

XVII NOTES ON THE FRESHWATER FISH OF MADRAS

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(Plates XXV—XXIX.)

INTRODUCTION.

The following notes, necessarily imperfect, on the habits, spawning season and early stages of some of the Madras freshwater fish, are based mainly on investigations made during 1910-11, the results of which were embodied in a dissertation which was submitted to the University of Madras in 1912. The enquiry, however, was continued in subsequent years amidst other work, and consequently the original paper has been considerably modified as the result of additions and corrections made in the light of further research and study.

Though a number of notes on the habits of Indian freshwater fish have appeared from very early times, they are comparatively few and most of them are at best random observations. In the following pages an attempt has been made to combine all that is known regarding the habits and early stages of the fish in question (by a fairly exhaustive though by no means complete reference to previous literature) with facts personally observed and recorded for the first time in this paper. Only such observations from previously published accounts as are likely to be of general interest have been included and duly acknowledged. They have been gathered for the most part from the writings of Hamilton Buchanan, Sir E. Tennent, Cantor, Jerdon, Day, Thomas and especially Dr. Willey, whose observations on the breeding habits of *Ophiocephalus striatus* and accounts of the nests, eggs and fry of some other species in his report on the inland fisheries of Ceylon are substantial contributions to our knowledge of the spawning habits of Indian freshwater fish.

The local limits of my collection and observation are defined by the title of this paper, my examination being confined to the rivers Cooum and Adyar and to the ponds within the municipal limits of the city of Madras, and in a few cases being extended to some large outlying tanks such as Sembarambakkam and Red Hills. The Red Hills, some seven miles west of Madras, is a large perennial tank, while Sembarambakkam, about ten miles from the city, is the largest irrigation tank in this neighbourhood, but runs dry during the hot weather. The ponds within the city limits are of the usual type and require no special consideration; nearly all of

them contain fresh water excepting a few on the sea-coast in which the water is brackish. The rivers Cooum and Adyar, like most rivers of the Coromandel coast, are almost dry for several months of the year; the season of their chief flow is usually during the N. E. monsoon (November and December). When in flood they are raging torrents and the water is brick-red owing to the admixture of a red deposit of light specific gravity: at other times the water is clear and collects in pools on the bed. Near the mouth for a distance of over two miles from the sea both rivers form extensive estuaries, and the embouchures of both are encumbered by natural bars. Since the construction of the Buckingham Canal it has been found necessary to keep the mouths of both the rivers closed throughout the year in order to regulate and confine their spill so as to contract the waterway for boat traffic: in the case of the Cooum a high level in the estuary is further necessary for sanitary purposes, in order to keep submerged its sewage-laden banks and shoals. Hence the estuary is not subject to tidal action and the percentage of salt is not very variable. A sample of water obtained from the Cooum estuary in August, when the river was at its lowest, had 3.576 per cent of dissolved salts and a specific gravity of 1.0164.¹

The Cooum estuary is always highly contaminated with sewage except during the freshets.

The flora of the ponds and the rivers in Madras is more or less the same and consists chiefly of many filamentous and unicellular algae notably species of *Chara* and *Spirogyra*; the former abounds in brackish water. A few species of Phanerogams, principally *Elodea* and *Vallisneria*, occur; the former is the commonest and the most abundant water-weed in Madras, while the latter is found in clumps in a few places in the rivers.

Of the 57 species of fish recorded, one (*Panchax parvus*) is described as new to science; in the case of at least three species, viz. *Catla catla*, *Doryrhamphus brachyurus* and *Mastacembelus pancalus*, the geographical distribution has been extended; in two species, *Anabas scandens* and *Macrones vittatus*, albinism has been noted and for more than a dozen, information regarding breeding habits has been furnished. Notes regarding growth and colouration of fry are based mainly on observations conducted in aquaria. However, I have been able to verify the results of such experiments in most cases by obtaining identical stages direct from nature.

I am indebted to Drs. J. R. Henderson and N. Annandale for many references and much help; and to Dr. B. L. Chaudhuri for kindly confirming my identifications in a few doubtful cases. My thanks are due to Mr. H. C. Wilson of the Madras Fisheries for permitting me to publish his figures of the eggs and larvae of *Gobius striatus* and for valuable information that he has kindly given me regarding the habits of some of the species.

¹ I am indebted to Mr. Ramaswami, B.A., of the Madras Fisheries, for this information.

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Elops indicus*, Swainson.¹(Elops saurus of the Fauna of Brit. India.)*Tamil—*Ālātti*.

Habitat and Habits.—Day mentions tropical and subtropical seas as the habitat of this fish, while Drs. Max Weber and De Beaufort regard *E. hawaiiensis* and *E. machnata* as sea fish.² The Madras species, however, appears to be essentially an estuarine fish, which

¹ Dr. B. L. Chaudhuri has discussed the Indian species of this genus in detail in his report on the fish of the Chilka Lake, in vol. V of the *Memoirs of the Indian Museum*, pp. 413-416. He concludes that the species that occurs commonly at Madras should be called *Elops indicus*, Swainson.

² *Fishes of the Indo-Australian Archipelago*, II, p. 4.

easily acclimatises itself to fresh water. Large numbers are caught in the river Cooum within tidal influence, and in brackish ponds near the coast.¹ During the floods young fish are common in the Cooum above tidal influence, while adult fish occur in the Madras Fort ditch² and in tanks in the Government House gardens, both of which have had no access to the sea for years. The above facts seem to show that this fish breeds in fresh water. A congener, *E. lacerta* of Africa, is known to enter rivers.³

E. indicus appears to breed during the cold weather. The fry of this genus, like those of the other members of the family, are said to be ribbon-shaped.⁴

***Megalops cyprinoides* (Broussonet).**

Tamil—*Morān Kendai*.

All the specimens examined, ranging from a length of 6 inches to 20 inches, are referable in most respects to Bleeker's *M. kundinga*, but the head is slightly smaller and there are a greater number of anal and dorsal rays.

Habitat and Habits.—*M. cyprinoides* is an estuarine fish frequently entering fresh water and easily accommodating itself to it. The larvae and young are common in the Cooum river, within and above tidal influence and in pools near the coast; but the largest specimens I have seen, about a foot and a half in length, are from ponds in the city. According to Thomas they acclimatise very readily to fresh water and grow fast and are said to breed in fresh water.⁵ In support of the last statement, I may state that I have obtained the species in various sizes from a pond about 4 miles from the sea which has no communication with river or backwater. I have not seen it in the Red Hills tank or in any of the larger lakes further inland.

M. cyprinoides is an active and powerful fish, predaceous in habits, subsisting mainly on the smaller Cyprinidae in ponds. In an aquarium young specimens are attractive, but their growth in such surroundings is not rapid. At frequent intervals they rise slowly till they are quite near the surface, when they make a sudden dash to the surface and descend down in a moment having swallowed air, which escapes through the opercular cleft. This habit is natural to the fish, as it often rises to the surface in ponds and the act is accompanied by a characteristic splash of water and the escape of air bubbles. According to "Skeen Dhu" they rise to the surface only between 5 and 6 p.m.⁶ Connected with this habit is the fact observed by Dr. Willey that this species lives

¹ At the lower anicut on the Col river, Tanjore district, specimens over a foot and a half in length are frequently captured with Hilsa (*Clupea ilisha*) during the floods in July and August.

² Thomas, *Tank Angling*, p. 168 (1887).

³ and ⁴ *Cambridge Nat. Hist.*, VII, *Fishes*, p. 547.

⁵ Thomas, *Rod in India*, p. 214.

⁶ Skeen Dhu, *The Mighty Mahseer*, p. 49.

for many hours out of water, rather an exceptional feature in the herring family to which *Megalops* belongs.¹

M. cyprinoides breeds during the cold weather. Thomas, however, in his *Report on Pisciculture in South Canara* states that *E. apalike*, Day (= *M. cyprinoides*) is said to breed from May to June. The larvae are common in the river Cooum in October and November in fresh water. As in *Albula vulpes* (*A. conorhynchus* of the "Fauna") the young pass through a characteristic larval stage analogous to that of the eel.²

***Notopterus notopterus* (Pallas).³**

(*Notopterus kapirot* of the *Fauna of Brit. India.*)

Tamil—*Chotta Vālai*.

Habitat and Habits.—Day records this species from fresh and brackish waters. In Madras, however, it is confined to the former and appears to thrive best in the stationary water of ponds and lakes; Hamilton-Buchanan, however, obtained his largest specimens (3 feet in length) from rivers.⁴

Uses.—Though the species is said to attain to 3 feet, I have not seen it above a foot and a half in length. It is esteemed as food.

***Engraulis purava* (H. B.)**

Tamil—*Ven Kannu*.

Young fish of *E. purava* occur in the river Cooum in fresh water during October and November, which appears to be the breeding season. It is an estuarine fish which ascends rivers when young. In 1910 a specimen was collected as far inland as Tirhoot in Bengal.⁵

***Labeo calbasu* (H. B.)**

Tamil—*Sēl Kendai*.

Habitat and Habits.—This species abounds in large tanks in the neighbourhood of Madras and in rivers above tidal influence. It also occurs in a few small tanks within the city. Like the other species of *Labeo*, it feeds on vegetable matter and minute crustacea and is essentially a bottom-feeder.⁶ *L. calbasu* breeds during the cold weather. Immature fish are common in the river Cooum in fresh water in January. Young fish of about 6 inches in length are silvery white in colour, the scarlet spots being entirely absent.

¹ *Spolia Zeylanica*, VII, p. 98.

² van Kampen, *Larvae of Megalops cyprinoides*: *Bull. Dept. Agri. des Ind. Neer. Buitenzorg*, 1908 (10-12).

³ Max Weber and De Beaufort, *Fishes of the Indo-Australian Archipelago*, II, p. 9. (Pallas, *Spicil. Zool.*, VII, p. 40.)

⁴ Hamilton-Buchanan, *Fishes of the Ganges*, p. 235.

⁵ *Journ. Bombay Nat. Hist. Soc.*, XX, p. 432.

⁶ Thomas, *Rep. Pisciculture S. Canara*, p. 70.

Uses.—This is a large fish, growing to about 3 feet in length, which is much esteemed as food.

***Cirrhina reba* (H. B.)**

Tamil—*Arinjal* or *Arinjal Kendai*.

This is a common species in large tanks in the neighbourhood of Madras; it however does not seem to occur within the city or in brackish water.

Uses.—It is a small fish growing to about 9 inches in length, and not much in demand as food.

***Catla catla* (H. B.)**

(*C. buchanani* of the *Fauna of Brit. India*.)

On 10th June, 1912 I obtained a fresh specimen in the Chintadripet Market, Madras which is preserved in the Madras Museum. This is apparently the first record of this species south of the Kistna. Mr. Wilson informs me that since the introduction of this species into the Cuddapah-Kurnool canal by the Fisheries Department, it has found its way into the Pennar river and some of the large tanks of the Nellore District. Some tanks further south are shortly to be stocked by the Fisheries Department.

It is a valuable food fish attaining to 6 feet and more in length and an inhabitant of fresh and brackish waters. "It is a very strong and active animal and often leaps over the seine of the fisherman" (H. B.). Growth is said to be very rapid in this species. Mr. Mitchell's specimens, which were only $\frac{1}{2}$ to 1 inch in length when introduced into his tank, had attained a length of 11 inches in the course of five months (*Nature*, 1875, XIII, p. 107). In the Godavari river, where this fish is quite common, it breeds about August. Young specimens from 2 to 3 inches in length are common in that river in January.

***Barbus chrysopoma*, C. and V**

Tamil—*Panjela*, also *Shani Kendai*.

I have referred to this species¹ a common tank *Barbus* in Madras, though it does not exactly agree with Day's description of the species. The original description by Cuvier and Valenciennes is very defective.²

In Madras specimens usually there are 3 or 4 anterior unbranched rays in the dorsal fin, the pectoral has 15 rays, the number of perforated scales on the lateral line varies from 29 to 32, the diameter of the eye varies from 4 to $4\frac{1}{2}$ in the length of the head, there are 10 to 12 rows of scales in front of the dorsal fin,

¹ Jerdon (*Madras Journ. Lit. Sc.*, 1849, p. 314), Thomas (*Tank Angling*, pp. 96-97) and Skeen Dhu (*Mighty Mahseer*, pp. 6 and 62) record this species from Madras.

² Gunther, *B. M. Catalogue*, VII, p. 113 (syn.).

the rostral pair of barbels are one-half longer than the orbit and the dark lateral blotch anterior to the base of the caudal fin may be present or absent.

