RECORDS

of the

INDIAN MUSEUM

(A JOURNAL OF INDIAN ZOOLOGY)

Vol. XIX, Part III.

AUGUST, 1920.

Calcutta:

PUBLISHED BY THE DIRECTOR, ZOOLOGICAL SURVEY OF INDIA.
PRINTED AT THE BAPTIST MISSION PRESS.

1920.

Price Two Rupees.

XII NOTE ON THE OCCURRENCE IN THE RIVER GANGES OF THE AMPHIPOD, *AMPELISCA PUSILLA* SARS

By DR. CHAS. CHILTON, *Canterbury College, New Zealand.*

Some time ago I received from Dr. N. Annandale a tube containing some Amphipods collected in the river Ganges at Buxar, about 600 miles from the mouth, by T. Southwell, Esq. These were sent for comparison with the Amphipods from the Chilka Lake Survey which I was then examining. The specimens from Buxar proved to be *Ampelisca pusilla* Sars, a species which was also represented by many specimens from several localities in the Chilka Lake. This species was originally described by Sars [1] from the seas off the coast of Norway at depths from 180 to 370 metres. These northern specimens had the eyes imperfectly developed, without any trace of the corneal lenses. In 1910 Stebbing [2] with some hesitation referred to this species a single specimen obtained by the "Thetis" off Wata Mooli on the east coast of Australia, but stated that in this specimen the corneal lenses appeared to be present. They are also present in the specimens both from the Chilka Lake and from Buxar, but from the very close resemblance in all other respects of the specimens, both male and female, to the descriptions and figures given by Sars, I feel quite confident that they are rightly referred to *Ampelisca pusilla*. The imperfection in the eyes of the northern specimens is probably to be associated with their occurrence at considerable depths in the ocean. In the specimens from Buxar the eyes in most of the specimens were distinctly red, though they had been for a considerable time in spirit, in some the whole eye with its two corneal lenses being red, in others the red colour being somewhat patchy.

As I have stated in my report on the Chilka Lake Amphipoda [3] I think *Ampelisca chevreuxi* Walker from Ceylon should be considered as a synonym of *Ampelisca pusilla*.

So far as I am aware, the numerous species of *Ampelisca* have hitherto been recorded from marine localities only, and the occurrence of this species in fresh water in the river Ganges seems therefore worthy of a special note. In the Chilka Lake it occurs at several localities at some of which the water is probably brackish or perhaps quite fresh at certain seasons of the year.

---

[1] Crustacea of Norway, I, Amphipoda, p. 181, pl. 63, fig. 2.

[2] Amphipoda of "Thetis" Expedition, *Australian Museum Mem.* IV, p. 576.

[3] *Mem. Ind. Mus.* V (*in the press*).

The occurrence of the species in such widely separated localities as the Arctic Seas, India and Australia will doubtless help to throw light on the causes that have led to the distribution of this and other Amphipods. In this connection it should perhaps be mentioned that in the Chilka Lake *Ampelisca pusilla* occurs along with *Paracalliope fluviatilis* (G. M. Thomson), a species which is common in fresh and brackish waters in New Zealand and has also been recorded under the name of *Pherusa australis* Haswell from Botany Bay, east coast of Australia. Quite recently I have received specimens also from the Philippine Islands.

XIII ON *MESOCOELIUM SOCIALE* (Lühe).

By R. B. SEYMOUR SEWELL, *B.A., F.A.S.B, I.M.S.*,
Offg. Superintendent, Zoological Survey of India.

This species of Trematode appears to be widely distributed throughout the tropical and sub-tropical zones: it was first discovered and described by Lühe (1901, p. 171) from *Bufo melanostictus* Schneid. from the East Indies; subsequently Odhner (1911, p. 88, footnote) obtained specimens, also from *Bufo melanostictus*, in material sent to the Berlin Museum from the island of Biliton in the Dutch East Indies between Sumatra and Borneo, and the same author also records its occurrence in a species of *Bufo* obtained by Fiebrig in Paraguay.

This Trematode was first found by me in a specimen of *Bufo melanostictus*, caught in the compound of the Indian Museum, Calcutta, in May, 1919; subsequent examination of other specimens of this toad obtained from the same locality proved that at this period of the year infection with the parasite is heavy and wide spread and in Table I I give a record of my observations during the months of May and June, 1919.

TABLE I.

Record of occurrence of *Mesocoelium sociale* (Lühe) in *Bufo melanostictus*.

Date.	Host.	No. of Specimens examined.		*Mesocoelium sociale* Lühe.	REMARKS.
May 14 ..	*Bufo melanostictus*	2	adults	present ..	in both examples.
,, 15	,, ,,	3	,, ..	present ..	in all three.
,, 16 ..	,, ,, ..	1	,, ..	present ..	30 specimens obtained.
,, 17 ..	,, ,, ..	2	,,	present ..	in both examples.
,, 18 ..	,, ,, ..	1	,, ..	present ..	50 specimens obtained.
,, 23 ..	,, ,, ..	1	,, ..	present ..	....
June 11 ..	,, ,, ..	3	immature, measuring 15-18 mm. in body length.	absent ..	....
,, 13 ..	,, ,, ..	1	adult ..	present ..	5 specimens only.
,, 18 ..	,, ,, ..	1	,,	present ..	in large numbers.
,, 21 ..	,, ,, ..	1	a young ♂ ..	absent ..	....
,, 29 ..	,, ,, ..	2	adults	present ..	in large numbers.

A point of interest revealed by the above record is the curious fact that it was only in *adult* specimens of *Bufo melanostictus* that examples of the worm were found: in the case of the three immature examples examined on June 11th, and the young ♂ examined on June 21st, no trace of the Trematode was discovered, although in all cases the intestinal contents showed a rich protozoan fauna and in one of the small immature examples several young Nematode worms were present in the large intestine. It appears probable, therefore, either that infection with this parasite occurs late in life or, as seems to me to be more probable, that the period of infection is an annual one and had occurred some time prior to the month of June, and that in consequence specimens of *B. melanostictus* that had been hatched in May or June—after the annual period of infection—were found to be free from the parasite. That the period of infection is not only an annual one but is moreover one of short duration is indicated by the fact that a further series of 5 adult examples of this toad caught in the museum compound in January, 1920 were found to be free from the parasite.

The anatomical locality, in which the worms were obtained by me, was in every case the upper portion of the small intestine. Lühe in his original description states that the worms were found "in the greater part of the small intestine, and especially in the upper part." I never found a single example in the large intestine. In every case the worms were adhering to the mucous membrane by means of their oral suckers but when the intestine was slit up and spread out in water, they quickly relaxed their hold and dropped to the bottom of the dish.

External Characters.

The body of the worm is capable of a considerable degree of extension and contraction and its shape varies accordingly. It is always more or less compressed and flattened dorso-ventrally and when fully contracted, or after fixation in Schaudin's fluid, its outline is an elongate oval with both ends bluntly rounded and the lateral margins roughly parallel with each other. When in this condition, my specimens agree with the original description (Lühe, 1901, p. 71), but during the process of extension in the living specimens the anterior region of the body lying in front of the acetabulum becomes narrow and somewhat tapered, whereas the posterior part situated behind the acetabulum undergoes considerably less change in shape, probably on account of the dense coils of the uterus contained in it. In this extended state the outline of the body is bottle-shaped.

The examples examined by me show a much greater range of measurement than is given by Lühe, who states that the length is $1\frac{1}{4}$—2 mm. and the greatest breadth 0·55—0·90 mm. In Table II I have given the measurements of a series of individuals: in each case the worm had been fixed in Schaudin's fluid and was in consequence in a contracted state; every example contained

ripe ova, though in the smaller examples only a few were present, whereas in the large ones the coils of the uterus were densely crowded.

TABLE II.

Dimensions of *Mesocoelium sociale* (Lühe) in millimeters.

Measurement.	1	2	3	4	5	6	7
	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Total body-length	0·684	0·842	0·982	1·702	2·018	2·06	2·21
Greatest breadth	0·403	0·349	0·438	0·860	0·596	0·706	0·737
Oral sucker .. Length ..	0·139	0·140	0·143	0·225	0·219	0·228	0·263
Oral sucker .. Breadth ..	0·125	0·140	0·132	0·214	0·228		
Acetabulum .. Length ..	0·121	0·093	0·107	0·168	0·175	0·175	0·210
Acetabulum .. Breadth ..	0·125	0·121	0·114	0·178	0·193		
Pharynx .. Length ..	0·064	0·050	0·054	0·086	0·096	..	..
Pharynx .. Breadth ..	0·064	0·057	0·064	0·107	0 105	..	..
Distance of end of intestinal caeca from posterior end of body.	0·161	0·236	0·314	0·564	0·632	..	..
Caeca extend back in body length	2·29/3·00	2·15/3·00	2·04/3·00	2·00/3·00	2·05/3·00	..	..

In the case of a living example the body when extended showed a length of 2·65 mm. and a breadth of 0·30 mm., but when fully contracted the length was only 1·18 mm. and the breadth had increased to 0·65 mm: in this example both suckers gave a measurement of 0·18 mm. in the transverse diameter, but the oral sucker was somewhat elongate in shape and had an antero-posterior length of 0·235 mm.

The oral sucker occupies the rounded anterior end of the body and, as is only natural, varies in size in specimens of varying degrees of growth, being smaller in specimens with a small body-length and larger in those whose growth and development has proceeded further. Its general outline is found to vary in different individuals; in some cases, as in Examples 1, 3 and 4 in Table II, its antero-posterior length is greater than the transverse diameter, whereas in others, such as example 5, it is the transverse measurement that is the greater. This difference is probably directly correlated with the degree of extension or contraction of the anterior end of the body, in the extended condition the long diameter being antero-posterior, while in the contracted state it becomes transverse. The mouth is subterminal in position and it leads back into the cavity of the oral sucker: around its margin in young immature specimens is a double ring of small papillae, but as the worm grows these appear to become proportionately smaller and in the largest examples seem to have disappeared entirely.

The acetabulum is situated on the ventral surface, where it forms a well-marked projection, about one-third of the body-length from the anterior end: its exact position varies according to the degree of growth to which the specimen has attained. As Cort (1919 (b), p. 295) has pointed out in the case of *Margeana californiensis*, during development " there is relatively a much greater growth of the post-acetabular region, undoubtedly correlated with the development of the coils of the uterus to hold the enormous numbers of eggs produced." Exactly the same phenomenon occurs in this species, and, in consequence, as the body-length increases the relative position of the acetabulum moves steadily towards the anterior end. In specimens having a body-length of 1·0 mm. the proportion of pre- and post-acetabular regions is 38 : 62; while in specimens which have attained a body-length of 2·0 mm. the pre- and post-acetabular regions have a relative proportion of only 30 : 70. This sucker is somewhat smaller than the oral sucker, the proportional sizes being about 5 : 4, and a study of the measurements given in Table II above show that at any rate in fixed and contracted specimens it is slightly oval in outline, its long-axis lying in the transverse diameter.

The skin is provided in the anterior two-thirds of the body with numerous fine posteriorly-directed spines, which are arranged in transverse rows, those of one row alternating in position with those of the row in front and behind: in the posterior third of the body the cuticular spines gradually thin out and finally disappear altogether. In addition to this cuticular armature the skin on the dorsal surface of the anterior region of the body is provided with a number of scattered unicellular glands: these gland-cells are somewhat irregular in shape, but usually possess an elongate pyriform outline; they are composed of refractile, finely-granular protoplasm and appear to possess a short narrow neck or duct, which opens by a small pore to the exterior. Exactly similar cutaneous glands have been described and figured by Looss in several closely-related species, e.g. in *Opisthoglyphe ranae* (Frölich) [Looss, 1895, p. 86, fig. 155] and in *Haplometra cylindracea* (Zed) [Looss, 1895, p. 66, fig. 149], both of which are placed by Odhner in his Family Lepodermatidae: also in *Pleurogenes claviger* (Rud) [Looss, 1895, fig. 171 A] and *P. medians* (Olss.) [Looss, 1895, figs. 36 and 187, C.], in *Lecithodendrium glandulosum* (Looss) [Looss, 1900, p. 66, fig. 43], *L. obtusum* (Looss) [Looss, 1900, p. 78, fig. 53], *L. hirsutum* (Looss) [Looss, 1900, p. 69, figs. 45, 47], and *L. sphaerula* (Looss), [Looss, 1900, p. 81, fig. 57] and in *Anchilotrema sanguineum* (Sons.) [Looss, 1900, p. 107, fig. 75], all of which Odhner places in the Family Lecithodendriidae. It seems probable that the presence of these unicellular cutaneous glands is of frequent, if not of universal, occurrence in the members of the Lepodermatidae and Lecithodendriidae and other closely related families, and that they are the persistent remains of the cystogenous cells that are present in the larval, cercarial stage [but see Looss, 1895, p. 124].

