, *Sál*, *Goira*, *Panchuria* and *Chapaut* of the catchers. Thus the distinction made by the Santali is a general one, whereas those of the catchers are evidently specific. It may be remarked here that the name *Hurumí* is not applied to any of the soft species of water-tortoises in the Santali language.

The following fishing tribes were found catching tortoises in the bed of the Ganges near Rajmahal:—The Binds and Banpars catch them by *bansis* (hook and line), the Teors harpoon them, but the Gondris make a speciality of catching them in nets manufactured for the purpose. Tortoises, great and small, are often caught in the *Bara jal* along with all kinds of fish, but this is an accident and tortoises so caught are often thrown back into the river, as the Malas and Myfarases do not take any interest in them. It is forbidden to the latter people to eat them, while the former consider them unclean.

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