The above particulars show that Madras examples combine the characters of the three species, *B. sarana*, H. B., *B. chrysopoma*, C. and V., *B. pinnauratus*, Day, all of which according to the *Fauna of British India* may occur in Madras. Day himself doubted the validity of his species *B. pinnauratus*, which he thought may be a variety of *B. chrysopoma*, while *B. sarana* is closely related to these.¹ The series examined, however, is entirely too limited to decide whether these three species are really distinct.

This fish is common in ponds in and around Madras and does not appear to occur in rivers. The breeding season seems to be about December, as the young are very common in January and February. In the young the eyes are comparatively large.² When they are an inch long, there are 4 undivided anterior rays in the dorsal fin. All the fins and the opercles are suffused with orange, the body is bright silvery and the dark lateral spot at the root of the caudal fin is very distinct.

Uses.—Much valued as food.

***Barbus amphibius* (C. and V.)**

Tamil—*Numbriki Kendai*.

Both in the *Fishes of India* and in the *Fauna of India* Day gives the number of undivided anterior rays in the anal fin as 2, while in his *Fishes of Malabar* he mentions 3 such rays; in Madras specimens the latter number usually occurs.

Habitat and Habits.—Though not uncommon it does not appear to be very numerous except in some tanks. In the river Cooum it occurs within tidal influence. It is a shallow-water species subsisting on a mixed diet composed of aquatic weeds, worms, flies, etc. *B. amphibius* breeds during October, November and December and also according to Thomas during June and July.³

Description of young.

"When young the summit of the head is golden green, and a yellow streak runs from opposite the centre of the eye to the centre of the tail. When about two inches in length the black spot on the side of the tail commences to appear, and by degrees the golden streak along the side disappears."⁴

Uses.—It is a small fish not much in demand as food.

***Barbus dorsalis* (Jerdon).**

Tamil—*Múkanáng Kendai*. "Saal Candee" (Day) is the name given to *Labeo calbasu* in Madras.

Habitat and Habits.—*B. dorsalis* occurs in ponds and rivers, but nowhere abundantly. It is rare in tanks within city limits.

¹ Day, *Fishes of India*, p. 562.

² *Ibid.*, p. 561.

³ *Report Pisciculture S. Canara*, p. 72.

⁴ Day, *Fishes of Malabar*, p. 214.

The spawning season is said to extend from August to October. Dr. Willey observes :

"On August 31st a half-spent spawning (*Barbus dorsalis*) accompanied by a batch of adhesive eggs was brought from the Colombo lake. The eggs measured 0.75 mm. in diameter with a pale grayish transparent yolk nearly uniformly granulous. The eggs had been caught in the act of being laid and were apparently unfertilized."¹

Uses.—This species attains to at least eight inches in length and is fairly good as food.

***Barbus sophore* (H. B.)²**

(*B. stigma* of the *Fauna of Brit. India.*)

Tamil—*Kulla kendai*.

In June, 1910 I obtained a dozen specimens of this species from a pond behind the Madras Museum, some of which possess a pair of small maxillary barbels. The chief characters of examples of the two kinds obtained simultaneously from the above pond are detailed below to obviate all possible doubt as to their identification—

I. SPECIMENS WITH A PAIR OF MAXILLARY BARBELS.

1. A specimen 3 in. in length.

D. 3/8. A. 3/5. V 2/7. LL. 26.

A dark lateral blotch on scales 22 and 23 of the lateral line.

Three rows of scales between the LL. and the ventral fin.

Length of head 5 in total length.

Nine scales before the dorsal fin.

A scarlet lateral band.

2. A specimen 4 in. in length.

D. 3/8. A. 3/5. V 2/7. LL. 26.

A dark lateral blotch on scales 22, 23 and 24 of the LL.

Three rows of scales between the LL. and the ventral fin.

A scarlet lateral band present.

Ten scales before the origin of the dorsal fin.

3. A specimen $4\frac{7}{10}$ in. in length.

D. 3/8. A. 3/6. M. 2/7. LL. 26.

A scarlet lateral band.

A dark lateral blotch on scales 22, 23 and 24 of the LL.

Three rows of scales between the LL. and the ventral fin.

Length of head $4\frac{1}{5}$, height of body $3\frac{1}{2}$ in total length.

The diameter of the eye $3\frac{3}{4}$ in the length of the head.

Ten scales before the dorsal fin.

¹ *Spolia Zeylanica*, VII, p. 103.

² Chaudhuri, *Mem. Ind. Mus.*, V p. 436 (1916).

II. SPECIMENS WITHOUT BARBELS.

1. A specimen $3\frac{1}{2}$ in. in length.D. $\frac{3}{8}$. A. $\frac{3}{5}$. V. $\frac{2}{7}$. LL. 25.

A dark lateral blotch on scales 22 and 23 of the LL.

Three rows of scales between the LL. and the ventral fin.

Length of head $4\frac{5}{7}$ in total length.

Nine rows of scales before the dorsal fin.

A scarlet lateral band.

2. A specimen 4 in. in length.

D. $\frac{3}{8}$. A. $\frac{3}{5}$. V. $\frac{2}{7}$. LL. 25.

A dark lateral blotch on scales 22 and 23 of the lateral line.

Three rows of scales between the LL. and the ventral fin.

Length of head 5, height of body $3\frac{1}{2}$ in total length.The diameter of the eye $3\frac{1}{2}$ in length of head.

Nine scales before the dorsal fin.

A scarlet lateral band.

In all the specimens the eyes are $1\frac{1}{2}$ diameters apart, the first dorsal ray is osseous and entire, the dorsal fin commences rather in advance of the ventral fin, midway between the end of the snout and the base of the caudal fin. The lateral line sense organs exist in all the specimens only on 25 scales, the 26th scale is a small scale, when present, without a perforation. In all, there are only 3 rows of scales between the LL. and the base of the ventral fin. A dark blotch on the mid-dorsal rays is present in all.

The only fish with which a possible confusion could arise is *B. amphibius*, which has a maxillary pair of barbels; but in all the specimens described above, there are 3 rows of scales between the LL. and the origin of the ventral fin. This character apart from others, such as the greater breadth of the body in *B. sophore*, is sufficient to distinguish it from *B. amphibius*, which has only two such rows of scales.

From the above statements it will be seen that maxillary barbels, while absent in most specimens, are present in some. If my observations are correct, the presence or absence of barbels is evidently variable and so cannot serve as a safe criterion for classifying species of *Barbus*. Day also doubted if the two species *B. mahecola* and *B. filamentosus*, distinguished by the presence of a small pair of maxillary barbels in the former, were really distinct.¹

From the history of *B. sophore* it is seen that till 1869 *B. stigma* (C & V.) destitute of barbels was considered identical with *B. sophore* (H. B.), and the mention of 4 barbels by the latter author in his description, as they were not shown in his figure, was considered a mistake. In 1869, Day discovered a form with 4 barbels in the Khasi Hills for which he adopted the name *B. sophore*, *B. stigma* being retained by him for the common form without barbels.²

¹ Day, *Fishes of India*, p. 556; *Fauna Brit. Ind.*, I, pp. 293 and 294.

² Day, *l. c.*, p. 566; *Proc. Zool. Soc.*, 1869, p. 376.

Though I have not seen the form with 4 barbels, it seems likely that these three forms—the common form destitute of barbels, the Madras one recorded in this paper with a pair of maxillary barbels, and the kind from the Khasi Hills with 4 barbels—represent phases of a very variable species which according to time or locality may possess four, two or no barbels.

Habitat and Habits.—*B. sophore* is one of the commonest species in Madras, occurring in abundance in the shallows of ponds and rivers. In the Cooum it is found within tidal influence in brackish water. It breeds during the cold weather; Day records finding 1850 mature eggs in a female at Madras in January.¹ The young, which are common in November and December, closely resemble the adult, except in their paired fins, which are comparatively long; the pectorals reach the ventrals and the latter the origin of the anal fin. The lateral scarlet band, frequently seen in the adult, is often present in the young also.

Uses.—A small species, reaching a maximum length of about 5 inches, not much in demand as food. Its flesh is bitter and is supposed to be medicinal. It is a valuable mosquito larvicide.

***Barbus filamentosus* (C. & V.)**

Tamil—*Sevāli* (red tail) or *Retha kendai*.

It is very doubtful if the present species is really distinct from *B. mahecola* (C. & V.).² Both forms, those with a pair of minute maxillary barbels (*B. mahecola*) and those without them (*B. filamentosus*), occur in Madras and are identical in all other characters.

This handsome fish frequents streams in small shoals.

***Barbus mahecola* (C. & V.)**

Occurs in a few tanks in the neighbourhood of Madras.

***Barbus vittatus* (Day).**

Tamil—*Sinna kulla kendai*.

Colour.—In Madras examples there are only three characteristic black spots, one on the dorsal fin, another at the root of the caudal and a third in front of the anal fin; the last though fairly constant appears to be caused by faecal matter.

"In the immature the colours vary: when the fish is about 8/10ths of an inch long, a vertical stripe begins to show itself in the posterior third of the dorsal fin, the summit of which also becomes edged with black, whilst there are some irregular orange markings, in very young specimens the line of demarcation between the green of the back and the silvery abdomen appears like a white band running from the eye to the middle of the tail." (Day).³

¹ Day, *Fishes of India*, p. 579.

² Day, *Fishes of India*, p. 556. Day combines the two species in his *Fishes of Malabar*, p. 215.

³ *Fishes of Malabar*, p. 215; *Fishes of India*, p. 582; *Fauna Brit. Ind.*, p. 333.

Habitat and Habits.—Very common in several ponds in and around Madras and in rivers in fresh water. After a heavy shower this is one of the foremost fish to enter drains and gutters in the city.

Uses.—Its small size, hardihood and the ease with which it could be kept alive for years in small aquaria make it one of the most valuable mosquito larvicides.

Rasbora daniconius (H. B.)

Tamil—*Ovari* or *Paravu*.

In Madras specimens, two complete horizontal rows of scales do not exist between the L. line and the root of the ventral fin as stated by Day,¹ there being only one and a half rows as correctly shown by his figures²; the number of rows in front of the dorsal fin varies from 14 to 16.

Habitat and Habits.—*R. daniconius* abounds in all the rivers and tanks in Madras in fresh water. It is a shallow-water species and feeds on both animal and vegetable matter.³ This species breeds during the rains in September and October in Madras, while its congener *R. rasbora* (*R. buechanani* of the 'Fauna') is said to breed on the West Coast in June and July.⁴ The fry, which are very common during the breeding season, enter drains and are frequently caught there with the young of species of *Amblypharyngodon*, *Nuria danrica* and *Barbus vittatus*, the other common tank-fish of Madras. They are easily distinguished from the fry of *Amblypharyngodon* by the absence of both the orange colour and the convex dorsal profile so characteristic of the latter; but are not easily separable from the fry of *N. danrica* before the barbels appear in them, and the fry of *B. vittatus*.

Uses.—Conflicting opinions exist as to their usefulness as mosquito-destroyers; my experiments show them to be at least as useful as *N. danrica* in this respect.

Nuria danrica (H. B.)

Tamil—*Paravū*.

The height of body in some large examples is 5 in total length and the eyes are usually $1\frac{1}{2}$ diameters apart.

Habitat and Habits.—*N. danrica* is very common in ponds and not uncommon in rivers. The breeding season extends from October to December, when many adults have the caudal portion

¹ Day, *Fishes of India*, p. 584; *Fauna Brit. Ind.*, p. 337.

² Day, *Fishes of India*, pl. cxlvi, figs. 2 and 3.

³ Jerdon, *Madras Fourn. Lit. Sc.*, xv, p. 320. The statement of Messrs. Chaudhuri and Sewell in their *Ind. Fish of Proved Utility as Mosquito Destroyers*, that this species is a pure vegetarian is contradicted by Mr. H. C. Wilson in his "Notes on larvicides and natural enemies of mosquitoes in South India," *Proc. Gen. Mal. Commit.*, 2nd meeting, Madras, 1912.

⁴ Thomas, *Rep. on Pesci. South Canara*, p. 72.

of their bodies with the caudal fin stained crimson; which is supposed by fishermen in Madras to indicate good rains. The fry are very common in November, when they frequently enter drains in the city after a heavy shower. Till they attain a length of 19 mm. the barbels are undeveloped and the scales are indistinct; when 25 mm. long, the maxillary barbels reach the eye, the colour is greyish white, a faint yellow band extends along the sides and some dark pigment spots are present at the root of the caudal fin.