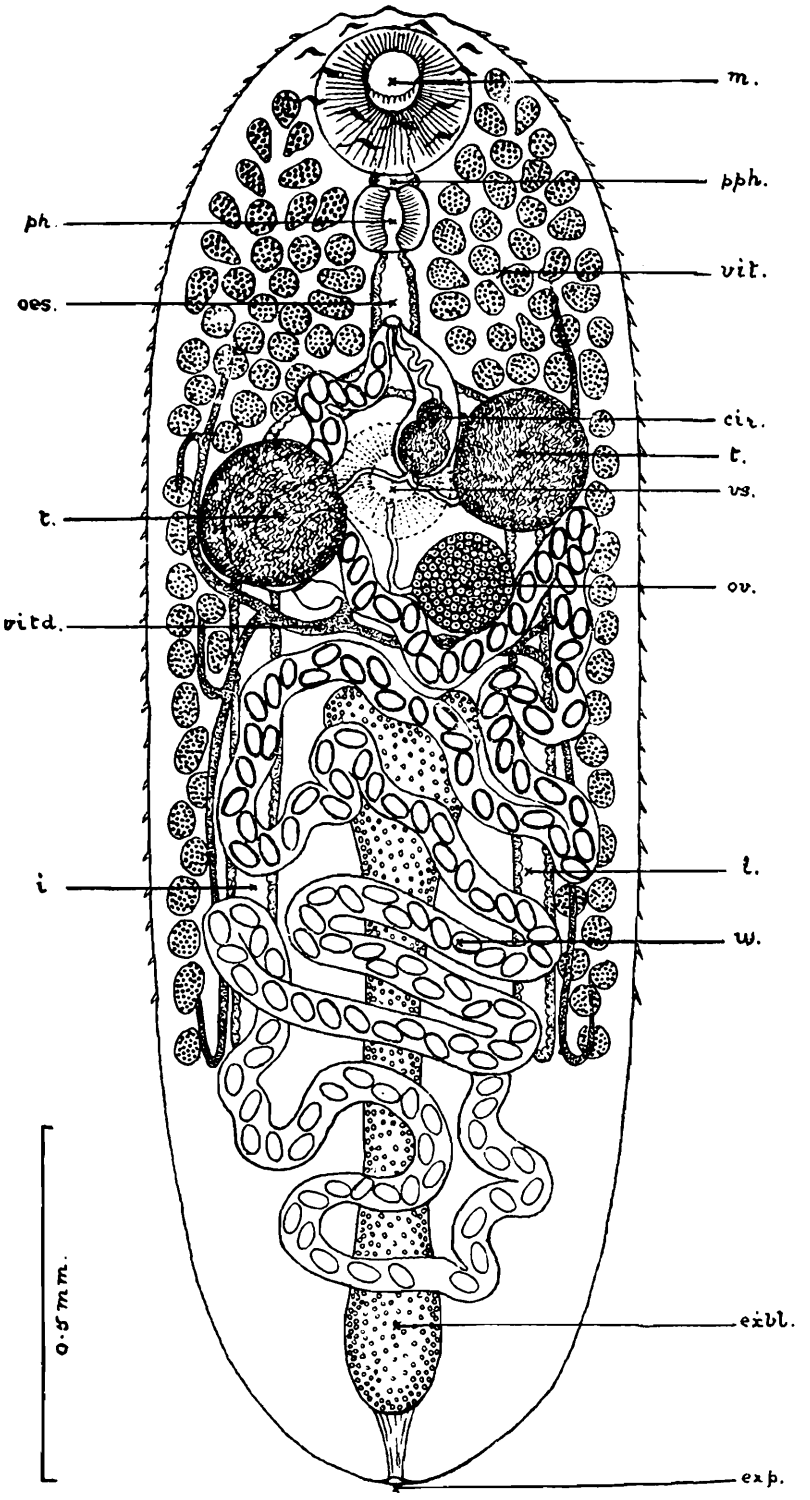


FIG. 1.—Dorsal view of *Mesocoelium sociale* (Lühe) slightly compressed.

cir., cirrus sac; *exbl.*, excretory bladder; *exp.*, excretory pore; *i.*, intestinal coecum; *m.*, mouth; *oes.*, oesophagus; *ov.*, ovary; *ph.*, pharynx; *pph.*, prepharynx; *t.*, testis; *u.*, uterus; *vit.*, vitelline gland; *vitd.*, vitelline duct; *vs.*, ventral sucker.

Internal anatomy.

The oral sucker leads back into a short and wide pre-pharynx (fig. 1, *pph.*) with thin walls, and this is followed by a well-developed muscular pharynx (*ph.*). Lühe in his original description states that this organ is rounded with a diameter of 0·075-0·100 mm.: in my examples it was only in the smaller specimens (vide Table II) that the organ presented a rounded outline; in all the larger specimens the pharynx was oval, the long axis being in the transverse diameter. The diameter ranges from 0·064 mm. in the smallest example to 0·105 mm. in the largest. At first sight it appears as if the pharynx did not increase in size proportionately with the rest of the body, for in example 5, although the total body-length is three times as great as in example 1, the diameter of the pharynx has only increased by 50 per cent., but, as I have already pointed out, this increase in the body-length mainly affects only the post-acetabular region and a comparison of the other measurements shows that, so far as they are concerned, the proportional increase in size is approxmiately also 50 per cent. Behind the pharynx is a short wide oesophagus (*oes.*), the wall of which is plentifully provided with muscles. The tube is lined by a layer of cells having a finely granular protoplasm, and outside this lies a double muscular coat, the internal layer consists of circular fibres surrounding the tube, and outside this is a layer of oblique, strong muscle-fibres (fig. 2 *exm.*), which are attached to the oesophageal wall and diverge outwards and forwards, blending with the supporting parenchymatous tissue of the body: external to this again is a further layer composed of a number of pyriform cells (*oesg.*), with oval or rounded nuclei. Monticelli (1893, p. 30) has described this layer of cells in other trematodes as the salivary gland; it is unfortunate that he should have used this term, for Looss (1895, p. 140) has described true "salivary glands," the ducts of which pass forwards to open just *behind* the mouth, in *Pleurogenes claviger* (Rud) and *Heterolope leptostoma* (Olss.). In the former species the salivary gland consists of 5—6 large granular nucleated cells lying behind the pharynx on either side of the oesophagus, from each of these cells a fine duct extends forwards, and they open in a row just behind the mouth, the orifice of each duct being visible as a small refractile spot.

In *Mesocoelium sociale* (Lühe) true salivary glands (fig. 2 *salg.*) also occur, situated behind and to the outer side of the pharynx at the level of the bifurcation of the oesophagus. Each gland consists of about ten pyriform cells, with round clear nuclei and granular protoplasm: these glands are very difficult to see owing to their being surrounded by follicles of the yolk-gland, but their position is shown in fig. 2. From each cell a fine duct arises (*sald.*), these pass forwards in a bundle lateral to the pharynx and reach the side of the oral sucker; they then sweep round its dorso-lateral aspect and open in a transverse row on the *anterior* lip of the mouth, the terminal portion of each duct appearing in

optical section, exactly as Looss describes, as a round refractile spot. It is extremely interesting to note that these gland-cells and ducts agree exactly as regards their appearance and distribution with the "stylet-gland" cells of the Polyadenous group of the Xiphidiocercariae (*vide* Cort, 1914, p. 53 and figs. 68 and 69), and I have no doubt that the two structures are identical.

About midway between the pharynx and the anterior margin of the acetabulum the oesophagus divides into two wide intestinal caeca (fig. 1 *i*), the lumen of which is lined with finely granular

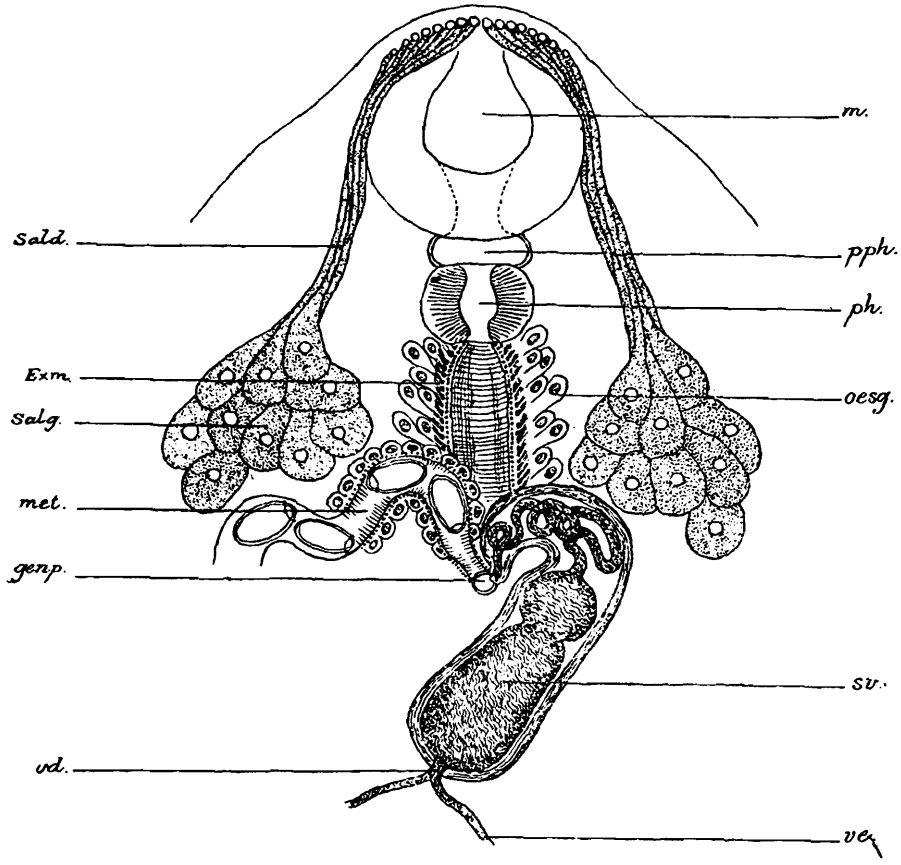


FIG. 2.—Anterior region of *Mesocoelium sociale* (Lühe).

exm., external muscle-fibres of oesophagus; *genp.*, genital pore; *m.*, mouth; met., metraterm; *oesg.*, oesophageal gland cells; *ph.*, pharynx; *pph.*, prepharynx; *sald.*, ducts of salivary glands; *salg.*, salivary gland; *s.v.*, seminal vesicle; *vd.*, vas deferens; *ve.*, vas efferens.

cells. Each caecum passes backwards and outwards around the acetabulum and is then continued back along the sides of the body to a point about one-third of the total body-length from the posterior end. Lühe in his original description states that they extend back three-quarters of the body-length, but here again there seems to be some difference in different individuals, according to the degree of development that has been attained. A reference to Table II shows that in smaller specimens the caeca extend proportionately further back in the body than they do in the larger

examples, as Cort (1919, p. 295) found also to be the case in *Margeana californiensis.*

The genital organs, with the exception of the coils of the uterus, lie in the anterior half of the body and are closely grouped around the acetabulum. A pair of testes (fig. 1. *t*) lie, one on each side, at about the level of the acetabulum: the right testis is as a rule situated rather more anteriorly than the left and is at the level of the anterior acetabular margin, whereas the left testis is usually opposite the posterior margin, but this difference of level appears to depend on the position of the ovary. Lühe in his original description figures the ovary on the right side of the body, and the right testis anterior to the left; in the majority of specimens examined by me this was the condition found but in a number of cases, roughly about 30 per cent. of those examined, the ovary lies on the left side of the body and in these cases it is the left testis that is the more anterior. Lühe further describes the testes as being triangular or oval and he figures the one lying anterior to the ovary as triangular, and the one on the other side of the body as oval. Johnston (1912, p. 336) in his table for the determination of the species of *Mesocoelium* gives "Testes triangular" as one of the diagnostic features of this species, but in all cases examined by me these organs have a rounded outline, when viewed from above: in transverse sections they are seen to be somewhat flattened dorso-ventrally and so present an oval appearance. From each testis a delicate narrow vas efferens arises: these ducts pass forwards and medianwards and unite together close to the base of the seminal vesicle to form a very short vas deferens (fig. 2 *vd.*), which pierces the cirrus-sac at its posterior end. The genital pore (*genp.*) is situated in the middle line of the body about midway between the two suckers and a little in front of the point of bifurcation of the oesophagus (*vide* fig. 1): the cirrus-sac (fig. 1 *cir.*) is large and thick-walled and extends backwards from the genital orifice to a short distance behind the anterior margin of the acetabulum; it is usually slightly curved and is deflected towards the right side of the body. Although Lühe makes no mention of this organ in his original description, he figures it quite correctly. The posterior half of the cirrus-sac is occupied by a large bi-lobed seminal vesicle (fig. 2 *sv.*), which in adult examples is full of ripe spermatozoa: in front of this lies the cirrus, which is long and narrow and is usually coiled up within the sac. The prostate gland appears to be somewhat diffuse; it extends backwards around the anterior end of the seminal vesicle and forwards around the cirrus nearly as far as the genital orifice.

The ovary (fig. 1 *ov.*) lies usually on the right side of the body behind and somewhat to the inner side of the right testis at about the level of the posterior border of the acetabulum, though, as I have remarked above, in about 30% of cases it lies on the left side. In this respect *Mesocoelium sociale* (Lühe) shows a variability that is exactly similar to that found by Johnston in *M mesem-*

brinum (*l.c.* 1912, p. 332). In mature specimens the ovary is considerably smaller than the testis: in all my examples its outline is circular and from the median and posterior aspect arises a short wide oviduct (fig. 3 *ovd.*). After a short course the oviduct receives on its posterior aspect the duct from the large pear-shaped receptaculum seminis (*r.s.*), and immediately beyond this point it gives off Laurer's canal (*l.c.*), which turns forwards and upwards and opens on the dorsal surface above the acetabulum: the oviduct is then continued on across the middle line and receives posteriorly the common vitelline duct (*vitd.*); it then enters Mehlis' gland (*Mg.*) and dilates to form the ootype (*oot.*). On leaving the ootype the uterus (*u.*) turns forwards for a short distance and then bends sharply backwards towards the posterior end of the body, which is almost completely filled with

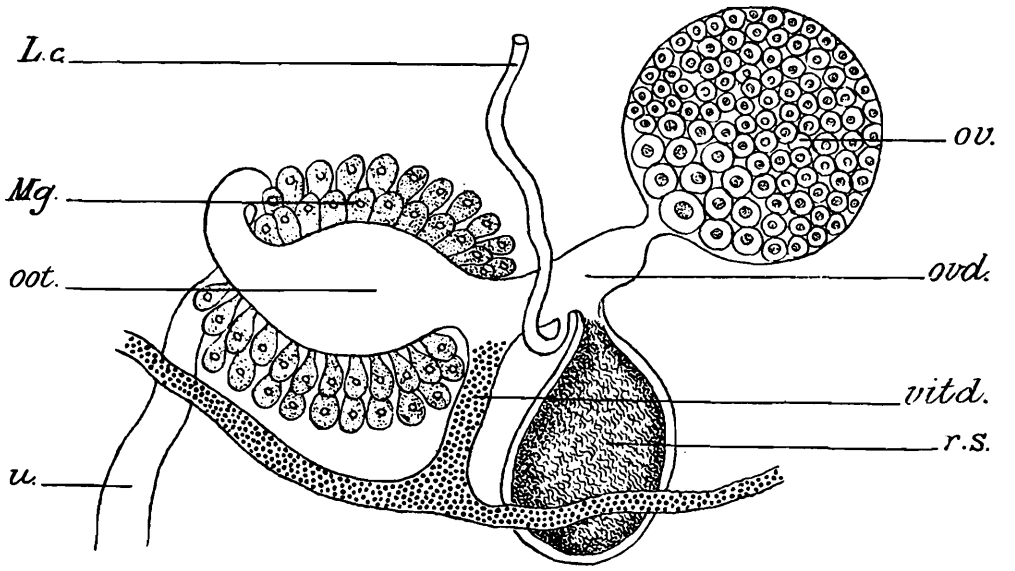


FIG. 3.—The female reproductive system of *Mesocoelium sociale* (Lühe).

La., Laurer's canal; *Mg.*, Mehlis' gland; *oot.*, ootype; *ov.*, ovary; *ovd.*, oviduct; *r.s.*, receptaculum seminis; *u.*, uterus; *vitd.*, vitelline duct.

its coils and convolutions (fig. 1 *u*): it finally turns forwards again and, passing ventrally to the testis on the side of the body opposite to that on which the ovary lies, it bends inwards towards the middle line and opens at the genital pore. The terminal portion of the uterus or metraterm (fig. 2 *met.*) is thick-walled and muscular; internally is a layer of circular muscle-fibres and immediately external to this is a layer of gland-cells, with oval or rounded nuclei

The vitellaria or yolk-glands (fig. 1 *vit.*) consist of a number of oval or rounded follicles, and extend from the side of the oral sucker, backwards along the sides of the body to the posterior extremity of the intestinal caeca: as a rule they do not extend backwards beyond this point, though in a few examples they are slightly more extensive. In the anterior region of the body in

front of the testes, the two glands spread inwards and almost reach the middle line in the region of the oesophagus; this mesial extension is greatest on the dorsal side of the body. Lühe states that in this region each gland may attain a breadth equal to one-third of the body-breadth, but in some of the specimens examined by me, they exceeded this. In the posterior region of the body, behind the acetabulum, the follicles of the yolk-gland lie almost entirely to the outer side of the intestinal caecum, between it and the lateral margin. Anterior and posterior branches of the vitelline ducts run respectively backwards and forwards in the lateral regions of the body and unite opposite the posterior margin of the ovary to form the main duct from each gland (fig. 1 *vitd*). These ducts then pass inwards towards the middle line and where they join the lumen is slightly dilated, forming the vitelline reservoir from which the common duct passes to join the oviduct (fig. 3 *vitd.*).

The eggs are oval in shape and when first formed have a thin greyish transparent capsule, but as they mature the thickness of the capsule increases very considerably and the colour changes to a pale yellow and eventually to a brown tint. At one pole is a small but well-formed operculum with a slightly raised edge. The dimensions of the eggs appear to vary somewhat in different individuals and also in different stages of their development. Young immature eggs in the coils of the uterus lying most posteriorly are distinctly shorter and broader than the ripe eggs in the terminal portion of the uterus. Immature eggs have an average measurement of 0·034 mm. in length and 0·027 mm. in breadth. The measurements of mature ova usually fall within the limits given by Lühe, namely, a length ranging from 0·038 mm. (I presume that the measurement of 0·0038 as given in his original description is a misprint) to 0·040 mm. and a breadth of from 0·024 mm. to 0·026 mm. In certain individuals, however, eggs are occasionally found which show a much greater range of variation; in one young specimen containing only a comparatively few eggs, these were found to vary from 0·037 mm. in length × 0·028 mm. in breadth to 0·050 mm. in length × 0·021 mm. in breadth. Cort (1915, p. 26) has recorded an instance of the eggs of *Pneumonœces similiplexus* Stafford showing a considerable range of variation in dimensions in specimens obtained in different localities, but the present phenomenon falls in an entirely different category, and seems to be more nearly related to the egg-variation described by Leiper (1918, p. 246) in a single female of *Schistosoma haematobium* in which ovulation had only just commenced.

The excretory system is extremely well-developed (fig. 4): a long tubular excretory-bladder (*b*), usually containing a large number of small globular refractile granules of excretory material, passes forwards from the posterior end to a point about the middle fo the body-length and a short distance behind the level of the ovary: it is somewhat narrow in its middle third; posteriorly

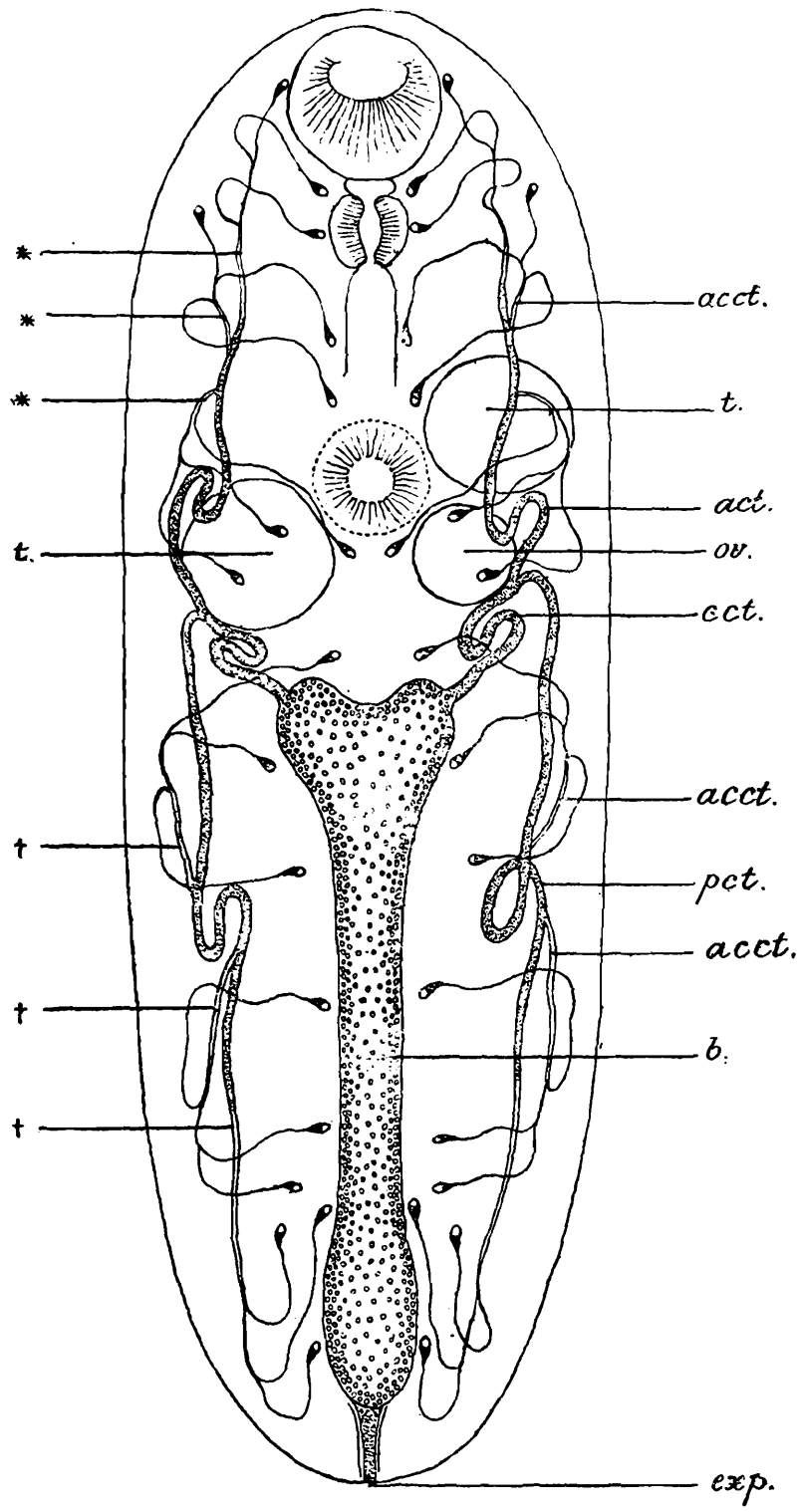


FIG. 4.—The excretory system of *Mesocoelium sociale* (Lühe).

acct., accessory collecting tube; *act.*, anterior collecting tube; *b.*, excretory bladder; *cct.*, common collecting tube; *exp.*, excretory pore; *ov.*, ovary; *pct.*, posterior collecting tube; *t.*, testis.