Uses.—This is a small species which is said to reach a maximum length of 5 inches. Being a surface feeder it is valuable as a mosquito-destroyer.¹

***Amblypharyngodon microlepis* (Bleeker).**

Tamil—*Puli Elai Kendai* or *Pacha Thalai Kendai*; both names refer to the metallic green colour of the back.

The rows of scales between the L. line and the base of the ventral fin is usually 6 and even 7; only occasionally is it 5 as stated by Day.

Habitat and Habits.—*A. microlepis* is one of the commonest tank-fish in Madras. It inhabits shallow water and is among the first to migrate from ponds with the shallowest of overflows, in which act it is frequently caught in drains after a heavy shower.

The breeding season extends from October to December, when the fry are extremely common.

Description of Fry.—There are usually 9 rays in the dorsal and 8 in the anal fin. When less than 2 centimeters long the scales are indistinct, the body translucent and bright orange in colour, except the abdomen, which is silvery; the dorsal profile is very convex; a dark green crescent mark on the head behind the line of the eyes is very distinct in preserved specimens; the pectoral fins reach the ventral, which reach the anal.

Uses.—A small species not more than 3 or 4 inches in maximum length, which enters largely into the diet of the poorer classes in consequence of its abundance. Experiments prove it to be a valuable mosquito-destroyer.

***Amblypharyngodon mola* (H. B.)**

Not so common as *A. microlepis* in Madras.

***Chela clupeoides* (Bloch).**

Tamil—*Vellichi*.

C. clupeoides is found chiefly in ponds and only occasionally in rivers. Though not uncommon it is rarely abundant in any single locality. It is an active fish and a fast swimmer and in-

¹ Sewell and Chaudhuri, *Ind. Fish of Proved Utility as Mosquito-destroyers*, p. 17.

habits clear water. Being a surface-feeder it is frequently seen near the surface of the water.

"The chelas are remarkably active in the early mornings and evenings, which means that they are thoroughly on the feed then. During the middle of the day they seem to favour the deeper waters and become less active, occasional rises being seen in the centre or deep parts of the pool, but not feeding regularly."¹

In sport or when chased they shoot into the air; more frequently they expose their silvery sides at the surface of the water in bright sunshine.

Uses.—This species attains a maximum length of six inches and is esteemed as food. The doubt cast on the usefulness of species of *Chela* in destroying mosquitoes by some writers² has been criticised by Mr. H. C. Wilson.³ My own experiments show that *C. clupeoides* readily eats mosquito larvae at any rate in captivity. Possibly *C. argentea* differs from the present species in this respect.

***Perilampus cachi* (H. B.)**

(*P. atpur* of the *Fauna of British India*.)

Tamil—*Salvāi*.

Cachius being the first of the two specific names (*cachius* and *atpur*), used for this species by Hamilton-Buchanan⁴, has to be adopted according to the law of priority.

In Madras specimens the anal fin has only 20 to 22 rays, the number of longitudinal rows of scales between the L. line and the base of the ventral fin is frequently only $3\frac{1}{2}$, and the number of perforated scales on the L. line usually only 50. I have not seen this species more than an inch and a half in length, though it is said to grow to a maximum length of 4 inches.

It is a rare fish in Madras. I have met with it very occasionally in the Cooum river and in the Sembarambakkam tank.

Uses.—Messrs. Sewell and Chaudhuri mention it as a mosquito-destroyer.⁵

***Lepidocephalichthys thermalis* (C. and V.)**

Tamil—*Asarai*.

This common species abounds in the rivers where the bottom is sandy, and in ponds.

Habits.—*L. thermalis* inhabits the bottom mud or sand of rivers and ponds, where it usually lies buried during the day, venturing out to feed at night. The burrowing in mud or sand does not appear to be a laborious process. In an aquarium, when

¹ Wilson, Some notes on larvicides and natural enemies of Mosquitoes in South India. *Proceedings Third General Malaria Committee, Madras* (November 18th, 19th and 20th, 1912).

² Bentley, *2nd Rev. Wellcome Laboratory*, p. 418; Sewell and Chaudhuri, *Ind. Fish of Proved Utility as Mosquito-destroyers*, p. 19.

³ H. C. Wilson, *l. c.*

⁴ Hamilton-Buchanan, *Fishes of the Ganges*, pp. 258 and 259.

⁵ *Ind. Fish of Proved Utility as Mosquito-destroyers*, p. 19.

disturbed, it rapidly darts about and suddenly strikes the bottom sand head-forwards, diving into it by sheer force. A favourite position for the fish is to lie buried with just the snout and the tail above the surface of the sand; often the latter is also concealed and the snout is withdrawn at the approach of danger, only to reappear almost immediately.

Branchial respiration appears to be insufficient in this loach. In an aquarium it grows restless at varying intervals, and rises to the surface to take air, which is apparently swallowed; consequently it lives for a long time out of water.

The erectile sub-orbital spine appears to be an organ of defence; when the fish is seized by the tail it rapidly swings round and dashes its head against the hand, when the prick of the erected spine is felt.

The breeding season extends from October to January, when the young, which resemble the adult, are quite common everywhere in shallow collections of rain-water.

Uses.—Though small it is considered very nourishing.

***Clarius batrachus* (Lin.)¹**

(*Clarius magur* (H. B.) of the *Fauna of British India*.)

Tamil.—*Karuppu thēli* (*theli*=scorpion, has reference to the poisonous pectoral spines).

Habitat and Habits.—*C. batrachus* is rare in Madras. It inhabits fresh and brackish water.

Like most Silurids it is sluggish and prefers muddy to clear water. It lives and feeds at the bottom of ponds and rivers, and in the mud sometimes lies concealed for hours, with no movements save those of respiration and the constant lashing of its barbels, which appear to be its chief organs of perception. Experiments in an aquarium seem to prove that this fish is practically blind to objects beyond the reach of its barbels. The colour is eminently protective and effectively conceals the fish in dark muddy surroundings.

As is well known *C. batrachus* is amphibious, possessing an accessory breathing organ; it lives a considerable time out of water.

The pectoral spines in this species are not dreaded.

Uses.—*C. batrachus* reaches a length of a foot and a half and is considered as wholesome and nourishing food. The air-bladder yields a coarse isinglass.²

***Saccobranchus fossilis* (Bloch).**

Tamil—*Thēli*.

Cuvier and Valenciennes in 1840 identified *S. fossilis* (Bloch) with *S. singio* (H. B.).³ Gunther in 1864 held the two to be dis-

¹ Max Weber and De Beaufort, *Indo-Australian Fishes*, II, p. 190. (Linné, *Syst. Nat.*, 1758, p. 305).

² Day, *Fishes of India*, p. 485. ³ *Hist. Nat. des Pois.*, XV p. 297.

tinct species.¹ Again Day united the two in 1878.² Since then, *S. singio* (H. B.) has been ranked as a synonym of *S. fossilis* (Bl.) by most systematists. Recent anatomical research, however, appears to show that the two are probably distinct species. Hyrtle³ (1853), followed by Hubrecht and Day (1877)⁴, states that in *S. singio* the right accessory air-sac is supplied with blood by the first afferent branchial artery, the left on the contrary being supplied by the fourth afferent artery. Burne in 1894 found that in *S. fossilis* both air-sacs are supplied by the fourth afferent arteries.⁵

Habitat and Habits.—Quite common in ponds and ditches, where it frequents the muddy bottom. Its distribution does not appear to be limited to fresh water as on the west coast (Cochin); it is said to occur in backwaters where the fishermen catch it at night with a torch, the light of which attracts it. *S. fossilis* is amphibious and consequently lives for a long time out of water. "Wounds from the pectoral spines of this fish are dreaded in India as they are reputed to be very poisonous."⁶

The breeding season extends from September to December; during the rains the fish deposit their eggs in irrigated fields, where the young, which are copper-red in colour, are frequently caught for stocking tanks.

Uses.—*S. fossilis* attains a length of a foot and a quarter when full grown and is highly esteemed as food by Indians.⁷

Wallago attu (Bl. and Schn.)

Tamil—*Vālai, Āthu Vālai.*

Habitat and Habits.—The "freshwater shark" inhabits lakes and rivers. Col. Tickell⁸ states that it occurs sometimes within tidal influence; this is probably the case when it is carried down by floods, as the least salinity seems to disagree with this fish and to cause death.

W. attu is a large and powerful fish and predaceous in habits. It feeds on both vegetable and animal matter, preferably on the latter, and is said to destroy fry and large numbers of smaller fish in ponds. It is sluggish in its movements and lives for the most part at the bottom. Thomas attributes the frequent slowness of this fish to discover the presence of food to deficient sight. The statement that it feeds mostly at night⁹ appears to be incorrect, as I have seen it very active and freely take a bait by day. It is usually caught in large nets and when handled it makes fierce attempts to bite.

¹ *Brit. Mus. Cat. Fishes*, V, pp. 30 and 31.

² *Fishes of India*, p. 486.

³ *Akad. Wiss. Wien*, XI, p. 302 (1853).

⁴ *Four. Lin. Soc. Zool.*, XIII, p. 198 (1877).

⁵ *Loc. cit.*, XV, p. 48 (1894).

⁶ and ⁷ Day, *Fishes of India*, p. 487.

⁸ *Rod in India*, 1881, p. 168.

⁹ Day, *Fauna of Brit. India, Fishes*, I, p. 127.

Uses.—This is a large fish which is said to reach a maximum length of six feet though specimens above four feet are very rare. It is esteemed as food and salts well.¹

***Pseudentropius atherinoides* (Bloch).**

Tamil—*Nā Keliti* (the epithet *na* = dog and hence an inferior kind).

The “three or four bands along the sides formed by black spots” (Day)² are not found in Madras specimens and the pectoral spines usually have about twelve denticulations.

Habitat and Habits.—*P. atherinoides* inhabits lakes and ponds in the neighbourhood of Madras and is rarer than most other Silurids.

***Arius falcarius*, Richardson.**

Tamil—*Uppu Kali Keliti*.

In most Madras specimens the pectoral fin does not reach the ventral nor does the ventral the anal.

Habitat and Habits.—A common estuarine species which occasionally ascends rivers and comes into fresh water.

The interesting breeding habits of species of *Arius* are well known.³ The breeding season in Madras extends from September to November, when large numbers congregate in estuaries to deposit their spawn. One of the breeding grounds for this species in Madras is the mouth of the River Adyar. The eggs, which are large and yolky measuring .5 to .6 inches in diameter, are probably deposited in batches by the female. The male takes up the eggs—usually about eight—into his mouth and keeps them there for many days till they hatch out as fry. They are retained by the male till the yolk is absorbed. During the whole of this period the ovigerous male never feeds. During the breeding season the males frequently have the caudal, anal and part of the dorsal fins stained red.

Uses.—*A. falcarius* attains a maximum length of two feet, and, being common, enters largely into the diet of the poorer classes.

***Macrones cavasius* (H. B.)**

Tamil—*Sōlai Keliti*.

It is common in lakes and rivers at a distance from the sea; while it is common in Sembadambakkam and Red Hills tanks, it is not known to occur within city limits.

In habits it closely resembles other Silurids. The pectoral spines cause painful wounds. Though it does not breathe air direct, it lives for a long time out of its native element.

Uses.—It is said to attain a maximum length of eighteen inches and is esteemed as food by Indians.

¹ Day, *Fishes of Malabar*, p. 193.

² *Fishes of India*, p. 475; *Fauna Brit. Ind.*, I, p. 141.

³ *Spolia Zeylanica*, VII, p. 97 (1911); Day, *Fishes of India*, p. 457; *Fauna Brit. Ind.*, p. 169.

Macrones vittatus (Bloch).

Tamil—*Nāttu Keliti*.

Habitat and Habits.—This is the commonest species of *Macrones* in fresh water in Madras. In the Cooum and Adyar rivers it frequently occurs within tidal influence.

In habits it closely resembles the previous species; Day¹ observes :—

"This fish is termed 'the fiddler' in Mysore; I touched one which was on the wet ground, at which it appeared to become very irate, erecting its dorsal fin and making a noise resembling the buzzing of a bee, evidently a sign of anger. When I put some small carp into an aquarium containing one of these fish it rushed at a small example, seized it by the middle of its back and shook it like a dog killing a rat."

In April, 1911 I obtained from a ditch near Chetput, which contained large numbers of this fish, two albino specimens perfectly pigmentless; they were translucent white, showing the surface blood vessels of the skin, and were less active and more sensitive to light than pigmented ones.

In March I found a female with eggs.

Uses.—Though small, it is very common, and is eaten by the poor.

Macrones keletius (C. and V.)

Comparatively rare in Madras; I have met with it only in one or two ponds in the city and in the Red Hills tank.

Anguilla elphinstonei, Sykes.

(*Anguilla bengalensis* (Gray) of the *Fauna of Brit. India*.)

Tamil—*Velangu*.

Dr. Max Weber, in his recent revision of the species of *Anguilla* of the Indo-Pacific region, considers the earlier name *A. bengalensis* (Gray) invalid, as the figure published by Gray and Hardwicke is altogether inadequate to identify the species.²

Habitat and Habits.—This is by far the commoner of the two species of *Anguilla* in Madras, and is abundant in ponds and rivers. It is carnivorous and is very voracious, hiding in the bottom mud during the day and emerging out to feed at night; hence it is mostly captured at night. Indian fishermen have an easy way of taking it "they leave small-mouthed earthen pots with a bit of sheep skin in each overnight, and draw them up in the morning, with their fish lying coiled up most comfortably in them."³ It is very tenacious of life and survives most adverse conditions such as drought and starvation. Like most eels, it lives for a long time out of water and leaving its native waters

¹ *Fauna of Brit. Ind.*, p. 158; *Fishes of India*, p. 449.

² Max Weber, Revision der Indo-Pacifischen Anguilla-Arten. *Zool. Jahrb.*, Sup. 15, Band I, p. 578 (1912).

³ Thomas, *Tank Angling*, p. 100 (1887).

migrates considerable distances overland in search of ponds and streams, when desirous of a change. "It is an irritable creature, swelling its head whenever angered; and constantly, when it can, buries itself in putrescent carcases."¹

Every year a large number of elvers, measuring two or three inches in length and perfectly transparent in colour, ascend the rivers Cooum and Adyar about November.

Uses.—Though good to eat there is little demand for this eel. It is consumed chiefly by Mahomedans. *A. elphinstonei* attains a large size; a specimen in the Madras Museum measures $4\frac{1}{2}$ feet in length.

***Anguilla australis*, Richardson.²**

(*A. bicolor*, McClelland, of the *Fauna of Brit. India*.)

A rarer species than *A. elphinstonei* in Madras but resembles it in habits. It is a smaller species, attaining a maximum length of about two feet.

***Haplochilus melanostigma*, McClelland.**

(Pl. xxv, figs. 1, 3, 4, 10; pl. xxvi, figs. 12-16).

Tamil—*Munda Kanni* (=big eye).

McClelland's specific name *melastigma* (Gr. = black spot) has been corrected in the *Fauna of British India* into *melanostigma*, which is the correct etymological rendering of the word.

The caudal fin is truncated and not rounded in Madras specimens.

In the adult male, which is larger than the female, the anal fin has most of its rays prolonged in a filiform manner beyond the membrane, and each præmaxilla has about four coarse 'teeth' at the angle of the mouth: whereas in the female the anal rays are not prolonged and the præmaxilla is drawn out into a bifid 'tooth' at the angle of the mouth.

Habitat and Habits.—This very common species abounds in ponds and rivers in both fresh and brackish water; in the latter it seems to thrive best, as the largest specimens in my collection are from the Cooum within tidal influence. It inhabits the shallows of ponds and rivers, where it affects the surface and swims very close to it frequently with its mouth touching it. "When swimming in their natural surroundings, the surface of the head is kept almost on a level with the plane of water."³ The flat head and the transverse mouth are adaptations to surface feeding and the species is well-known as an effective mosquito-destroyer. The habit of inhaling the oxygenated surface water enables it to

¹ Hamilton-Buchanan, *Fishes of the Ganges*, p. 22.

² Max Weber, Revision der Indo-Pacifischen Anguillidæ. *Zool. Jahrb.*, Sup. 15, Band I (1912).

³ Sewell and Chaudhuri, *Ind. Fish of Proved Utility as Mosquito Destroyers*, p. 3.

withstand to a considerable extent foul water full of organic impurities detrimental to most fish : in the city it frequently occurs in gutters and sewage-farms.

Being a surface fish it is diaphanous, but possesses a remarkable capacity to change colour in accordance with its environment. Fish inhabiting the Cooum river often, within a distance of a few yards, show variations in colour ; those among green weeds are greenish, those in dirty water correspondingly brown and those in clear water translucent white ; while I have caught specimens reddish in colour during the floods, when the water is brick-red owing to the admixture of clay.

The breeding season extends chiefly from September to February or even later, but is certainly not limited to these months. In the Cooum the earliest specimens with eggs are found in brackish-water and only later in fresh water higher up. The peculiar breeding habits were first observed by Dr. Jenkins.¹ During the spawning season the dorsal, caudal and anal fins in both sexes usually acquire a bright golden-yellow edge. The eggs after extrusion are attached in two rounded clusters, one on each side, to the genital opening of the female. In the natural surroundings the eggs are probably carried till they are hatched, a condition highly favourable for their protection and aeration ; but in an aquarium they are sooner or later cast and, being demersal, sink to the bottom. Gobies and carp attack the fish when it is carrying eggs and feed on the latter. On an average from 20 to 40 eggs are carried by a female at a time.

Description of egg.—The eggs are transparent and large, about 1 mm.² in diameter. Under the microscope the outer egg-membrane is seen to give off externally numerous short adhesive threads, by means of which the eggs adhere to one another or to foreign objects (figs. 12-14). From a certain area on each egg a group of very long filamentous threads arise, and these from different eggs are twisted together to form a common cord which protrudes from the genital opening of the female (fig. 12). In the yolk there is a small oil globule, not large enough to make the egg float. The embryo is clearly seen within the egg-membrane in all stages of development (figs. 13 and 14). In an advance stage dark pigment cells appear on the body of the developing embryo and the egg looks dark in colour.

Distinguishing characters of the fry.—I succeeded in hatching some eggs in an aquarium. The fry when hatched measure 4 mm. in length and possess the pectoral fins and a single median fin starting dorsally about the middle of the back, and continued round the tail up to the remains of the yolk-sac on the ventral surface. They are easily identified from the fry of other fish by the characteristic arrangement of dark stellate pigment-spots. On the head and snout a few large scattered spots occur ; immediately behind

¹ Jenkins, *Rec. Ind. Mus.*, V, p. 137, pl. vi, figs 7 and 7a.

² Jenkins, *l. c.* (His measurement of the egg "about a centimeter" is obviously wrong).

the root of the pectoral fins, dorsally, is a semi-circular patch of close-set small spots: on the body and tail there are five longitudinal rows of spots, one mid-dorsal, two lateral and two ventral rows, one on either side of the mid-ventral line of the body (figs. 15 and 16).

During growth the following changes occur: the dorsal, caudal and anal fins become distinct in about 3 weeks; the pigment spots slowly disappear, except the lateral row which is retained in most adults as a faint black streak. The eyes acquire a glittering azure-blue colour and a pearly white speck is developed on the head—two unmistakable features of the immature *H. melanostigma*.

Uses.—A valuable mosquito-destroyer.

***Panchax parvus*, sp. nov.¹**

(Pl. xxv, figs. 2, 8; pl. xxvi, fig. 11).

Tamil—*Pachai Munda kanni*.

Br. VI. D. 2-3/5. A. 3/11-12. C. 24. V 6. P. 12. Vertebrae 26.

The length of the head is $3\frac{1}{3}$ to $3\frac{1}{2}$ times, and the depth of the body 4 to $4\frac{1}{3}$ times in the total length (exclusive of the caudal fin). The snout is longer than the diameter of the eye, which latter is $3\frac{2}{3}$ to $3\frac{1}{2}$ in the length of the head, and nearly half the interorbital width; the lower jaw is slightly projecting. *Teeth* are present in bands on both the jaws, some three vestigial ones on the anterior edge of the vomer. *Fins*—the pectorals reach considerably beyond the root of the ventrals which reach the anal. In the male, the 4th or 5th dorsal ray and the 11th and 12th anal rays are prolonged and both the fins reach the caudal; in the female these fins are rounded and do not reach the caudal. *Scales* possess both concentric and radiating seriations. The *lateral line* is absent; there are 26 to 27 scales along the mid-lateral line of the body counted from the top of the branchial aperture to the root of the caudal fin (scales on the caudal fin are not included). Seven longitudinal rows of complete scales exist between the root of the dorsal fin and that of the anal.

Colour.—Males are larger and are more brightly coloured than females. In both during life a metallic green spot exists on every scale of the back and upper half of the body, and on alternate scales of the mid-lateral row and a few horizontal rows below it. In this latter portion light Italian pink dots alternate with

¹ Day appears to have described this species from Madras under the name *Panchax rubrostigma* (*Proc. Zool. Soc. London*, 1867, p. 706) in the idea that it was identical with Jerdon's *Aplocheilus rubrostigma*. Later, in 1878, in his *Fishes of India* the description of *Haplochilus rubrostigma* is identical with that of Jerdon, and obviously he has mixed up the two species. *P. rubrostigma* differs from the present species chiefly (1) in size, as it reaches nearly 3 inches in length, (2) in having the second ray of the ventral fin elongated. *P. parvus* reaches only a maximum length of $1\frac{1}{2}$ inches and never has the rays of the ventral fin elongated.

the above-mentioned green dots. The ventral surface is more or less translucent in life, and the scales possess a purplish gloss. The usual pearly white speck is present on the head. An ocellus, with a black centre and light margin, is usually present at the root of some of the anterior rays of the dorsal fin, most distinct in female and immature examples. In the males, the longitudinal rows of alternating green and pink dots extend over the proximal half of the caudal, dorsal and anal fins; in the two latter fins the spots gradually increase posteriorly so as to completely cover the posterior half of the dorsal and a third of the anal fin. In the female the above-mentioned fins are unspotted and of a light orange colour. These brilliant colours disappear more or less completely in spirit.

Type-specimen.—In the Indian Museum.

Habitat and Habits.—*P. parvus* is found only in fresh water and confined, so far as I am aware, to the tanks and rivers in and around Madras city. It is somewhat local in distribution and inhabits stationary and sheltered waters of tanks and rivers overgrown with vegetation.

The breeding season appears to be January and February. The eggs are demersal and adhesive and are not carried in clusters by the female after extrusion. Thomas remarks :

"*H. panchax*" (I have no doubt he means this species) "extrudes one egg at a time and that disproportionately large, as big as its own eye. This keeps hanging to the vent as the fish is moving and feeding till it is cast and adheres; and so single eggs are laid and distributed." ¹

Description of egg (pl. xxvi, fig. 11).—The egg of *P. parvus* closely resembles that of *H. melanostigma* but is slightly larger, the adhesive threads of the outer membrane are thinner, longer and more numerous. The chief difference, however, is the absence of the tuft of long processes by which the eggs of *H. melanostigma* are held together and are suspended from the genital opening of the female. This is obviously due to the fact that the eggs in this species are not carried about by the female.

Uses.—A small species (adult male about 42 mm. and adult female about 28 mm.) which is valuable as a mosquito larvicide.

***Doryrhamphus*² *brachyurus* (Bleeker).**

(*Doryichthys bleekeri* of the *Fauna of Brit. India*.)

In a recent paper ³ George Duncker has united *D. brachyurus* (Bleeker) with *D. bleekeri* (Day). The only appreciable difference between the two, as would appear from descriptions, was in the number of the rays of the dorsal fin, there being 40-45 rays in *D. bleekeri* and only 36-37 in *D. brachyurus*; from an examination

¹ Thomas, *Tank Angling*, p. 112 (1887).

² The name *Doryrhamphus* has priority over *Doryichthys*. Max Weber, *Fish. Siboga-Expedition*, 1913, p. 116.

³ Duncker, *Syngnathids from Ceylon. Spol. Zeylan.*, VII, pt. 25, p. 26 (1910).

of a large number of Ceylon examples Duncker has now shown the number to vary from 37 to 43. In an adult Madras example I found 41 rays in the dorsal fin.

For want of material (ovigerous males), I have placed this species as usual in Kaup's genus *Doryrhamphus* (= *Doryichthys*) and not in Duncker's new genus *Microphis*.

Habitat and Habits.—Rare in Madras, a few occur in the Cooum River just above tidal influence in November. *D. brachyurus* is usually sluggish in its movements and keeps close to the banks of the river amidst grassy weeds; when frightened, however, it swims very rapidly and skilfully after the manner of eels. According to most writers¹ the Pipe-fishes swim in a vertical position like *Hippocampi*. *D. brachyurus*, *D. cuncalus* and at least one species of *Syngnathus*, which I have had the opportunity of observing in their natural surroundings, swim in the normal horizontal position, flush with the surface of the water.