On the left side of the figure the three anterior accessory collecting tubes are shown * and the three posterior tubes †.

it is somewhat dilated and from this dilated portion a short canal passes backwards to the excretory pore (*exp.*), which is situated at the extreme posterior end of the body. Anteriorly the bladder becomes somewhat dilated and it terminates in two very short and wide lateral diverticula. From each diverticulum a short common collecting tube (*cct.*) can be traced forwards and outwards to a point opposite the posterior margin of the acetabulum, where it divides into anterior (*act.*) and posterior (*pct.*) collecting tubes, running forwards and backwards respectively in the lateral region of the body. Both anterior and posterior collecting tubes receive three accessory collecting tubes (*acct.*), each of which is formed by the union of three capillary vessels originating in three flame cells: of these capillary vessels two unite together to form a single trunk and this is then joined by the capillary of the third flame cell, thus showing what Cort (1919, p. 290) has termed the "two-one" arrangement in the capillary groups. The excretory system of this species is summarised in the formula $2 \times 6 \times 3$, and in fig. 4 I have shown the distribution and arrangement of the capillary groups and collecting tubes. A comparison of this figure and those given by Cort of the excretory systems of *Cercaria polyadena* (*l.c.*, 1919 (a), p. 277) and *Margeana californiensis* (*l.c.*, 1919 (b), p. 293) shows that in all three the systems are identical.

As almost the whole of my researches on this species, *Mesocoelium sociale* Lühe, were confined to the study of living examples, it was found to be impossible to work out the nervous system in detail. On either side of the oesophagus lies a ganglionic mass which is connected across the middle line with its fellow of the opposite side by a short stout commissure running dorsally to the alimentary canal: a pair of large ventral nerves can be traced backwards on the ventral aspect, extending as far as the posterior ends of the intestinal caeca, and a smaller dorsal pair of nerves can be made out on the upper aspect of the body, while several smaller nerves appear to pass forwards around the oral sucker towards the anterior end of the body.

Development.

At the present time nothing is known regarding the larval development of this species. Cort (1919 (b), p. 295) has put forward the view that *Margeana californiensis*, which he places in the subfamily Brachycoeliinae Looss, is developed from a cercaria that in all probability will be found to belong to the Polyadenous group of the Xiphidiocercariae. This sub-group of cercariae was created by Cort (1914, p. 53) to accommodate certain forms that possess quite distinctive characters dividing them off from other of the Xiphidiocercaria groups. Omitting certain entirely larval characters, the Polyadenous cercariae were shown by him to possess the following anatomical features:—

(1) Acetabulum smaller than the oral sucker.

(2) Stylet glands, six or more on each side, between the acetabulum and the pharynx.
(3) Excretory bladder bicornuate.
(4) Very short prepharynx and small pharynx. Oesophagus (when developed) short to, of medium length. Intestinal caeca (when present) reaching to posterior end of the body.

Subsequently (1919 (a), p. 275) he described the excretory system in detail in *Cercaria polyadena* and showed that it possesses the 2 × 6 × 3 formula.

All the arguments that Cort adduces in support of his view regarding the development of *Margeana californiensis* apply with equal force to *Mesocoelium sociale* Lühe: here likewise the relative size of the two suckers, the characters of the digestive tract, the type of excretory bladder and the 2 × 6 × 3 type of excretory tubules and flame cells render it probable that this species also possesses a Polyadenous cercaria as its larval stage; and moreover the presence in the adult worm of true salivary glands, as I have shown above (p. 86), comparable in every way with the stylet-gland of the cercaria, serves to still further strengthen the belief that in the case of this species also the cercaria will be found to belong to the Polyadenous sub-group of the Xiphidiocercariae.

Classification.

The genus *Mesocoelium* was created by Odhner (1911, p. 88) in order to accommodate this species, which was described by Lühe (1901, pp. 171—173, fig. 5) under the name *Distomum sociale*, and he includes the genus in the subfamily Dicrocoeliinae Looss, though, at the same time, he points out that in many respects this species approximates closely to the sub-family Brachycoeliinae Odhner (*nec* Looss). A year later Johnston (1912, pp. 329—341, figs. 13, 14, 15, 69—76) described three more species (*Mesocoelium mesembrinum*, *M megaloon*, and *M. oligoon*), which he refers to this genus and all of which he found inhabiting the intestine of certain species of Anura. On p. 340 he gives in a tabular form the main features of this genus and of both sub-families for the purpose of comparison, and he arrives at the conclusion (p. 336) that "amongst known distomes, it is to *Brachycoelium crassicolle* R. that the four species of this genus appear to be most closely related"; while on p. 338 he admits that "of all the Brachycoeliinae, the various species of *Mesocoelium* appear to approach more closely to the Dicrocoeliinae than any others of their subfamily." In many respects *Mesocoelium* appears to be a connecting link between the two subfamilies: as regards the spiny integument, the relative sizes of the oral and ventral suckers, and the habitat of the various species, i.e. the intestine of amphibia, *Mesocoelium* agrees with the diagnosis of the Brachycoeliinae; on the other hand in respect of the situation and arrangement of the genital organs, the position of the ovary behind the testes, the juxtaposition of these latter to the

acetabulum, and the opening of the genital pore in the immediate neighbourhood of the bifurcation of the intestine this genus agrees with the Dicrocoeliinae; and as regards the distribution of the yolk-glands and the length of the intestinal caeca the conditions existing in the present known species of *Mesocoelium* are intermediate between or a combination of the conditions existing in the two subfamilies, though the length of the intestinal caeca more nearly approximates to the conditions found in the Dicrocoeliinae and especially is this the case in *M megaloon* Johnston and *M sociale* Lühe.

The resemblance between the genera *Mesocoelium* and *Dicrocoelium* becomes still more marked if we accept the view first put forward by Looss (1899, p. 632), and later accepted by Braun (1902, p. 97), and confine the limits of the genus *Dicrocoelium* "to forms with leaf-like shape, with testes lying near or obliquely behind each other and symmetrically developed yolk-glands," relegating the more elongate forms to Looss' provisional genus *Lyperosomum*. Johnston himself admits (1912, p. 341) that *Mesocoelium* agrees with the Dicrocoeliinae as regards the position of the ovary behind the testes, and he gives this as one of the diagnostic features of the genus. The fact that the ovary may in a certain proportion of cases lie on the left side of the body, as he found in *M mesembrinum* and as I have shown above also occurs in *M sociale* Lühe, instead of being on the right as is usually the case, does not seem to me to have any bearing on the matter and his criticism that we cannot therefore regard the positions of the ovary "as of dominant importance in referring the genus to its subfamily" is invalid In no specimen of this genus examined by me or by any previous observer, not excluding Johnston himself, is it recorded that the ovary has ever been seen to lie *in front* of the testes. We have here a constant anatomical feature that in my opinion definitely separates the genus *Mesocoelium* from the subfamily Brachycoeliinae, in which the ovary invariably lies in front of the testes, and completely justifies its inclusion by Odhner in the subfamily Dicrocoeliinae Looss.

BIBLIOGRAPHY

1. Braun, M. 1902 "Fascioliden der Vögel." *Zool. Jahrbücher, Syst. Abth.* Vol. XVI, pp. 1—162, pls. 1—8 (Jena).
2. Cort, W W 1914 "Some North American larval Trematodes." *Illinois Biol. Monographs*, Vol. I, No. 4, pp. 1—70, pls. i—viii (Urbana, Illinois).
3. Cort, W W 1915 "Egg variation in a Trematode species." *Journal of Parasitology*, Vol. II, pp. 25, 26 (Urbana, Illinois).
4. Cort, W W 1919 (*a*) "The excretory system of a stylet cercaria." *Univ. Cal. Pub. Zoology.*

Vol. XIX, No. 7, pp.275—281 (Berkeley).

5. Cort, W. W. 1919 (*b*) "A new Distome from Rana aurora." *Univ. Cal. Pub. Zoology*, Vol. XIX, No. 8, pp. 283—298 (Berkeley).

6. Johnston, S. J 1912 "On some Trematode parasites of Australian frogs." *Proc. Linn. Soc. N.S. Wales*, Vol. XXXVII, pp. 285—362, pls. xiv-xliii (Sydney).

7. Leiper, R. T. 1915 "Report on the results of the Bilharzia mission in Egypt 1915." *Journal of the R.A.M.C.*, Vol. XXX, No. 3, pp. 235—260 (London).

8. Looss, A. 1895 "Die Distomen unserer Fische und Frösche." *Bibliotheca Zoologica*, Vol. VI, pp. 1—296, pls. 1—1x (Stuttgart).

9. Looss, A. 1899 "Weitere Beiträge zur Kenntniss der Trematoden-Fauna Aegyptens." *Zool. Jahrbücher, Syst. Abth.* Vol. XII, pp. 521—784, pls. xxiv—xxxii (Jena).

10. Looss, A. 1900 "Recherches sur la faune parasitaire de l'Egypt." *Mem. L'Inst. Egyptien*, Vol. III, pp. 1—252, pls. i-xvi (Cairo).

11. Lühe, M. 1901 "Zwei neue Distomen aus Indischen Anuren." *Centralbl. Bakt.* Vol. XXX, p. 166.

12. Monticelli, Fr. Sar. 1893 "Studii sei Trematodi endoparassiti." *Zool. Jahrbücher*, Supplement III, pp. 1—229, pls. i—viii (Jena).

13. Odhner, T. 1911 "Nordostafrikanische Trematoden." Sweedish Zoological Expedition to Egypt and the White Nile, Pt. IV, pp 1—166, pls. i-vi (Uppsala).

XIV NOTES FROM THE BENGAL FISHERIES LABORATORY, No. 7

On some Indian Torpedinidae from the Orissa Coast.

By B. Prashad, *D.Sc., Offg. Director of Fisheries, Bengal.*

(Plates VI, VII.)

The present paper deals with some Torpedinidae that I have had a chance of collecting and observing at irregular intervals during the past two years at Puri, on the Orissa coast of the Bay of Bengal. For the sake of completeness, I have also gone over the entire collection of these forms in the Zoological Survey of India (Indian Museum, Calcutta). It has thus been possible to clear up certain doubtful points regarding the nomenclature, synonymy and variation of the various forms dealt with here. A description of a fairly advanced stage of embryos of *Narcine indica*, Henle, obtained by dissection out of a gravid female, and of the structure of the gravid uterus is also included.

Four of the six Indian genera of Torpedinidae were found at Puri; these are *Torpedo, Narcine, Narke* and *Bengalichthys*. Of the other two, *Narcobates* is a deep-sea genus and is not likely to occur near the coasts, while the occurrence of the other (*Temera*) in Indian waters is still problematical.

For the facilities regarding material and literature afforded by the officers of the Zoological Survey of India I am greatly indebted to them. My thanks are also due to Mr. J. Clinton Bond, Curator, McMahon Museum, Quetta for kindly sending me for examination a co-type of *Torpedo zugmayeri*, Englh., a species discovered in recent years on the Mekran coast of Baluchistan. It may be of interest to mention here that this is the only specimen of this species preserved in any of the Indian Museums.

Torpedo, Houttuyn.

1764. *Torpedo*, Houttuyn, *Nat. Hist.* VII, p. 453.
1909. *Torpedo*, Annandale, *Mem. Ind. Mus.* II, p. 42.
1913. *Narcacion*, Garman, *Mem. Mus. Comp. Zool. Harvard* XXXVI, p. 304.

Garman's valuable memoir, in which he has proposed to replace the generic name *Torpedo* by *Narcacion*, calls for some remark. *Narcacion* is one of the various names used by Klein, a pre-Linnean writer, in his *Historia Piscicum Naturalis* (1740–1744). The names were later accepted and published in an anonymous work commonly known as *Neuer Schauplatz* (1775–1781). In this work the authorities for generic and specific names are given, and

this in Garman's opinion amounts to republication after 1st January, 1758, the date of the development of the System of Linnaeus in the tenth edition of his *Systema Naturae.* No author, however, has accepted Garman's version; Jordan and Evermann,[1] after considering the additional arguments of Garman, are of the opinion that the generic names of Klein in *Neuer Schauplatz* are of very doubtful eligibility, as even in this work the Linnean code is not adopted for species, and further because the dictionary is an anonymous publication with an "elliptical and disorderly" method of exposition. In view of these facts it does not seem desirable to displace such well established names as *Torpedo* by Klein's nomenclature.