The males are known to take charge of the eggs after extrusion, in a brood-pouch on the abdomen. Such males were found in summer by George Duncker in Ceylon in 1909. "The eggs were small, in 4—13 longitudinal and 60—110 transverse rows."²

***Doryrhamphus cuncalus* (H. B.)**

(*Doryichthys cuncalus* of the *Fauna of Brit. India*.)

Tamil—*Usi kolachi* (=needle fish).

A few occur in the Cooum during November and December.

In habits it closely resembles *D. brachyurus*, in whose company it frequently occurs.

***Belone cancila* (H. B.)**

Tamil—*Kolachi*, "*Pissu kolah*" (Day).

In Madras this species appears to be confined to freshwater ponds and lakes. Though common it is never abundant in any one locality. According to Jerdon "It is very voracious and devours large quantities of the little *Aplocheili*" (*Haplochilus* and *Panchax*).

***Ophiocephalus striatus*, Bloch.**

Tamil—*Verāhl*.

Habitat and Habits.—Common everywhere in ponds, ditches and rivers. In the Cooum it occasionally occurs within tidal influence. In its natural surroundings *O. striatus* often resorts to the margin of the water overgrown with weeds. It frequents shallow water probably because air is easy of access and so suits its amphibious habits. The air-breathing habit of this fish is well-known: in consequence it lives hours, sometimes days, out of

¹ *Fauna of Brit. India, Fishes*, II, p. 460.

² G. Duncker, *Syngnathids from Ceylon. Spol. Zeylan.*, VII, p. 26.

water, especially when kept among moist water-plants. Like most other air-breathers it is never seen to perform the usual respiratory movements of fish. During the rains in Madras young *Ophiocephali* are often caught on land in the course of their migrations: out of water they progress in a serpentine manner, by means of their pectoral fins and the alternate contractions of the lateral muscles of the body. During periods of drought they are known to bury themselves in the soft bottom mud of ponds.¹

All the species of *Ophiocephalus* are monogamous and build nests² for depositing their eggs. Under favourable conditions *O. striatus* breeds twice a year, about January³ and February and again in June and July; but the same pair do not seem to breed twice in the year. The nest consists of a circular clearing in grassy swamps or in the weedy edges of ponds and rivers. Both parents, the male in particular, keep guard. The eggs, which are large (1.25 mm.) and float at the surface, are never numerous but vary from a few hundreds to a few thousands according to the size of the fish. Dr. A. Willey gives a full description of the nest, egg and young of this species in *Spolia Zeylanica*, Vol. VI, pp. 108—123. The following is a brief résumé of facts observed by him.

Eggs.—Translucent golden-yellow or amber-coloured. They are spread like a sheet, flush with the surface in a sub-circular area in the centre of the nest. Diameter of egg 1.25 mm.

"The floating eggs owe their buoyancy to the presence of a single large oil-globule which occupies the greater part of the ovum, and is immersed in the golden-yellow yolk. It is adjacent to the upper pole of the egg, and in surface view under a low power of the microscope is seen to be surrounded by a narrow zone of the yolk, the whole being contained within a space bounded by the vitelline membrane."

The subjoined table gives a summary of the chronological data ascertained by him regarding the external features of the development of *O. striatus*.

Days after hatching.	Total length.	Principal events.
1 ...	3.5 mm.	Yolk-sac circulation established; pigment cells develop their black colouration; pigment begins to appear in eyes.
2 and 3 ...	4.5 to 5 mm.	Pectoral fins arise; mouth opens, and respiratory movements commence.
4 ...	6.75 mm.	Larvæ leaving the surface and swimming freely at all levels. Bright yellow spots over eyes.
7 ...	7 mm.	Larvæ swarming and turning in unison at the slightest concussion. Caudal cartilages appear.

¹ Day, *Fishes of India*, p. 363; *Fauna of Brit. Ind.*, II, p. 359.

² Col. Puckle (quoted by Day), *Fishes of India*, p. 362; Thomas, *Rep. Pisc. S. Canara*, p. 37 (1870).

³ Thomas, *Rep. Pisc. S. Canara*, p. 74 (1870); Day, *Freshwater Fish and Fisheries of India and Burma*, p. 23 (Calcutta, 1873).

Days after hatching.	Total length.	Principal events.
12—15	6.75 mm.	Posterior end of notochord bends up.
28	8 to 10 mm.	Caudal rays jointed and articulated with the basal cartilages. Larvæ rise to surface to take air.
37	10 mm.	Primordia of dorsal and anal rays.
40	10.25 to 13 mm.	Rudiments of ventral fins appear. Dorsal and anal fins separating from caudal. End of larval development.
63	17 mm.	Fry now hide in the mud.
73	25 mm.	

*Characteristic colour of the Larvæ.*¹—On either side of the body there is a broad reddish-orange band occupying almost the entire height of the myotomes, commencing from the eye on each side, and ending behind with a rounded edge at the base of the caudal fins. The iris is golden with a red flush; there is a bright golden occipital point, and the base of the anal and dorsal fins is black along their whole length. This characteristic livery is retained by the fry till they reach a length of about 40 mm. (nearly for 3 months after hatching); after which period the definitive markings begin to appear, in the form of 9 dark vertical half-stripes on either side descending from the base of the dorsal fin.

Growth.—From the fifth day after hatching, when the larvæ begin to feed independently, the daily growth begins to vary. Some young *O. striatus* kept by Dr. Willey in Colombo had an average total length of about 35 mm. in February 1908, 45 mm. in July 1908, 96 mm. in April 1909; the series last measured consisted of six individuals ranging from 85 mm. to 115 mm. The average measurements of a brood hatched in the central pond of the Marine Aquarium, Madras, was as follows:—

April 1913	.	hatched from eggs.
„ 1914	.	6 inches.
„ 1915	.	over a foot in length.

In nature growth is even more rapid and the young under favourable conditions begin to breed in about two years.

Uses.—*O. striatus* is one of the largest and most valuable food fishes of our inland waters. Being an air-breather it is transported with ease²; and is admirably adapted for pisciculture. Care, however, should be exercised in introducing it into preserved waters³ as it is very voracious and destructive to fry. The young are susceptible to attacks from internal parasites (? *Schistocephalus* larvæ).⁴

¹ Willey, *Spol. Zeylan.*, V, p. 145 (1908); VII, p. 116 (1910).

² Day, *Rep. Freshwater Fish and Fisheries Ind. and Bur.*, p. 25 (1873).

³ Thomas, *Rod in India*, p. 234 (1897); Willey, *Spol. Zeylan.*, V p. 146 (1908).

⁴ Willey, *l.c.*

Ophiocephalus punctatus, Bloch.

(Pl. xxvii, figs. 17—22).

Tamil—*Maniāṅ koravai* (*Para korava* (Day) is the name of *O. gachua* in Madras).

Habitat and Habits.—A very common species in ponds, ditches and rivers. In the last it is known to occur in brackish water when it is said to acquire a purplish colour.¹ It is a mud-burrowing fish² and prefers stagnant and muddy to running water.³ It is one of the fish Day saw exhumed from the mud of a dried-up tank.⁴

The breeding habits are very similar to those of *O. striatus*. *O. punctatus* is monogamous, and breeds twice in the year, about January and February and again about July and August; occasionally nests are met with at other times.⁵ At these seasons the fish come together in pairs and construct a nest among the rushes in the shallows of ponds and rivers. I have never seen the nest in water deeper than a foot and a half, as a rule it is built in water only a foot in depth. The nest is the usual roundish clearing measuring 8 or 9 inches in diameter. The nests of *O. striatus* differ in being larger (about 12 to 14 inches in diameter) and are found in water at least 2 feet, frequently 3 or 4 feet deep. At the surface the nests of both species appear as circular areas of clear water with the eggs floating in the centre. Both parents tend the nest; while the male keeps a vigorous guard, aggressively protecting the spawn from intruders, the female is found in the neighbourhood.

Eggs.—Oviposition usually takes place at night; a few thousand eggs⁶ are deposited by the female in a single night. The eggs measure about 1.25 mm. in diameter and are of a pale amber colour. In size and appearance they are hardly to be distinguished from those of *O. striatus* and like the latter contain a large oil-globule and float flush with the surface of the water⁷ (figs. 17 and 18).

The rapidity of the embryonic development seems to depend on the strength of the sun. On all occasions when I obtained collections of eggs they invariably hatched during the night following, *i.e.*, on the average in 24 hours after procuring them. This corroborates the statement of fishermen that the eggs of *O. punctatus* usually hatch on the night following that on which they are laid.

¹ Day, *Fishes of India*, p. 368.

² Willey, *Spol. Zeylan.*, V, p. 149.

³ Day, *Fishes of India*, p. 368; *Fauna of Brit. India*, II, p. 365.

⁴ Day, *Freshwater Fish and Fisheries of India and Burma*, p. 28 (1873).

⁵ Willey records finding a nest in October, *Spol. Zeylan.*, VII, p. 101 (1911), and I have seen nests in the Cooum in December.

⁶ Day, *Fishes of India*, p. 318 (records finding 4702 eggs in a female in February).

⁷ Willey, *Spol. Zeylan.*, VII, p. 101.

The embryonic and larval development of this species closely resembles that of *O. striatus*,¹ but is more rapid. In fresh eggs the outline of the embryo encircling the yolk becomes evident in about 8 hours; the eyes and auditory sacs are developed in 16 hours; and the heart begins to beat and the curious yolk-sac circulation also starts soon after this (figs. 19 and 20). At the time of hatching the embryo violently twitches its tail, which is now free of the yolk-sac, and performs rotations within the egg-membrane.

On hatching the fry measure 3.25 mm. in length and are almost identical in general appearance with the first day hatchings of *O. striatus* (fig. 21). They, however, do not remain at the surface for 3 days like the latter fry but begin to descend down even at the close of the first day, though this is accomplished with considerable effort.

On the second day, the pigment cells are well developed, the eyes being quite black; the length increases to 4½ mm.; the mouth opens and respiratory movements begin; and the pectoral fins develop. The larvæ move in unison and effect their descent from the surface in a long procession, swimming slowly close to the bottom sand of the aquarium. Most of the above changes are those of the 3rd day in the development of *O. striatus*.

On the third day, the fry swim at all levels with ease. On the sides of the body the mid-lateral line is clear of pigment, but pigment is intense along the root of the dorsal and ventral portions of the median embryonic fin. During the second and third days the capillary network formed by the caudal vein in joining the subintestinal vein, and the "marvellous yolk-sac circulation" described by Dr. Willey, arise in the same way as in *O. striatus*.

On the fourth day (fig. 22), the length is 5 mm. The characteristic black and yellow colour of the fry, which distinguishes it from the brown and pink fry of *O. striatus*, now begins to appear.

It will be seen from the above observations that the larval development in this species, while it closely resembles that of *O. striatus*, goes forward more rapidly. This is true of most of the subsequent stages, such as the formation of the network of vessels at the root of the caudal fin (which happens about the eighth or ninth day instead of on the twelfth as in *O. striatus*²); the deflection of the end of the notochord, the commencement of aerial respiration, etc.

*Characteristic colour of the young*³ (fig. 22).—The characteristic larval colouration begins to appear as early as the fourth day after hatching. On the sides of the body, as noticed above, pigment is intense along the root of the dorsal and ventral por-

¹ Willey, "Nests, eggs and larvæ of *Ophiocephalus striatus*." *Spol. Zeylan.*, VI, pp. 108-118 (1909).

² Willey, *Spol. Zeylan.*, VI, p. 112 (1909).

³ Willey, *Spol. Zeylan.*, V, p. 150; VI, p. 116.

tions of the median embryonic fin, but the mid-lateral line is free of pigment and is consequently traversed by a pale longitudinal band, which later on acquires a bright golden-yellow hue. There is also a more or less uninterrupted pale longitudinal band in the mid-dorsal line of the head and fore-body.

The larval colours when fully assumed are as follows:—The body is dark olive along the back and sides, becoming slightly pale or whitish along the abdomen. This dark ground colour is resolvable into close-set longitudinal stripes along the scales, clearly seen in specimens preserved in spirit. Three longitudinal golden-yellow bands pass from the snout to the caudal fin; a mid-lateral band on each side which becomes narrow as it passes over the opercle and the upper portion of the eye to meet its fellow on the tip of the snout, and a narrow median dorsal band extending from the junction of the above two bands on the tip of the snout, along the base of the dorsal fin to the root of the caudal. These three bands are of a brilliant golden-yellow colour and stand out clearly on the dark ground colour; while the two lateral bands extend on the caudal fin to the extent of nearly one-third the length of that fin; the dorsal band, which is comparatively narrow and is more distinct in younger than in older stages, has two spindle-shaped enlargements in front of the dorsal fin (fig. 22). Thus the fry of *O. punctatus* are easily distinguished from the fry of *O. striatus* after they assume their characteristic larval colour.

In growth the dorsal median band is the first to disappear. In specimens above two inches in length the dark olive brown of the back and sides changes to a dirty brown, and a double row of ill-defined brown blotches appear on either side of the body one above the other, the blotches of the upper row alternating with those of the lower. These blotches encroach on the lateral golden bands and disfigure and destroy it in growth; the three golden bands are, however, retained for some considerable time on the head.

The parents guard the young till they reach two inches in length, *i.e.*, till they lose their larval colours. It is quite a sight to see the parents leading their brood of brightly coloured fry in bright sunlight in shallow water in fields,¹ where they usually come out to feed.

Uses.—*O. punctatus* is extensively eaten.

***Ophiocephalus gachua*, H. B.**

(Pl. xxvii, fig. 23).

Tamil—*Para koravai*.

Habitat and Habits.—This very common species is found in ponds but much more abundantly in rivers, where it often frequents brackish water within tidal influence.

¹ Willey, *Spol. Zeylan.*, V p. 149.

In habits it closely resembles *O. punctatus*. The breeding season is December and January in Madras (June and July in South Canara).¹ I have not seen the nest of this species; from the accounts of fishermen it does not appear to be among weeds but in sheltered crevices in the bank. A brood of young with the parents were brought to me on the 15th February, 1911, from the river Cooum near Chetput. The adults refused to feed and died after a few days, but the fry continued to live. In habits and appearance the fry were very different to those of the previous two species. The entire brood consisted of some 300 individuals, a comparatively small number.

Description of Fry (fig. 23).—The average length of the young was 7 mm.; traces of the yolk-sac and the continuous embryonic median fin devoid of fin-rays were present. The colour was dark brown, due to a very considerable development of pigment cells, which were arranged on the sides of the body chiefly in two horizontal rows, one dorsal and one ventral, with a more or less unpigmented area between them along the mid-lateral line. Of the two the ventral band was the more conspicuous, being very broad on the abdomen and tapering gradually into a streak posteriorly. A number of pigment spots are also found on the head; a concentration of them occurs behind each eye. Scattered spots are found on the continuous median fin.

Later on, some much older fry were brought to me from the same locality. These measured on an average 48 mm. long and had the following characteristic colour. The body was of a pale olive-brown, and the sides were crossed by ten or twelve <-shaped light bands with their apices on the lateral line pointing forwards. I have not seen the large ocellus on the dorsal fin mentioned by Day² and doubt if it ever occurs in this species. It is frequently present in the young of some larger species of *Ophiocephalus*.

Uses.—A small fish not much in demand as food.

Anabas scandens (Daldorff).

Tamil—*Panai ēri kendai* (=fish that climbs palmyra-trees).

Habitat and Habits.—"Estuaries and freshwaters"³ .most numerous in maritime provinces and the deltas of the larger rivers" observes Day.⁴ In Madras I have not seen it in estuaries or in rivers; Hamilton-Buchanan, Jerdon⁵ and Thomas⁶ record it only from ponds and ditches.

This species is the well-known "Climbing perch." Though I have never witnessed a display of the extraordinary scansorial powers attributed to it by Daldorff⁷ and John, and wholly

¹ Thomas, *Rep. Pisc. South Canara*, p. 74 (1870).

² Day, *Fishes of India*, p. 368.

³ Day, *Fishes of India*, p. 370; *Fauna of Brit. India*, II, p. 367.

⁴ Day, *l. c.*, p. 369.

⁵ *Madras Journ. Lit. Sc.*, XV, p. 144.

⁷ Daldorff, *Trans. Linn. Soc.*, III, p. 62, 1797.

⁶ *Tank Angling*, p. 99.

discredited by most subsequent writers, I have no doubt it sometimes takes place. Gill records Mr. Rengaswamy Mudaliar's and Capt. J. Mitchell's (once Superintendent, Govt. Museum, Madras) experiments which show the reliability of the early reports.¹ Mr. Wilson of the Madras Fisheries tells me that he once trained a few of these fish to climb up a nearly vertical sheet of cloth, when held over the water in the aquarium in which he kept them. The highly mobile sub-operculum and its spines are the chief organs of climbing.²

Many records exist of these fish leaving their native waters and migrating long distances on land to other ponds, and of their aestivating during the hot months.³ Day describes how they progress on land⁴ either by lying flat on one side or by keeping their erect position. The power that the fish possesses of erecting its fins, scales and opercles assists it to move on land.

The air-breathing habit of *A. scandens* is well-known, and its great tenacity of life enables it to live out of its native element, as Hamilton-Buchanan observes, even for six days.

The breeding season extends from May to July.⁵ On the 20th of May, 1915 a brood of very young fry were obtained from a pond. On the average they measured 17 mm. in length. They were of a light olive-brown colour above, becoming pale white below. On the sides there were eight (somewhat indistinct in live but quite distinct in preserved specimens) dark vertical bands extending from the pectoral to the root of the caudal fin. A dark terminal band was found at the free edge of the dorsal and anal fins. A very distinct ocellus, consisting of a black central spot surrounded by white, was present at the root of the caudal fin on either side. The iris was red.

By the 25th of July they had grown to 25 mm. in length; the anterior vertical bands were fading away, while the posterior ones were still clear; the ocellus continued to be quite distinct. A dark band was observed to pass from the corner of the mouth backwards and downwards, and another parallel to it below: the upper and lower lips were silvery.

By November the fish had attained a length of over 8 cm. and had lost all traces of the vertical bands; the ocellus, however, remained as a black round dot.

The young of *A. scandens* grow up rapidly; the fry in the marine aquarium, spoken of above, have grown to 80 mm., *i.e.*, more than four times their original length (17 mm.) in the course of six months (May to November). Dr. Willey records a much

¹ Jordan, *Guide to the Study of Fishes*, II, pp. 367 and 368.

² Jordan, *l. c.*, pp. 366—368.

³ Tennent, *Nat. Hist. Ceylon*, p. 354, 1861 (speaks of a specimen dug out from a depth of a foot and a half in the bottom mud of a dried-up tank).

⁴ Day, *Fishes of Malabar*, p. 133.

⁵ According to Day the breeding season is June and July (*Fishes of India*, p. 370). I have seen them breed in May while Willey found a female egg-laden ate in January in Ceylon. *Spol. Zeylan.*, VII, p. 92.

slower growth in the case of half a dozen young which he kept under observation at Colombo.¹

I have recently obtained two albino specimens.

Uses.—*A. scandens* is a small fish attaining a maximum length of 9 inches. It is highly esteemed as food. It bears transport well and is employed for stocking tanks.

Nandus nandus (H. B.)

(*Nandus marmoratus* of the *Fauna of British India*.)

Tamil—*Mapanji*, or *Seepu-meen* (=comb-fish).

Habitat and Habits.—A comparatively rare species which inhabits a few freshwater tanks in the interior. It is never abundant in any locality, feeds voraciously on small Cyprinidae and, as observed by Buchanan, is very tenacious of life.²

According to Thomas the breeding season is May and June and again in December and January³, when this “fish builds nests among the rushes at the margin of the water, deposits its eggs therein and keeps guard over them like a stickle-back.”⁴

Lates calcarifer (Bloch).

Tamil—*Koduwā*.

Habitat and Habits.—A common estuarine species which ascends rivers and is frequently captured in fresh water. Immature specimens are met with in the Cooum river far above tidal influence; Day records the capture of one at Mandalay in Upper Burma about 680 miles from the sea.⁵ While it is common at the mouths of rivers and in backwaters, its occurrence at sea appears to be very scarce and occasional; thus Willey records the remarkable fact that statistical reports show that this fish is never captured out at sea at Kalutara (Ceylon), where it is very common.⁶

Pertwee⁷ observes that *L. calcarifer* breeds in backwaters and lagoons generally about January and February, but the breeding season is known to vary; some spawn as late as March.

Uses.—A highly esteemed food fish which attains a large size.

Ambassis ranga (H. B.)

Tamil—*Sennel* or *Kaka Sennel*.

A. ranga appears to be very local in its distribution; while it abounds in some freshwater ponds and ditches in the vicinity of

¹ Willey, *Spol. Zeylan.*, VI, p. 120.

² Hamilton-Buchanan, *Fishes of the Ganges*, p. 97.

³ Thomas, *Rep. Pisc. South Canara*, p. 73 (1870).

⁴ Thomas, *l. c.*, p. 57.

⁵ Day, *Freshwater Fish and Fisheries Ind. and Burma*, para. XXVIII.

⁶ *Spol. Zeylan.*, VII, p. 100 (1911).

⁷ A. H. Pertwee, Notes on the Freshwater Fish of Ceylon. *Spol. Zeylan.*, VIII, p. 246.

Madras, it is entirely absent from others. "It breeds everywhere during the rains and has in some instances been found breeding as early as March."¹

Uses.—A small species which is said to be an effective mosquito-destroyer.²

***Ambassis ambassis* (Lacepede).**

(*A. commersoni* of the *Fauna of Brit. India.*)

Tamil.—*Aunē Kakachi.*

The occurrence of this species in fresh water is very rare and occasional.

***Ambassis miops*, Gunther.**

(Pl. xxviii, figs. 24, 25).

(*Ambassis myops* of the *Fauna of Brit. India.*)

A very common estuarine fish in Madras which ascends rivers when young and comes into fresh water.

Fry almost certainly of this species swarm the river Cooum in November and December, which appears to be the breeding season.

Characters of Fry.—D. 9/10. A. 10 (2/3). The fry measured from 12 to 14 mm. in length when captured. The scales were undeveloped. The body was diaphanous, of a translucent yellow colour, except the abdomen and opercles which were bright silvery; the upper two-thirds of the first dorsal fin black; a beautiful arrangement of dark stellate pigment-spots occur in clusters along the back. The shape of the body was similar to the adult (figs. 24 and 25).

***Osphromenus gourami*, Lacep.³**

(*O. olfax* of the *Fauna of Brit. India.*)

Tamil—*Sangarā.*

The gourami is a large freshwater fish of the Malay Archipelago⁴ which has been introduced into Europe, Mauritius, Cayenne, Australia (1864), Madras (1866), Ceylon (1909)⁵ and other places as a valuable food fish.

Sir William Denison⁶, when Governor of Madras, imported them from Mauritius about 1865. The fish arrived in the early part of Lord Napier's stay and were introduced into the Govt.

¹ and ² Chaudhuri and Sewell, *Ind. Fish of Proved Utility as Mosquito-Destroyers*, p. 10.

³ Tate Regan, Asiatic Fishes of the Family Anabantidae. *Proc. Zool. Soc.*, 1909, II, p. 774.

⁴ The locality China (Richardson and Day) has been omitted by most authorities such as Gunther (*Brit. Mus. Cat.*, III, p. 382); Boulenger (*Cambridge Nat. Hist., Fishes*, p. 669).

⁵ *Spol. Zeylan.*, VII, pp. 95, 96, 210 and 221.

⁶ *Rod in India*, 1881, pp. 279 and 280; *La Pisciculture et la Pêche en Chine*, 1872.

House ponds at Guindy and Madras, while a few were taken to the Nilgiris. In 1874 eight young fish are on record as having been caught in the ponds at Madras; about 1883 they must have been breeding in Madras as Gilbert ¹ mentions obtaining a supply of fry from Thomas for the Ana Sagar tank that year. Dr. Henderson informs me that a few years ago they existed in two ponds close to the Madras Museum, from one of which he once took a four-pounder. One of these tanks has since been filled up and the other is at present low and said to contain no gourami. Mr. Wilson of the Madras Fisheries, in connection with his proposal to re-introduce this fish into Madras, examined the ponds at Guindy and Madras about April 1915 ², with the result that he found only a few in the ponds at Madras and none at Guindy.

In May, 1911 I obtained from the Red Hills tank, seven miles from the city, two full-grown specimens. The larger was a female measuring 48 cm. in length and contained numerous small eggs of a bright orange colour. I am certain that the fish were breeding in the tank at the time, as later on, in July, I obtained a young one about 10 cm. in length.