There is a further difficulty regarding the author of the name *Torpedo.* Günther[2] assigned it to Dumeril,[3] who established the genus in 1806 with *Raja torpedo* as the type. Houttuyn (*loc. cit.*) had in 1764, however, used the name *Torpedo* without assigning a type, but his description of the fish fixes the Electric Ray—*Raja Torpedo*, Linn. as the type. I have, therefore, accepted Houttuyn as the author of the genus *Torpedo.*

Torpedo marmorata, Risso.

1870. *Torpedo marmorata*, Günther, *Brit. Mus. Cat. Fishes* VIII, p. 450.
1909. *Torpedo marmorata*, Annandale, *Op. cit.*, p. 42.
1913. *Narcacion marmoratus*, Garman, *Op. cit.*, p. 305.

Garman's work, in connection with his description of the distribution of this species, calls for some further criticism. Except in a few instances, he has ignored Annandale's valuable papers on the Indian Elasmobranchs. For example, he gives the distribution of *T marmorata* as "Mediterranean Sea and Eastern Atlantic," leaving out the record of the occurrence of this species at Puri on the Orissa coast. There is in the collection of the Zoological Survey another specimen taken near Vizagapatam on the same coast. Zugmayer[5] has also recorded the occurrence of this species (with a closely allied one) on the Oman and Mekran coasts of Baluchistan. The species, therefore, has a wide distribution in the Indian seas.

The closely allied species *T zugmayeri* described by Engelhart[6] from a female specimen collected by Dr. E. Zugmayer off Baluchistan on the Mekran coast is quite distinct from *T marmorata*, as I have satisfied myself by the examination of a male specimen of this species preserved in the Quetta Museum. It is distinguished from *T marmorata* in having semilunar instead of circular spiracles, much smaller though more numerous spiracular

---

[1] *Genera of Fishes*, pp. 35-37. *Leland Stan. Univ. Pub. California* (1917).
[2] *Brit. Mus. Cat. Fishes*, VIII, p. 448 (1870).
[3] *Zool. Analyt.*, p. 102 (1806).
[4] *Mem. Ind. Mus.* II, pp. 1-60, pls. i-v (1909), and *ibid.*, III, pp. 1-6 (1910).
[5] *Abh. Kön. Bayer. Akad. Wiss. Munchen* XXVI, Bd. 6, pp. 1-35 (1913).
[6] *Zool. Anz.*, Bd. XXXIX, Nr. 21-22, p. 647 (1912).

papillae, proportionately much smaller tail, by general colouration and a much heavier build.

Narcine, Henle.

1878. *Narcine*, Day, *Fishes of India* II, p. 733.
1909. *Narcine*, Annandale, *Op. cit.*, p. 43.
1913. *Narcine*, Garman, *Op. cit.*, p. 246.

In the paper cited Annandale recorded three species of this genus from Indian seas, viz. *N. timlei*, *N. brunnea* and *N. mollis*. Garman, however, has shown that the true *N. timlei* is not an Indian form, being confined to the East Indies and Japan. He thinks that the Indian species is what was described as *T indica* by Henle,[1] a conclusion with which I agree. In the same work he has also described a new species from Colombo, Ceylon under the name *N. firma*. I have not seen this form, there being no representatives of it in the Calcutta collection.

Garman, in his key for the identification of the various species of the genus *Narcine*, states that in *N. tasmaniensis* and *N. mollis* the spiracles are "at a short distance from the orbits," whereas in his description of *N. mollis* he describes them as being "near the orbits." Llyod[2] in the original description states that they are situated close to the orbits and this is the condition in the unique type, which I have examined. Garman's key in view of the above is incorrect. The four Indian species can, however, be distinguished from one another as follows:—

I Origin of first dorsal opposite the ends of ventrals.
  (i) Dorsal surface spotted ... ... *N. indica.*
  (ii) Dorsal surface uniform brown ... ... *N. brunnea.*
II Origin of first dorsal slightly behind the ends of the ventrals, dorsal and ventral surfaces of the body uniformly coloured ... ... *N. mollis.*
III Origin of first dorsal behind the ends of the ventrals by about its own basal length ... ... *N firma.*

Narcine indica, Henle.

(Plate VII, figs. 4-9).

1834. *Narcine indica*, Henle, *Op. cit.*, p. 35, pl. ii, fig. 2.
1841. *Narcine indica*, Müller and Henle, *Plagiostomes*, p. 130.
1878. *Narcine timlei*, Day, *Op. cit.*, p. 733 (in part, not the figure).
1909. *Narcine timlei*, Annandale, *Op. cit.*, p. 44.
1913. *Narcine indica*, Garman, *Op. cit.*, p. 209.

Annandale pointed out in his paper the confusion made by Day in including two distinct species in his discription and figure of *N. timlei*, and separated the uniformly coloured Indian species under the name *N. brunnea*, retaining the name *N. timlei* for the spotted form. This latter, however, as has been pointed out above, should be known as *N. indica*.

---

[1] *Ueber Narcine*, p. 35, pl. ii, fig. 2 (1834).
[2] *Rec. Ind. Mus.* I, p. 8 (1907).

Garman's description of *N. indica* is incomplete and erroneous owing to his having ignored the question of variation in the outlines of the disc, the relative size of the eyes and spiracles, the size and proportion of the dorsal and the caudal fin and the colouration, so well discussed in Annandale's account of *N. timlei.* All these facts are fully borne out by the large series of specimens of this species in the collection of the Zoological Survey, as also by a large number of fresh specimens that I have examined at Puri and elsewhere. The species is fairly common round Puri and a large number of specimens is caught every day in the shore seine-nets.

Except for a doubtful specimen of *N. brunnea* found in an advanced state of decomposition on the Puri beach, I did not secure any specimen of this latter species.

Narke, Kaup.

1826. *Narke,* Kaup, *Arch. Anat. Physiol.* p. 365.
1887. ? *Astrape,* Day, *Op. cit.,* p. 734.
1909. *Astrape,* Annandale, *Op. cit.,* p. 46.
1913. *Narke,* Garman, *Op. cit..* p. 312.

Day recorded a single representative of this genus from Indian waters as *Astrape dipterygia.* It is doubtful, however, in view of the arguments stated further on, whether he had ever seen the true *N dipterygia* of Indian waters. Müller and Henle's generic name *Astrape* [1] cannot stand owing to Kaup having described the same genus as *Narke* some fifteen years earlier.

Garman in his memoir combined Annandale's new genus *Bengalichthys* with *Narke* without giving any reasons. This point is fully discussed further in the account of *B. impennis.*

Narke dipterygia (Bloch., Schn.).

(Plate VI, figs. 1, 2).

1870. *Astrape dipterygia,* Günther, *Brit. Mus. Cat. Fishes* VIII, p. 454.
1887. ? *Astrape dipterygia,* Day, *Fishes of India,* p. 734 (in part, not the figure).
1889. ? *Astrape dipterygia,* Day, *Faun. Brit. Ind. Fishes* I, p. 46 (in part, not the figure).

Günther and Day included in the synonyms of this fish Shlegel's *N japonica* but this has since been recognized as a distinct species by Jordan and Fowler,[2] Garman and others.

In his first work Day gave a figure of *N. dipterygia* prepared from a specimen from Malabar; this figure was later reproduced in the "Fauna" volume. The specimen is preserved in the collection of the Zoological Survey. The figures referred to above led me to doubt as to whether these could be that of the true *N dipterygia,* for they rather resembled *B. impennis* in the shape and position

[1] *Sitzb. Akad. wiss. Berlin,* p. 117 (1837).
[2] *Proc. U. S. Nat. Mus.* XXVI, p. 656 (1903).

of the ventral or pelvic fins, but the eyes in this figure are shown as being fairly large and prominent. The doubt was confirmed by an examination of the original specimen, which is certainly a true *B. impennis*. The eyes in the specimen are exactly as in normal specimen of *B. impennis*, and Day's figures are wrong in this particular. The second specimen from Day's collection is from Madras and is also a specimen of *B. impennis*. These are the only specimenss in Day's collection of fishes in Calcutta, and both belong to *B. impennis* but were wrongly identified as *Astrape dipterygia*.

In view of these facts, therefore, it seems a little doubtful whether Day's description of *A. dipterygia* does not really apply to *B. impennis*; this fact unfortunately is, however, not easy to decide, as in certain particulars, such as the proportions of the tail and disc, his description does not apply to either species. Both the specimens from Day's collection are in a poor state of preservation and therefore give a very imperfect idea of the normal appearance of *Bengalichthys*. In any case Day's identification does not affect the nomenclature or taxonomic position of either genus. As no complete description of *N. dipterygia* is available, I have thought it desirable to redescribe the species.

Disc subcircular, slightly shorter than the tail, snout short, rounded on the anterior margin. Nostrils small. Anterior valves confluent, forming a quadrangular flap with concave lateral margins, rounded at the sides posteriorly and with a median projection; this flap is free posteriorly, extending back over the mouth and covering the upper jaw entirely in both young and adult specimens; posterior valves well developed with a free triangular portion first curving backwards and then forwards in a half loop-like manner, and lying in the concavities on the sides of the anterior flap. Mouth small, protrusible, enclosed in a deep fold of skin and divided by a median projection on both the jaws, that of the lower jaw being more prominent than that of the upper. Teeth small. Eyes small but prominent, a little less than half the length of the spiracles. Spiracles large, abutting on the eyes, varying in outline according to the condition of preservation of the specimens, with a smooth raised margin. Gill-openings small; the last one particularly reduced. Dorsal fin rounded along the margins, with an elongated base, arising a little in front of the bases of the ventrals, and separated from the caudal by its basal length. Tail slightly longer than half the total length, with a well developed caudal, and a feebly developed fold on either side. Subcaudal rounded; supracaudal much larger, rounded in some specimens, in others ending in a point. Ventrals large; with a concave outer margin in the young, becoming nearly straight in full grown individuals; arising below the pectorals. Claspers short, stout, with a deep groove on the upper surface throughout their length and another on the outer side extending to not more than half the length. Pectorals broad, with straight fin-rays showing through the skin. Electric organs kidney-shaped, extending to a little in front of the eyes, formed of irregular quadrangu-

lar or pentagonal areas, distinctly marked on both dorsal and ventral surfaces.

Colour olive-brown dorsally, borders of the disc, ventrals, the posterior margin of the dorsal and the caudal creamy white; a circular white spot on each side behind the electric organs and a similar but larger one at the junction of the pectorals and the body on each side, ventral surface creamy white.

For the sake of comparison with *B. impennis*, photographs of the dorsal and ventral surfaces of a well-preserved specimen of this species (figs. 1, 2) from Puri, and those of one of *B. impennis* (figs. 3, 4) are reproduced on plate vi.

The species is widely distributed in Indian seas, there being specimens in the collection from the Sandheads, Orissa Coast, Bay of Bengal, off Colombo and from Bombay.

Bengalichthys, Annandale.

1887. *Astrape*, Day, *Fishes of India*, p. 734 (in part), fig. 19.
1889. *Astrape*, Day, *Faun. Brit. Ind. Fishes* I, p. 46 (in part), fig. 19.
1909. *Bengalichthys*, Annandale, *Op. cit.*, pp. 47, 48.
1913. *Narke*, Garman, *Op. cit.*, p. 312 (in part).

As has been remarked already the two specimens from the late Dr. F. Day's collection in the Indian Museum identified as *A. dipterygia* really belong to this genus. Unfortunately these specimens escaped Dr. Annandale's attention at the time of his revision of the Indian Batoids, and the creation of his new genus *Bengalichthys*. His description of this genus was also short owing to his having only two specimens. Probably this, and the rather poor figure of the only species published by him, led Garman to unite the genus *Bengalichthys* with *Narke*. The two genera, however, are quite distinct and with a fair number of specimens before me, I have thought it desirable to redescribe the genus at some length, and publish good photographs of the only known species.

Head, body and electric organs united in a subcircular, fleshy disc, ending abruptly in front of the anus and including only a small anterior part of the ventral fins, snout broadly rounded, anterior narial valves confluent in a small quadrangular flap, extending up to the mouth but not covering it. Mouth small, protrusible, enclosed in a thick fold on the two sides. Eyes very small, degenerate, sunken. Spiracles large, with a smooth border without raised edges. Gill-openings small. Electric organs not distinguishable externally in fully grown specimens. Ventrals large, fleshy, lateral united with the tail and not enclosed by the disc as in *Narke*. Pectorals except for a narrow fringe entirely enclosed in the fleshy disc. One dorsal. Tail long, without any fold on lateral sides. Skin thick, fleshy, with large numbers of glandular pits on both dorsal and ventral surfaces.

Type: *Bengalichthys impennis*, Annandale, the only known species.

The genus, though closely allied to *Narke*, is certainly quite

distinct from it. As was pointed out by Annandale, probably as a result of adaptation to its presumable habits of wriggling and squirming at the bottom, the body has become very massive and fleshy, while the fins have been greatly reduced. The mouth, owing to a suctorial function, has become small, and is protrusible as a tubular structure. The eyes also have degenerated to minute structures sunk in pits, and probably functionless. All these features combined with the lateral situation of the ventrals on the tail, and the very much smaller anterior narial flap are sufficient characters for separating the genus from *Narke.*

Bengalichthys impennis, Annandale.

(Plate VI, figs. 3, 4; pl. VII, figs. 1-3).

1887. *Astrape dipterygia*, Day, *Fishes of India*, p. 734 (in part), fig. 19.
1909. *Bengalichthys impennis*, Annandale, *Op. cit.*, p. 48, fig. 9, pl. iii (a), fig. 7.
1913. *Narke impennis*, Garman, *Op. cit.*, p. 315.

In addition to the original description by Annandale, the following points may be noted. The narial flap is very small and does not cover the mouth. The glandular pits are present on both the dorsal and ventral surfaces; they are specially prominent on the border of the electric organs. The electric organs, though well developed and occupying the usual position between the head and the pectorals, are not visible externally, except in young individuals as pentagonal areas, through the thick skin. The pectoral "fringed ridge," mentioned by Annandale, consists of skin covering only the terminal joints of the fin-rays. It was found on dissecting out the skeletal parts in this region that the rays, instead of remaining quite straight, are retroverted upwards (pl. vii, fig. 1) for a considerable part of their length, and thus give double support to the fleshy margin of the disc; the fins as such being reduced to the narrow fringe. The ventral fins have the greater part of their length situated behind the disc, but are enclosed, like the pectorals, in a thick muscular coating, and form lateral expansions of the tail in this region.

In the male specimens the claspers are well-developed structures but the greater part of their length is enclosed within the fin-folds. The free part shows the main channel and a small groove on either side on the dorsal surface (pl. vii, figs. 2, 3).

Besides the two original specimens of Dr. Day, one from Malabar and the other from Madras, there are in the collection of the Zoological Survey two specimens from Balasore Bay on the Orissa coast, and four from off Gopalpur, Madras. I also saw two partially decayed specimens on the Puri beach in January, 1920. It appears from these records that the species, though rare, is widely distributed in the Indian seas.

Annandale has described the colouration of the species at some length, and there is nothing further to note except that in fresh specimens it closely resembles that of *N. dipterygia.*

I. GRAVID UTERUS AND EMBRYOS OF *GARCINE INDICA.*

In January, 1919, while collecting at Puri, I secured a gravid specimen of *N indica* measuring 31 cm. in length. On dissection the specimen was found to contain four embryos in its uterus.

The uterus shows certain peculiarities. The entire inner surface is covered with spatulate villi-like trophonemata (pl. vii, fig. 4). The covering of trophonemata is so thick that no part of the uterine wall is to be seen between them. In a square inch of the wall of the preserved uterus 198 villi were counted. A typical trophonema (pl. vii., fig. 5) is spatulate, and measures 7 mm. in length with an average width of 2 mm. near the tip and 0·5 mm. near the base. Examined under the microscope (pl. vii, fig. 6) the marginal arterial loop and the thick plexus of capillaries all over the surface is distinctly to be made out.

Structures of this type have been described for a number of Indian Batoids originally by Wood Mason and Alcock [1] and later by Alcock [2]; to the two authors we also owe the very appropriate name of "trophonemata." I do not propose going into the histological details of these structures, as these have been admirably described by Brinckmann [3] and Widakowich [4]; further, the material at my disposal would not permit my going into these details. It is, however, of interest to note that the trophonemata of this species greatly resemble those of *Torpedo ocellata*, described by Brinkmann. It may also be mentioned that the uterus was full of a yellowish milk-like secretion in which the embryos were enclosed.

But for the embryos of *Torpedo marmorata* described by De Sanctis [5] in fair detail, no good description of Torpedinid embryos has been published. De Sanctis in his valuable paper divides the embryos into five stages:—

(1) *Embrione squaliforme, opleurotrema,*
(2) *Embrione Raiforme, oipotrema,*
(3) *Embrione Torpediforme ad archi incompleti,*
(4) *Embrione topedinetta biana ad archi completi,* and
(5) *Embrione topedinetta macchiata e seuza filli esterni branchiali.*

The specimens (pl. vii, figs. 7, 8) described below are of interest in that they belong to a stage intermediate between stages 4 and 5 of De Sanctis.

Disc ovoid, incomplete, owing to anterior region of pectorals not having fully developed and fused with the disc. Snout prominent, knob-like, rounded at the end. Nostrils small. Anterior narial valves quite separate from one another, not having fused as yet; posterior valves very small and not fully developed. Mouth small, nearly straight, protruding above the surface and

---

[1] *Proc. Roy. Soc. London* XLIX, p. 363 (1891).
[2] *Ann. Mag. Nat. Hist.*, (6), X, pp. 4, 5 (1892).
[3] *Mitt. Zool. Stat. Neapel* XVI, pp. 365-408, pls. xii-xiv (1903-1904).
[4] *Zeitschr. Wiss. Zool.* LXXXVIII, pp. 499-545, pls. xxx, xxxi (1907).
[5] *Atti R. Accad. Sci. Fis. Mat. Napoli* V, pp. 1-62, pls. i–iv (1873).

with well-developed longitudinal folds of skin surrounding it. Eyes large, protruding, much larger than the spirales. Spiracles semi-lunar with a smooth margin. Dorsal fins small; second much better developed than the first. Pectorals horn-shaped, with a convex outer edge and with feebly developed fin-rays. Ventrals a little more than half the size of the pectorals. In a male specimen small elongate lobes of skin are separated off on the inner side as the clasper rudiments. Tail less than half the total length, with a feebly-developed caudal.

Measurements of a ♂ specimen (in millimetres).

Length of disc	27·8
Maximum breadth of disc	8·2
Length of snout	5·1
Interorbital distance	3·4
Mouth to vent	8·1
Tail	14·9
Length of yolk-stalk and yolk-sac	20·9

The yolk-stalk is well developed and enters the body a little in front of the anterior edge of the pectoral fins. The sac is a large, somewhat triangular, bag-like structure and has the lower surface thrown into folds. The branchial filaments (pl. vii, fig. 9), which are to be seen protruding out of all the gill-openings, are long but few in number at this advanced stage of the embryo.

The specimens preserved in rectified spirit, after fixation in formaldehyde (10%), are of a creamy colour, the yolk sac, however, is more yellowish.

EXPLANATION OF PLATE VI.

Narke dipterygia (Bl., Schn.).

FIG. 1.—Photograph of the dorsal surface of an adult, from **Puri.**

,, 2.—Photograph of the ventral surface of the same individual.

Bengalichthys impennis, Annandale.

FIG. 3.—Photograph of the dorsal surface of a rather young individual from Puri, Orissa.

,, 4.—Photograph of the ventral surface of the same individual.

1

3

2

4

D. Bagchi Photo.

INDIAN TORPEDINIDÆ.

EXPLANATION OF PLATE VII.

Bengalichthys impennis, Annandale.

FIG. 1.—Skeleton of the pectoral fin of a specimen showing the rotroverted fin-rays.

,, 2.—Pelvic fin region of a male specimen, × 1¼.

,, 3.—Terminal part of a clasper of a male, seen from above, × 1¼.

Narcine indica, Henle.

,, 4.—Part of the uterine wall of a gravid female showing the trophonemata.

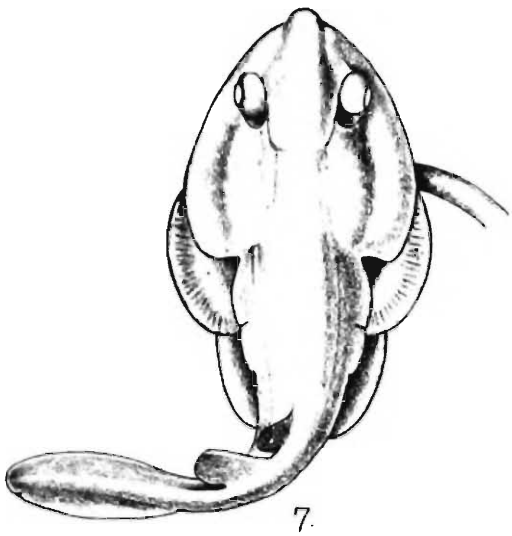
,, 5.—A single trophonema enlarged.

,, 6.—Terminal part of a trophonema seen under the low power of the microscope.

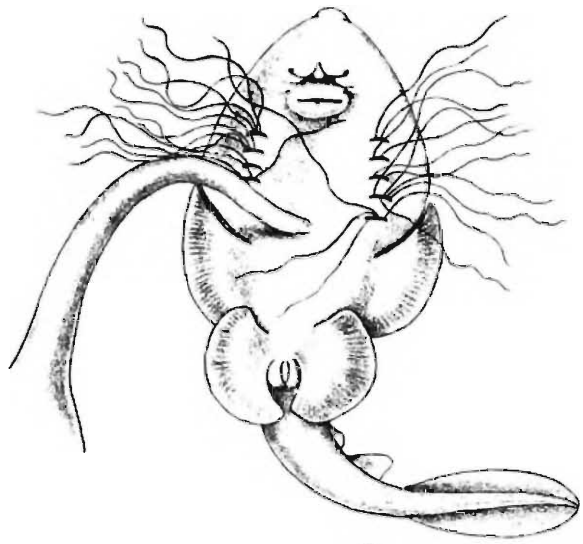
,, 7.—Embryo seen from above. The branchial filaments are not shown.

,, 8.—Embryo seen from the ventral surface.

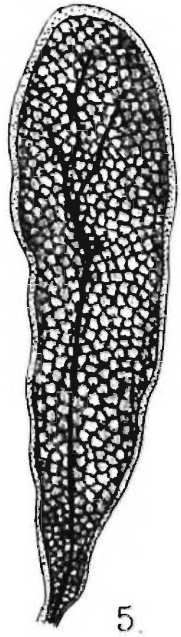
,, 9.—A branchial filament as seen with the low power of the microscope.



7.

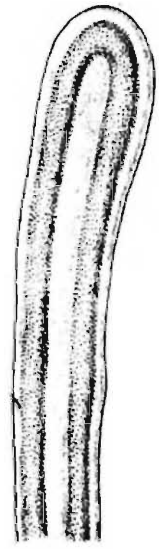


8.

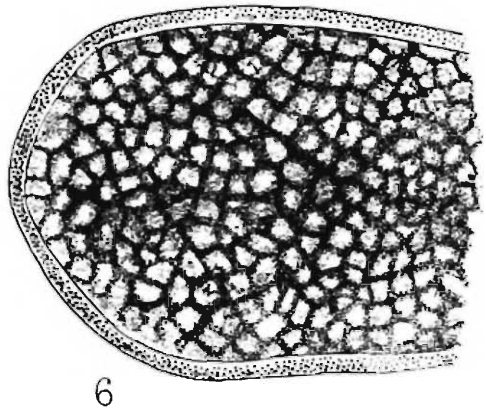


5.

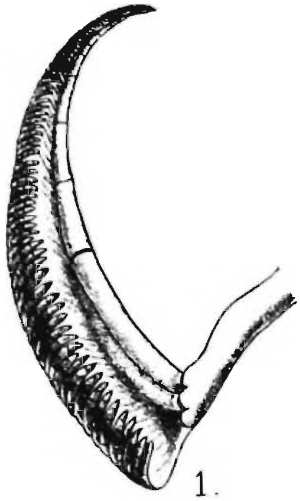
4.



9.

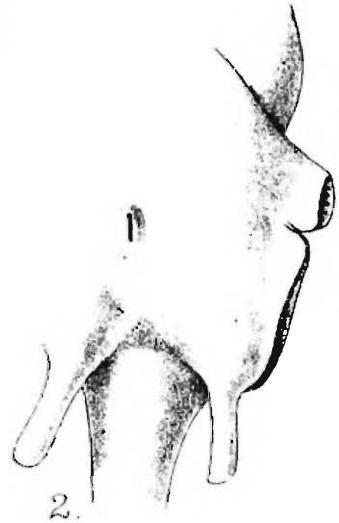


6.