The above facts prove that the introduction of the gourami into Madras is not a failure, and the fact that they have done very well and were numerous and of fair size till lately in the Govt. House ponds, combined with their character as a non-predaceous and herbivorous species, show that they are well fitted for the waters of India.

Gourami inhabit ponds and rivers and in the latter some have been found within tidal influence in brackish water ³; they however prefer stationary waters and thrive best in the shallows of large weedy ponds and lakes. In Java, according to M. Dabry de Thiersant ⁴, they thrive in ponds not more than three feet in depth; survive with difficulty at 2800 ft. elevation and die promptly at any higher altitude. Its sensitiveness to cold is further shown by the fact that in spite of the numerous attempts to introduce it into France, the fish have never been successfully acclimatized in the Republic.

The gourami though essentially a vegetarian, being fond of several araceous plants ⁵ and of water-lilies in India, is omnivorous and feeds at times on flesh, fish, insects, etc. Among themselves they are said to be pugnacious. ⁶ They are able to respire air direct and possess an accessory super-branchial organ; but, according to Gilbert, this is done only when the water is foul. ⁷ I doubt the accuracy of the latter statement. In a pond in the old Powder Factory grounds in Madras where some 200 gourami recently received from Mauritius and Java are kept under observa-

¹ *Journ. Bombay Nat. Hist. Soc.*, VIII, p. 436.

² G. O. No. 632, 10th March, 1915. Govt. Madras, Revenue Department.

³ Jordan, *Guide to the Study of Fishes*, II, p. 369. (Quotes from Gill.)

⁴ *La Pisciculture et la Pêche en Chine*, 1872.

⁵ Jordan, *l. c.*

⁶ Cantor, *Cat. Mal. Fish. Journ. As. Soc. Bengal*, XVIII, p. 1071 (1849).

⁷ *Journ. Bombay Nat. Hist. Soc.*, VIII, p. 436.

tion, they are seen to come up at all hours and take air though the water is beautifully clear.

The breeding season in Java is March¹ and in Madras about May. "The fish is assiduous in the care of its young" and constructs complex nests for the reception of its eggs. General Hardwicke² has described the interesting breeding habits of this fish in Mauritius, while Gilbert gives an account of its breeding in an aquarium.³ The nest is of a nearly spherical form composed of plants, preferably tufts of a peculiar grass (*Panicum jumentorum*) which grows on the surface of the water, and considerably resembles a bird's in form. It is usually attached to plants or weeds growing at the edge of the pond and the bottom selected is muddy while the depth varies.⁴ According to Gilbert, whose observations were on aquarium fish, the gourami assume a jet black colour and flashing red eyes during this season and become highly pugnacious. The female emits a stream of 15 to 20 eggs which (in the aquarium) adhered to the undersurface of a rock, and are aerated by the female frequently rising to the surface and bringing down a mouthful of air which she lets go against the underside of the rock. In its natural surroundings the eggs are attached to water plants.⁵ The eggs hatch in about a month.⁶ The fry on hatching are transparent and possess a yolk-sac. "When I had had them about two months" observes Gilbert "they were perfectly formed and very handsome but alas they were only two inches long at the outside."

The rate of growth appears to be rapid if conditions are favourable; "the gourami is known to attain a length of about 4 inches in the first year, 7 or 8 in the second and 10 or 11 in the third";⁷ "the young has black bands across the body and also a blackish spot at the base of the pectoral fin."⁸ In captivity they are fed on bran and oil cakes.

Uses.—The gourami is well-known and highly prized as an article of food. It attains a large size (nearly 2 feet in length) and bears transport and acclimatization well. It is one of the few fish well adapted for pisciculture.

***Macropodus cupanus* (C. and V.).⁹**

(*Polyacanthus cupanus* of the *Fauna of Brit. India.*)

Tamil—*Punnah, Panni* (Day).

Habitat and Habits.—A rare species in Madras occurring in a few small ponds in the city.

¹ Dabry de Thiersant, *La Pisciculture et la Pêche en Chine*, 1872.

² *Zool. Journ.*, IV, p. 309.

³ *Journ. Bombay Nat. Hist. Soc.*, VIII, p. 436.

⁴ Jordan, *Guide to the Study of Fishes*, II, pp. 166-167.

⁵ Dabry de Thiersant, *l. c.*

⁶ Hardwicke, *Zool. Journ.*, VI, p. 309. ⁷ Willey, *Spol. Zeylan.*, VI, p. 120.

⁸ Jordan, *Guide to the Study of Fishes*, II, p. 368.

⁹ Tate Regan, *Asiatic Fishes of the Family Anabantidae. Proc. Zool. Soc.*, 1909, II, pp. 769 and 775.

“ It lurks under stones or amongst weeds ” observes Day, but so far as I have observed, it appears to be a gregarious surface fish. In an aquarium, however, it at times settles on the bottom, when the prolonged ventral rays are stuck perpendicularly into the sand to support the forepart of the body. They are pugnacious and often fight and chase each other ; the immature fish are afraid of the adults. According to Jerdon ¹ “ it must be handled with caution, for the spines inflict a most severe burning pain which lasts a few hours.” They are air-breathers and in an aquarium they mount up to the surface every 2 or 3 minutes to take air, but unlike most other fish which respire air, the act is not usually accompanied by the escape of air-bubbles. *M. cupanus* is essentially a vegetable-feeder and in captivity eats crumbs of bread, but feeds also on insects and insect larvae. Ground-feeding is not natural to this fish, as it does so with deliberation and effort, and in an aquarium I have often seen it fail to pick up the particle of food on the bottom in spite of repeated efforts : the mouth is dorsal in position and in order to feed on the bottom it has to stand almost vertically upside down.

The breeding season has been ascertained to be May and June.² *M. cupanus* probably builds a nest like its congener *M. viridiauratus*.³

Uses.—According to Mr. Wilson it is an effective mosquito-destroyer.

***Etroplus maculatus* (Bloch).**

(Pl. xxviii, figs. 26—30).

Tamil—*Burakāsu*.

Habitat and Habits.—This pretty little fish is abundant all over Madras in ponds, ditches and rivers ; in the last many habitually live and breed within tidal influence in brackish water.

E. maculatus frequents the weedy shallows of ponds and streams and feeds for the most part on aquatic vegetation and partly on worms and insects. It is highly pugnacious in disposition and at times, as observed by Day ⁴, turns almost black with passion. “ This species does not live long after its removal from water ” observes Day ⁵ ; but on the contrary its tenacity of life has frequently surprised me. It is one of the few fish that is occasionally brought to the market alive ; out of water it sometimes makes, at regular intervals, a peculiar ticking noise by the sudden closing and opening of its mouth.

The spawning season extends from January to April : most fish breed during February and March. The only account of the nidification was published in 1848 by Jerdon in his paper “ On the

¹ Day, *Fishes of India*, p. 371.

² Thomas, *Rep. Pisc. South Canara*, p. 72.

³ Gill, Parental care among F. W. Fishes. *Ann. Rep. Smith. Inst.* 1905, p. 529.

⁴ and ⁵ *Fishes of India*, p. 415.

Freshwater Fishes of South India'' in the *Madras Jour. of Lit. and Science*, Vol. XV, p. 143. He observes that

"At the season of spawning the fish (both male and female I believe though I am not quite certain of this) assumes a brighter livery than at other times; the yellow of its lower surface deepens, and the one dark spot on its side is accompanied by several others so much so as to give it a marbled appearance, which however is somewhat transient. The eggs are not very numerous, and are deposited in the mud at the bottom of the stream, and when hatched, both parents guard their young for many days, vigorously attacking any large fish that pass near them. I have had an opportunity of observing this, as well among fish in confinement as in the streams."

The colours are very variable, but usually become very vivid and bright during the breeding season. The whole fish becomes orange, especially the ventral half of the body, the ventral fins turn jet black, and a broad terminal band of the same colour extends along the margin of the anal covering nearly $\frac{3}{4}$ ths of that fin. The eyes are red, and shining metallic blue lines appear below them and on the opercles.

During the breeding season the fish are found in pairs and several pairs build their nests close together in the same locality. Early in February, 1910 I had the opportunity of observing several such nests in an inundated paddy-field in Puruswakam, Madras. They contained eggs and fry in various stages of development, with the parents guarding them. The nest is a shallow cup-shaped pit, roughly an inch deep at the centre and about 3 to 4 inches in diameter, scooped in the bottom debris and lined with the silky fibres of the common freshwater alga (*Spirogyra*).¹ All the nests were in very shallow water, the depth varying from 4 to 9 inches. The eggs are not very numerous (in a nest recently obtained there were 266) and are demersal and adhesive in character. They are oval, about $1\frac{1}{2}$ by 1 mm. each, and of a dark brown colour. They were deposited in the centre of the nest and each egg was found adhering to a plant-fibre, being attached at one end by a short thick stalk. The yolk is dark brown and contains a large oil globule (fig. 26). I have not been able to ascertain the interval between oviposition and hatching. The eggs hatch by the top of the egg-membrane lifting off like a lid. The shallow water which becomes tepid during the day no doubt helps to develop the eggs. The parents keep a vigorous guard and every now and then the male or female is seen to stoop over the nest and scrutinise the eggs.

Description of fry.—A few eggs obtained from one of the above nests hatched in the aquarium. On the first day the fry measure $4\frac{1}{2}$ mm. in length (fig. 27), the eyes are pigmentless, the yolk-sac is large, the median fins are continuous and there is no trace of the paired fins. The larvae rest on the bottom with the ventral surface uppermost. There are two cement organs on the head, one above the other, by which they adhere to the bottom debris. Once

¹ Recently in South Arcot I saw a nest which was a mere pit in the sand and the eggs were attached to a submerged rock.

the larvae are hatched they are restless; an incessant vibration of their bodies continues day and night.

On the second day the length increases to 5 mm. (fig. 28), pigment appears in the eyes and in the form of stellate cells on the yolk-sac, the pectoral fins appear as buds. The habits are the same as on the first day.

In a few days the mouth and anus are formed, the fry assume their normal position, *i.e.* have their backs directed upwards, and the yolk-sac is considerably reduced.

In a fortnight the yolk-sac becomes completely absorbed, only two clusters of pigment spots are now seen, one on the head and the other on the nape: the embryonic median fin still persists, and the fry still adhere to the bottom and oscillate their bodies (fig. 29).

So long as the fry keep to the nest the parents guard it and, in the natural surroundings, I have noticed that one of them, the female probably, is engaged in the task of what appears to be feeding the fry. She is seen constantly to go to a selected spot in the neighbourhood, usually only a few feet from the nest, and there dig with her mouth at the root of an aquatic plant and bring up a mouthful of dark sediment which she ejects into the nest. If the nest is attacked she leaves her task and joins the male in defence.

As soon as the young are able to swim freely the parents and their brood desert the nest and a life of wandering in quest of food commences. In such rambles, the mother occupies generally the centre of the family group and the male takes charge of the circumference. When thus engaged the adults are highly pugnacious and vigorously attack any large fish that pass near them: on one occasion I saw an adult *O. punctatus* chased for several yards by one of these fish.

As the body of the adult is much compressed and elevated, there is a curious disproportion at various stages of growth in the relative length and height of the body, as will be seen from the table below:—

Length	9—12	—16	—18	—19—30 mm.
Height	3—4½	—4½	—7½	—8—14 mm.

In a specimen 9 mm. long the back is green or olive, a well-marked white band is found across the nape and the body is elongated (fig. 30). In young 19 mm. long there is a considerable increase in height so that the body is oval in shape, the back is olive and has 6 broad transverse bands descending half way on the sides and the ventral surface is dirty white. In the adult fish these bands disappear and the lower ends of 3 of them alone are retained as the characteristic 3 spots on either side of the body. When the young are about an inch long they are abandoned by the parents.

***Etroplus suratensis* (Bloch).**

Tamil—*Pani shettai*, *Setha kendai*.

Habitat and Habits.—Fairly common in fresh and brackish water, both in ponds and rivers. Salinity does not appear to affect this fish, while it lives and breeds in the Red Hills in absolute fresh water. I have obtained adult fish on at least two different occasions from the sea opposite the mouth of the river Adyar. In the Madras marine aquarium specimens captured in the backwater live in sea water with marine fish. Saltwater specimens are much more vividly coloured than freshwater ones.

"*Etropus* greatly affect the shallows of a tank or river and congregate near rocks and stones, and if there are wooden palings going into the water, they are often to be found round about them, probably for the sake of the moss and weeds."¹

It is essentially a vegetable-feeder but takes worms and insects also, and according to Thomas ejects the cuticle. It is said to be a very powerful fish for its size, but very sluggish.