1.

3.



2.

A. Chowdhary del. et lith.

INDIAN TORPEDINIDAE

XV MATERIALS FOR A GENERIC REVISION OF THE FRESHWATER GASTROPOD MOLLUSCS OF THE INDIAN EMPIRE.

INTRODUCTORY NOTE.

[Under the above title I propose, with the help of other members of the Zoological Survey of India, to issue a series of short papers embodying the main taxonomic results of our recent survey of the freshwater molluscs of India.[1] The definitions and limitations of the genera we have adopted are in many instances different from those hitherto accepted, and it will be as well that our views should be subjected to criticism, which we will welcome, before our final monograph is published. *N. A.*].

No. I—THE INDIAN GENERA OF MELANIINAE.

By N. ANNANDALE, *D.Sc., F.A.S.B., Director, Zoological Survey of India.*

It is convenient to separate the family Melaniidae or Tiaridae into two subfamilies, the Melaniinae (or Tiarinae) and the Paludominae, and to include in the former all the species with elongate narrow shells. Among the Indian forms with this type of shell only two genera have hitherto been generally recognized, namely *Faunus*, de Montfort and *Melania*, Lamarck (=*Tiara*, Bolten); but *Melania* has been divided into a number of subgenera, as to the names of which there has been considerable confusion. My conclusions may be introduced conveniently by a key to the genera I now recognize. Their status and limits will be discussed thereafter.

Key to the Indian Genera of Melaniidae.

1. Outer lip of shell forming a broad and prominent lobe defined above and below by well-developed canal-like prolongations of the aperture. Operculum thick, without spiral figure ... ... *Faunus.*
2. Outer lip not lobular, upper and lower canals of the aperture ill-defined or absent.
   - A. Shell very small (less than 1 cm. high), hairy, sculptured with spiral incised lines only. Operculum extremely thin, paucispiral, with the nucleus eccentric. Foot produced into a filamentous process behind. Marginal tooth of radula with three sharp denticulations and a pointed process near the base ... ... *Mainwaringia.*
   - B. Shell large or of moderate size, as a rule without hairs, with at least a trace of longitudinal grooves and ridges. Operculum at least moderately thick. Foot without posterior process.

---

[1] See Kemp and Gravely, *Ind. Jour. Med. Research*, VII, p. 252 (1919).

Radular teeth without basal process, either with more than three sharp denticulations or with three much broader blunt denticulations.

i. Shell large, heavy, ovoid, with strong spines round the upper extremity of the body-whorl. Operculum without spiral figure, long, narrow, oval... ... ... *Melania* (=*Tiara*).

ii. Shell as a rule more elongate, without, or with relatively feeble, spines. Operculum bearing a spiral figure.

a. Shell never very thick or large and as a rule relatively long and slender, tapering to a sharp point at the apex, with the aperture ovate and never produced above, the sculpture consisting of numerous longitudinal and spiral grooves which form by their intersection a reticulate or nodular pattern, rarely obsolescent. Spines sometimes present on upper extremity of body-whorl. Operculum relatively large, ovate, paucispiral, with the nucleus situated near the inner lower margin and the spiral figure occupying only a small part of the surface. Mantle bearing on its inner surface near the margin a row of digitiform processes. Radular teeth relatively long, with numerous sharp denticulations ... ... *Melanoides.*

b. Shell as a rule large heavier and broader, with more solid sculpture or nearly smooth, more or less biconical in outline and with the aperture frequently produced slightly both above and below. Spines never present on the upper margin of the body-whorl. Operculum relatively small, subcircular, with a spiral figure that occupies most of its surface. No processes on or near edge of mantle. Radular teeth relatively short with fewer and blunter denticulations ... *Acrostoma.*

Faunus and *Mainwaringia* do not belong to the freshwater fauna as both are estuarine. The geographical range of the former is wide but in the main insular, while *Mainwaringia* [1] is known only from the Gangetic delta. The synonymy and diagnosis of the two freshwater genera may be discussed further.

Genus **Melanoides**, Olivier (*nec* H. and A. Adams).

1807. *Melanoides*, Olivier, *Voy. l'Emp. Ottoman*, II, p. 40.
1854. *Plotia, Melania, Tarebia*, H. and A. Adams, *Gen. Recent Moll.*, I, pp. 295, 301, 304.
1874. *Melanoides, Melania*, s.s. (in part), *Plotia, Tarebia, Striatella*, Brot. *Conch. Cab.*, pp. 6, 7.
1885. *Melania* (s.s.), *Striatella, Melanella* (in part), *Tarebia, Plotia*, Nevill, *Hand List Moll. Ind. Mus.*, II, pp. 221, 231, 271, 272, 280.

[1] Annandale & Prashad, *Rec. Ind. Mus.*, XII, p. 251, fig. 5, pl. xx, fig. 8 (1919).

1897. *Stenomelania, Melanoides, Plotia, Tarebia,* von Martens in Weber's *Zool. Ergebn. Reis. Niederl. Ost-Ind.*, IV, pp. 40, 50, 62, 69.
1898. Neomelanien (in part), P. and F. Sarasin, *Sussw. Moll. Celebes,* p. 38.
1915. *Radina, Striatella, Melanella* (at least in part), *Tarebia, Plotia,* Preston *Faun. Brit. Ind., Freshw. Moll.*, pp. 10, 15, 32, 33, 35.
1919 *Melanoides*, Annandale and Prashad, *Rec. Ind. Mus.*, XVIII, p. 28.

There has been much confusion in nomenclature owing to the fact that H. and A. Adams used the name *Melanoides* in quite a different sense from that in which it had been introduced thirty-seven years earlier by Olivier, who applied it to a race or phase of the common "*Melania*" *tuberculata*. A reference to this author's "voyage" shows that Nevill (*op. cit.*, p. 248) was wrong in stating that the form of the name employed was "Melanoïde," a form that might not have been considered valid, and Preston has ignored von Marten's remarks on the subject.

M. tuberculatus (Müller), the type of this genus, is perhaps the most widely distributed of all the non-marine Gastropods that occur in India, for it is found in most parts of the Oriental and Ethiopian regions and even in parts of the Palaearctic and Australasian Regions adjacent to them. With this species a large number of Oriental forms must be associated generically on account of the fact that they possess the characters noted in the key. The Sarasins were the first authors to lay stress on the peculiarities of the radulae and opercula of these forms, but they were apparently not acquainted with the peculiarities of the mantle. They did not regard the structures they examined as of generic importance and associated species I retain in *Melania* with those here assigned to *Melanoides* in their group "Neomelanien."

The description given in the key, with the figures published in the various works to which I have referred, should render the recognition of species of the genus easy, if the animal as well as the shell be examined. The processes of the mantle are arranged in a small series along a line running parallel to the margin. As a rule they increase in size from left to right. When the animal is fully expanded they are elongate and pointed and often resemble small parasitic leeches protruding from the mouth of the shell. In preserved specimens they are as a rule contracted and much less conspicuous.

Genus **Acrostoma**, Brot.

1854. *Melanoides*, H. and A. Adams (*nec* Olivier), *Gen. Recent Moll.*, I, p. 296.
1874. *Melanoides, Acrostoma*, Brot, *op. cit.*, p. 7.
1885. *Melanoides, Acrostoma*, Nevill, *op. cit.*, pp. 248, 270.
1897. *Brotia*, von Martens, *op. cit.*, p. 33.
1898. Palaeomelanien, P. and F. Sarasin, *op. cit.*, p. 30.
1915. *Melanoides, Acrostoma*, Preston, *op. cit.*, pp. 21, 30.

I cannot find any difference of generic importance between the soft parts, radula, operculum or shell of *Brotia*, von Martens (=*Melanoides*, auct.) and *Acrostoma*, Brot. Indeed, in the single species I call *Acrostoma variabile* (Benson) an almost complete

gradation can be observed. In the type-species of *Acrostoma* (*A. hügeli*) the structure is similar in every respect to that of *A. variabile* and the shells of certain individuals of the latter are by no means unlike those of the former.

I have been able to find no trace of digitiform processes on or near the edge of the mantle in either living or preserved specimens of *A. variabile* or in preserved specimens of *A. hügeli*. In both, however, there is a peculiar arrangement of the pigment on the inner surface of the mantle. It is distributed in alternate longitudinal dark and pale streaks, the pale pigment in the living animal being of a bright yellow colour but fading to white in spirit.

Some of the largest of the freshwater Mollusca are included in this genus. It is usually found in running water, but *A. variabile* is common in ponds in Calcutta. The headquarters of the genus are in Burma and the Sunda Is., but the type-species has an apparently discontinuous range in Assam and South India, and *A. variabile*, though mainly Assamese and Burmese, extends for some distance up the Ganges.

I am not yet quite sure as to the generic position of the Burmese species assigned by Nevill and Preston to *Pachychilus*, Lea. They are probably dwarf forms of *Acrostoma* and do not seem to be closely related to the Central American species for which the genus *Pachychilus* was originally used.

Genus **Melania**, Lamarck.

(1798. *Tiara, Mus. Bolten.*)
1799. *Melania*, Lamarck, *Prodromus.*
1854. *Tiara*, H. and A. Adams, *op. cit.*, p. 294.
1874. *Tiara*, Brot., *op. cit.*, p. 7.
1884. *Tiara*, Nevill, *op. cit.*, p. 278.
1897. *Melania*, s.s., von Martens, *op. cit.*, p. 66.
1898. Neomelanien (in part), P. and F. Sarasin, *op. cit.*, p. 38.
1915. *Tiara*, s.s., Preston, *op. cit.*, p. 10.

The distribution of this genus is mainly insular and largely Pacific. Within the limits of the Indian Empire it is found only in the Nicobars and (doubtfully) in one of the Anadaman Islands. I know nothing of the animal, but the shell and operculum are very distinct from those of *Melanoides* or *Acrostoma*. Troschel[1] and P. and F. Sarasin (*op. cit.*) describe and figure the radular teeth of species of *Melania* as very like those of *Melanoides*, with which the latter authors associate these species in their group of Neomelanias. The type-species is *Helix amarula*, Linn. Those interested in the revival of forgotten generic names may refer to Dall's[2] account of the *Museum Boltenianum*, reviewed in the *Ann. Mag. Nat. Hist.* (8) XVI, p. 232 (1915) by "B.B.W"

---

[1] Troschel, *Geb. der Schnecken. z. Bergründung ein. nat. Classification*, I, pl. viii (Berlin: 1856-1863).

[2] Dall, *Misc. Publ. Smithsonian Inst.* No. 2360 (1915). Not available to me.

No. II—THE INDIAN GENERA OF VIVIPARIDAE.

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

Until recently all the Indian species of this family have been placed in the genus *Vivipara*, Montfort; but in 1918[1] I separated certain forms from Upper Burma and the Shan States under the name *Taia*, while still more recently[2] I have described three fossil or subfossil subgenera of this genus from the same country. In the present paper I give reasons for regarding one of these (*Temnotaia*) as generically distinct and put on record the occurrence of a living species in Upper Burma. An examination of the animal of Benson's *Paludina lecythis* proves that it and its allies must also be separated from *Vivipara*. I propose for them the new generic name *Lecythoconcha*.

Key to the Indian Genera of Viviparidae.

1. Columellar callus of shell broad and plate-like.
   - A. Sculpture usually consisting of prominent nodular, squamose or spinulose spiral ridges and of coarse longitudinal striae. Operculum with an internal scar of oval or ovate outline and without a rounded boss in the centre of the scar. Mantle of adult with a rather feeble sphincter muscle and a smooth or lobular margin ... ... *Taia.*
   - B. Shell smooth or with incised spiral lines. Operculum as in *Taia*. Soft parts and radula unknown ... *Temnotaia.*

2. Columellar callus not plate-like. Sculpture minute or including smooth spiral ridges.
   - A. Shell of small or moderate size, conical or conoidal. Operculum as in *Taia*. Mantle with the sphincter muscle moderately developed and prominent; its margin bearing in the young well-developed digitiform processes, which persist in the adult of some species ... ... *Vivipara.*
   - B. Shell large and globose. Operculum with a well-defined funnel-shaped pit on the external surface corresponding to a smooth, prominent rounded boss in the centre of the internal muscular scar, which is ring-shaped and poorly developed. Mantle sphincter very strong and prominent; mantle itself greatly thickened and highly muscular, bearing three digitiform processes in the young, smooth in the adult ... ... *Lecythoconcha.*

An examination of the mantle in these genera shows that it provides good generic characters. In all it is highly vascular, but in *Taia* and *Vivipara* it is thin and has a comparatively feeble musculature, while in *Lecythoconcha* it is much thickened and has both longitudinal and transverse muscles very strongly developed. In all three genera the transverse muscles are congregated on the outer surface a short distance above the margin. It is probable that all the Oriental species of the family have digitiform pro-

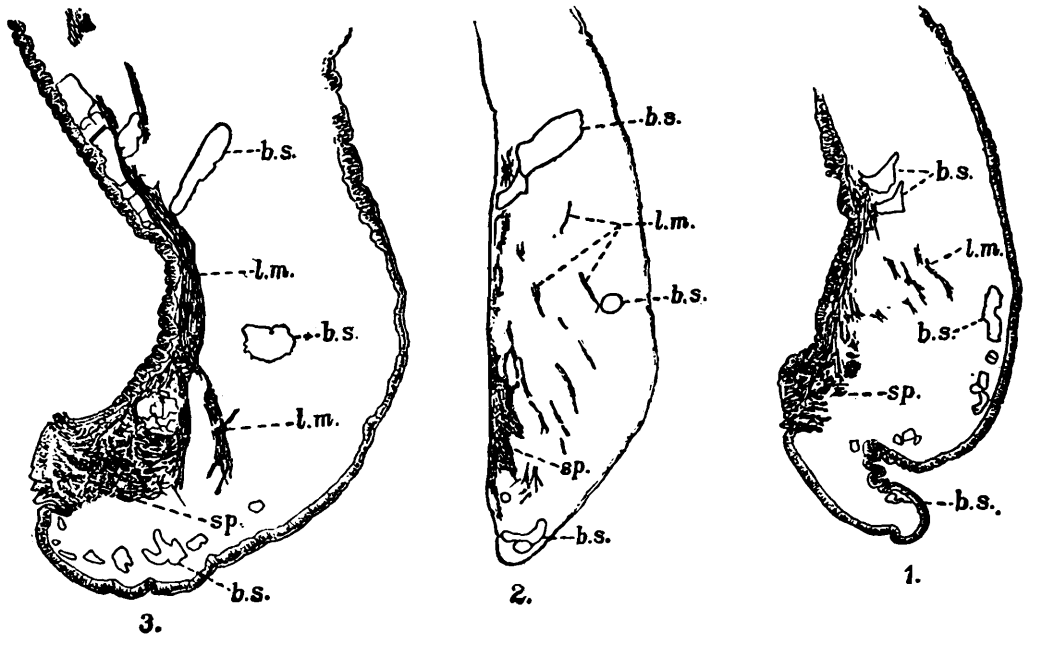
---

[1] *Rec. Ind. Mus.*, XIV, p. 123 (1918).
[2] *Rec. Geol. Surv. Ind.*, L, p. 231 (1919).

cesses[1] on the extreme edge of the mantle in the young. In those species in which the shell of the adult possesses smooth spiral ridges of a dark colour (notably *Vivipara oxytropis*) the processes persist in the adult, but in those that have smooth unicolourous shells they become small and inconspicuous or disappear altogether. In *Taia*, in which the spiral ridges are never quite smooth, but as a rule nodular, squamose, or even spinulose, there are no such processes in the adult, and they are also absent in the somewhat similar Chinese genus *Margarya*, but apparently temporary lobes of the mantle-edge can be thrust into the small concavity at the base of each nodule, scale or spine. I hope to elaborate this point on another occasion.

Genus **Vivipara**, Montfort.

This genus is so well known that it is unnecessary to give a full description. The Indian species fall naturally into four



Vertical sections through the mantle-edge of Indian Viviparidae.
1. *Vivipara oxytropis*. 2. *Taia intha*. 3. *Lecythoconcha lecythis*.
b.s. blood-space; *l.m.* longitudinal muscle; *sp.* transverse sphincter.

groups, which may be named after the type-species of each as follows:—

VIVIPARAE BENGALENSES. The shell is normally of moderate size, occasionally large, as a rule thin but thickened in certain phases. The whorls of the spire are not greatly swollen and the suture is not deeply impressed. The outline is ovate, but varies considerably. Spiral bands darker than the rest of the shell are always present, though sometimes obsolescent. They are never very numerous and vary considerably in breadth. In some forms these bands become thickened to form ridges and there is often a

[1] I can find no reference to these processes in the European forms. Erlanger (*Morph. Jahrb.*, XVII, pl. xxii: 1891), and other authors figure the edge of the mantle in the fully formed embryo as smooth.

tendency for the outline of the body to become biangulate owing to two of them assuming the form of carinae. Corresponding to these bands there are on the edge of the mantle an equal number of small digitiform processes. The operculum is thin, sharp round the periphery and with the internal muscular scar moderately developed. The radular teeth are normal. Their denticulations are by no means large and the central lobular process of the free edge of the central tooth is broad and quadrate or triangular.

I believe that all described Indian forms[1] of this group can be comprised in the single species *Vivipara bengalensis* (Lamarck), of which several distinct races and phases can be distinguished. Major Sewell and I hope to describe it in detail shortly. It is found in all parts of the plains of the Indian Empire at which there is perennial still water.

VIVIPARAE OXYTROPIDES. The shell is large or small, thin, acuminate and more or less distinctly biconical. The whorls of the spire are not at all swollen and the suture is less impressed than in *V bengalensis*. Dark spiral bands are present. They are always more or less thickened, at any rate in the young, and in the typical species form prominent ridges in the adult. The peripheral band forms a prominent keel, separating the shell into two regions. The region below it is obliquely flattened on the ventral surface. The operculum and radula resemble those of *V bengalensis*, but in the typical species the marginal processes of the mantle are much larger in the adult.

Only one species of this group has as yet received a name, viz. *V oxytropis* (Benson), but another, smaller and less specialized species, awaits description. The former is apparently endemic in the Manipur valley, while the latter occurs in the plains of the eastern part of Assam.

VIVIPARAE DISSIMILES. The shell is always small, rather high and narrow, never very sharply acuminate, moderately thin or thick, with the whorls of the spire swollen and the suture deeply impressed. There are no dark spiral bands or prominent spiral ridges, but a minute spiral sculpture of punctured lines can often be detected. There is often a broad but rather obscure pale transverse bar on the body-whorl. The operculum is thicker than in the other three sections and the muscular scar better developed. Round the periphery of the operculum there is often a thickened spongy ridge. The edge of the mantle is smooth in the adult. The central lobe of the central tooth of the radula is rounded.

Most of the forms that belong to this group are classified by Nevill[2] as varieties of *V dissimilis* (Müller), but I think that he has included several species. Pilsbry[3] regards the characters of the operculum as subgeneric and has given the subgeneric name

---

[1] *V. nagaensis*, Preston may be distinct, but I have not seen the species. I have another (undescribed) from Manipur.

[2] Nevill, *Hand List Moll. Ind. Mus.*, II, pp. 27-30 (1885).

[3] Pilsbry, *Proc. Ac. Nat. Sci. Philadelphia*, LIII, p. 188 (1901).

Idiopoma to a Burmese species, *V henzadensis*. These characters, however, are adaptive and are not found either in all species of the group, or even in all individuals of the species in which they are present. They are connected with the habit of aestivation in drying mud, the Viviparae dissimiles being found mainly in bodies of water liable to desiccation. The species are widely distributed in the plains of Peninsular and North-Western India and in the drier regions of Burma.

VIVIPARAE SINDICAE. Shells of this group are distinguished by their very pale colour, by the absence of distinct spiral bands and by the thinness of the operculum, in which the muscular scar is very feebly developed. Nothing is known of the anatomy.

The only Indian species is *V. sindica* (Nevill) from Sind, but another occurs in Seistan. Kobelt has caused great confusion in the *Conch. Cab.* by basing his description [1] and figures of this form on the type-series of Nevill's *Paludina dissimilis sindica*, which I regard as a distinct species, and conversely describing and figuring specimens from Seistan as *sindica*. His *hilmendensis* is, therefore, an absolute synonym of *sindica* (Nevill). I propose for the Seistan species the name *V. helmandica*.

Genus **Lecythoconcha**, nov.

The shell is of large, sometimes of relatively gigantic size, but never very thick, it is smooth or with obscure and never very prominent sculpture and always translucent when fresh; it is globose in form, with broad swollen whorls, and often bears a striking superficial resemblance to that of *Pachylabra* (Ampullariidae). The colour is uniform or nearly so, as a rule rather bright olive green, often with irregular blackish longitudinal lines. The aperture is large and patent, subcircular or broadly ovate. The columellar fold is not strongly developed, the umbilicus narrowly perforate and the outer lip thin.

The operculum is large, thin, horny, stiff and brittle. Externally it is marked with fine but prominent concentric ridges and bears a deep, funnel-shaped pit in a subcentral position. On the internal surface this pit is represented by a smooth, prominent rounded boss, which is surrounded by a smooth or minutely granular area representing the muscular scar.

The animal differs from that of *Vivipara* in the greatly thickened and very muscular free edge of the mantle, the sphincter muscle running along it is very prominent and unusually well developed. There are three marginal processes in the young, but none in the adult.

The radula is identical with that of *Vivipara*.

Type-species. *Paludina lecythis*, Benson.

Geographical Range. The range of the genus probably extends from Manipur (and possibly Sylhet) in the west through

[1] This description was originally published in *Nachr. Malak. Ges.* LX, p. 161 (1908).

Upper Burma and across China to the Philippines, Formosa and Japan, but I am not sure as to the generic identity of some of the Far Eastern species.[1] The only one of those of which I have been able to examine the soft parts is *Vivipara chinensis* (Gray) from Yunnan. This species, from which I regard *L. lecythis* as specifically distinct, agrees in the structure of the mantle and operculum with the type-species of the new genus.

All the Asiatic genera of the Viviparidae are closely similar in anatomy, but the structure of the mantle-edge and its sphincter is characteristic.

Genus **Taia**, Annandale.

1918. *Taia*, Annandale, *Rec. Ind. Mus.*, XIV, pp. 123, 160.
1919. *Taia*, *id.*, *Rec. Geol. Surv. Ind.*, L, p. 231.

I have already discussed this genus in the papers cited and here need only give my reasons for regarding the subfossil *Temnotaia incisa* as generically distinct. In the key on page 111 I have pointed out the distinctive characters of the mantle.

Temnotaia, Annandale (1919).

1919. *Temnotaia* (subgenus of *Taia*), Annandale, *Rec. Geol. Surv., Ind.* L, p. 231.

The discovery of a recent specimen[2] of *Temnotaia* in the old collection of the Indian Museum renders it advisable to enlarge the original description slightly and to separate the species generically from *Taia*.

The shells of the genus thus proposed are rather narrowly ovate, externally smooth and without prominent spiral sculpture but bearing rather coarse longitudinal striae and either microscopic spiral striae or well-defined incised lines. There are $5\frac{1}{2}$ to $6\frac{1}{2}$ whorls, and the spire is exserted and acuminate. The mouth of the shell is ovate, with the outer lip thin and not at all expanded and the columellar margin flattened, plate-like and polished, resembling that of *Taia*. In the only fresh specimen examined there are no dark spiral bands and the external surface is highly polished. The operculum is thin and resembles that of *Taia*. Nothing is known of the radula or soft parts.

Only two species have as yet been discovered, namely *T incisa* (Annandale), found in an apparently subfossil condition in the Chindwin watershed, and *T bhamoensis* (Nevill) from north-eastern Burma. The genus may thus be regarded as characteristic of the fauna of Upper Burma. It is apparently related to the Indo-Chinese *Chlorostracia*, Mabille, but the shell is much less globose and the mouth narrower.

---

[1] For one, the common species in Lake Biwa, Japan, I am proposing a new genus in a paper to be published in the *Journal of the Asiatic Society of Bengal.*

[2] This specimen is labelled as the type-specimen of Nevill's *Paludina dissimilis*, subvar. *bhamoensis*, but the resemblance to the Viviparae dissimiles is quite superficial and the structure of the mouth entirely different.