"On hot days the *Etroplus* may be seen basking in large shoals on the surface. They take best from about five o'clock until dusk; the larger fish especially seem very particular as to the time of day they feed."²

Day's statement that this fish buries itself in the mud³ has not been confirmed by other observers. Recently, while engaged in stocking operations when hundreds of *E. suratensis* had to be captured, I have observed that it has the peculiar habit of lying flat on the bottom of ponds and rivers to escape drag nets. It occurs almost entirely in the maritime districts and hence is probably unsuitable for stocking waters far inland; the experiment however is being made by the Madras Fisheries.

The only published account of the breeding habits is that of Dr. Willey,⁴ who describes the nest, eggs and young of this species in his preliminary account of the Inland Fisheries of Ceylon, (Reports of 1908 and 1909); from which the following extracts are taken:—

The breeding habits are very similar to those of *E. maculatus*.

"The eggs . . . are attached to the lower surfaces of stones and logs and are watched over by the male. On May 21, 1909, a Koraliya (*E. suratensis*) nest was found . . . I went there about 11-30 A.M. and saw the adults, both male and female keeping guard. When the man who was with me advanced his hand to the small stone projecting from the bank of the canal under which the eggs were attached, the smaller, male, . . . approached and pecked at the man's fingers. The large, female, kept a little in the background in deeper water. . . . The eggs were attached contiguously in a single layer on the underside of the stone, which was partially imbedded in the earth at the base of the bank of the canal. Some of the eggs were white, indicating failure and death. The living eggs were in an advanced stage of development, the embryo being formed and the yolk pigmented. The yolk is yellow opaque, and

¹ Thomas, *Tank Angling*, p. 91 (quotes from "*Fleur de Lys*").

² Thomas, *l. c.*, p. 92.

³ Day, *Fishes of Malabar*, p. 162; *Fishes of India*, p. 416.

⁴ Notes on the Freshwater Fisheries of Ceylon. *Spol. Zeylan.*, VII, p. 102 (1911).

darkly pigmented, but no pigment was present in the eye. The circulation of the blood is active, and the embryo can change its position within the egg membrane.

The surface of the egg appeared minutely rugulose. The length of the egg, without the short stalk, is 2 mm., the width 1 mm., slightly narrower at the free end. Within 24 hours after finding the nest one of the eggs hatched out, the top of the egg membrane lifting up like a lid; there is still no pigment in the eyes, and no mouth; length 5 mm. On the second day after hatching pigment begins to appear in the eyes, and on the third day, when the larva is 6 mm. long, the mouth opens and respiratory movements commence; foreign particles were noted adhering to what looked like a cement organ at the front of the head. The eggs of *Koraliya* are very difficult to rear when removed from their proper habitat. On May 23, and again on June 1, more eggs were found attached to cocoanut husks, branches, and stones at Hunupitiya, Colombo. . . . On October 28, 1909, another series of *Koraliya* eggs containing formed embryos was found . . . attached to the outer surface of a short length of water-logged bamboo stem. This species is therefore a perennial spawner."

According to Thomas ¹ *E. suratensis* breeds twice in the year in S. Canara, in May and June and again in December and January. In Madras the specimens in the Red Hills tank build their nests in the open canal in which water is brought to the city, during April and May.

Of the later changes which the fry undergo in growth nothing is known, except that "very young fish have a large black ocellus surrounded by a white margin extending from the fourth to the tenth soft ray of the dorsal fin." ²

Uses.—*E. suratensis* attains a large size, more than a foot in length, and is a highly esteemed food fish. Its non-predaceous and vegetarian habits make it a very suitable fish for stocking tanks.

Eleotris fusca (Bl. and Schn.).

Tamil—*Mussoorie* (Day), in Madras *Kul Uluvay*.

Habitat and Habits.—*E. fusca* is common in fresh and brackish waters, occurring in ponds, ditches, rivers, and more abundantly in the backwater.

It is apparently nocturnal in habits. During the day it is very slow in its movements, "concealing under stones and among weeds, and remaining for hours motionless." ³ In an aquarium it becomes very active by night and frequently jumps out of the vessel if uncovered; and as Jerdon has observed "it is very fond of fixing itself vertically to the side of a tub or vase (in which it may be confined) with its head downwards." Experiments with a specimen in confinement tend to show that the sense of sight in this species is very poor, at least by day. It is said that black fish appear pale white in colour at night; and according to Jerdon "it has the faculty of changing its colour, at times becoming nearly black, at other times marbled; and usually with a strong line of demarcation between the tint of the back and sides." It is tenacious of life and lives a fairly long time out of water. It is carnivorous and a bottom-feeder.

¹ *Rep. Pisc. S. Canara*, p. 73 (1870). ² Day, *Fishes of Malabar*, p. 162.
³ Jerdon, *Madras Journ. Lit. Sci.*, XV, p. 149.

E. fusca breeds during the cold weather in Madras, but in S. Canara, as ascertained by Thomas¹, in June and July and again in January and February. I have not seen young below 2 cm. in length, and when of that size they are easily distinguished from other young fish by their distinctive colour. A broad black lateral band, very conspicuous and sharply distinguished from the pale colour of the back and abdomen, extends from the snout to the caudal fin, while the summit of the head and the portions of the body above and below this band is pale gray. The younger the specimens the more sharply contrasted are the two colours.

Gobius (Acentrogobius) neilli, Day.

This small species abounds in shallow pools in the bed of the Cooum and Adyar rivers both in fresh and brackish water. Though essentially a backwater fish, I have kept it living for months in fresh water.

It is a bottom-feeder with limited powers of swimming; when resting on the bottom it spreads out its ventral sucker as a support and by means of this organ often adheres to stones and in the aquarium to the glass, and climbs aquatic weeds on the leaves of which it frequently rests. In its natural surroundings it delights to bask in the sun, coming up close to the margin of the water, receding at the least sign of danger and raising a cloud of mud under cover of which it escapes.

G. neilli seems to be a perennial spawner as I have seen young ones throughout the year, but it is specially prolific about March and April. It is evidently monogamous and during the breeding season each pair inhabit a horizontal burrow excavated in the mud.

Gobius (Acentrogobius) acutipinnis, C. and V.

Tamil—*Nation pulowe* (C. and V.).

Cuvier and Valenciennes describe this species under the two names *G. acutipinnis* (from Malabar) and *G. setosus* (from Pondicherry); the chief differences between the two being:—(1) the length of the head is 6 in the total length in the former while it is only 5 in the latter; (2) spots and blotches occur on the body of the former whereas they are absent in the latter. There is no constant difference in the relative lengths of the head between the blotched and unblotched forms, and the difference in colour between the two forms appears to be due to the difference in sex; the males, having their bodies spotted and blotched, represent *G. acutipinnis* and the females, being destitute of such spots, correspond to *G. setosus*.

Habitat and Habits.—Not uncommon in pools within tidal influence, in the Adyar and Cooum rivers where the bottom is muddy; occasionally ascending into fresh water higher up.

¹ *Rep. Pisc. S. Canara*, p. 73.

Like most of its congeners *G. acutipinnis* is a bottom-feeder with limited powers of swimming. It habitually inhabits horizontal burrows, which it excavates in the soft mud full of organic debris. These tunnels, which are nearly straight, measure on an average 4 inches in length and half an inch in diameter and are provided with two orifices, one at each end, hidden under some aquatic plant. A pair inhabit a burrow. The two entrances are a repetition of the usual device employed by shallow-water forms; if danger threatens at one end, the fish escape by the other, causing a cloud of mud which effectually hides the animal and its burrow. *G. acutipinnis* breeds about February when the females contain ova.

Gobius (Glossogobius) giuris,¹ H. B.

(Pl. xxviii, fig. 31; pl. xxix, figs. 32—36).

Tamil—*Uluway* or *Nallatanni uluway*.

The term *uluway* appears to have been derived from a Tamil word which means to plough, and is appropriate to a fish which is a bottom-feeder and a burrower.

Habitat and Habits.—One of the most common and best known freshwater fish of Madras, occurring everywhere in ponds, ditches and rivers, in abundance. While the typical *G. giuris* is an exclusively freshwater form, the variety *kokiuis* is confined to backwaters and the sea.

In habits *G. giuris* closely resembles other gobies. It is voracious and lives for a considerable time out of water, dying with its opercles dilated. The colour of this fish is well adapted to its muddy surroundings.

The breeding season extends from October to December in Madras, while it is said to be May to July in Ceylon.² The fish deposit their eggs as a rule in shallow water, in crevices and burrows, usually not of their own construction. The nests have been found under submerged rocks and tiles, in demersed pieces of iron piping, bamboo and cocoanut shells, and more frequently in the deserted burrows of such aquatic animals as crabs (*Paratelphusa* sp.).

The eggs are very numerous and of a pale greenish-yellow colour and are attached in contiguous clusters (fig. 31) to the roof of the burrow. The egg-membrane is in the form of an elongated tube 3 to 6 mm. long and about $\frac{1}{4}$ to $\frac{1}{2}$ mm. in diameter and holds the egg at the slightly swollen distal free end. It is attached at the other end by means of a short stalk to a shapeless basal stolon which adheres to the substratum (fig. 32). The parent remains on guard in the burrow and by the movements of its pectoral fins promotes the aëration of the eggs.

In the early stages of development the embryo faces the attached end, with its tail coiled up in a spiral behind (figs. 33 and

¹ Max Weber, *Die Fische der Siboga-Expedition*, p. 468 (1915).

² Willey, *Spol. Zeylan.*, VII, pp. 102-103.

34); but when the tail is detached from the yolk-sac the embryo changes its orientation by the agitation of its tail (fig. 35). The fry on hatching (fig. 36) measure about 2.25 mm. long and are not quite so helpless as the larvae of *Ophiocephalus*, *Etroplus*, etc., but are able to feed and swim. The parents do not appear to guard them after hatching. The eggs and fry of this species are very difficult to rear when removed from their natural surroundings.

Uses.—*G. giuris* grows to a foot and a half in length and fetches a high price in the local market when large.

Gobius (*Oxyurichthys*)¹ *striatus* (Day).

(Pl. xxix, figs. 37, 38).

Tamil—*Kundalam*.

Habitat and Habits.—Not uncommon in ponds, rivers and in the backwater.

It is a sluggish fish, chiefly nocturnal in habits, and frequents sandy shallows, where it is fond of lying half buried during the day time. Its movements are for the most part confined to the bottom, but it swims occasionally in a feeble clumsy manner, swaying and rolling irregularly.

This species breeds from October to November. Mr. Wilson of the Madras Fisheries obtained a nest of this fish with eggs in an advanced condition. Figs. 37 and 38 are copies of his figures reproduced by kind permission. The eggs closely resemble those of *G. giuris* and like them are attached to the under surface of demersed stones, tiles, etc., by means of a gelatinous stolon.

***Rhyncobdella aculeata* (Bloch).**

Tamil—*Ārāl*.

Fairly common in fresh and brackish water.

In an aquarium *R. aculeata* habitually conceals itself by day in the bottom sand or mud, with just the snout and at times the whole head projecting above the sand for respiration; even this is withdrawn at the least disturbance. At night however it emerges to feed. The pointed snout, the weak sight, the conical head, the absence of the ventral and the poorly developed pectoral fins are obvious adaptations to the burrowing habits of this fish. The dorsal spines are organs of defence, while the trilobed proboscis is evidently an organ of touch. The fish lives a long time out of water, and is known to withstand periods of drought by burrowing in the bottom mud of ponds and streams.² “It becomes drowned in water if unable to reach the surface, as it apparently requires to respire air directly.”³

Uses.—It is moderately esteemed as food.

¹ Max Weber, *Die Fische der Siboga-Expedition*, p. 475.

² Day, *Freshwater Fishes and Fisheries of India and Burma*, p. 28 (1873).

³ *Fauna of Brit. India, Fishes*, II, p. 332.

Mastacembelus pancalus (H. B.).

Tamil—*Pil Ārāl*.

Colour.—In Madras examples the vertical stripes are as a rule absent in adults and the pectoral fins are unspotted.

Habitat and Habits.—*M. pancalus* abounds in tanks all over Madras and in the Cooum, usually above tidal influence. Day is obviously in error in stating "I have taken this species in the Ganges but have not seen it in the Coromandel coast south of the Kistna", as the fish is too common on the Madras coast to escape notice. Its habits are those of the genus. It is a much smaller species than *M. armatus*, and in its natural haunts it frequents the soft loose mud close to the margin of the water. One of the easiest ways to capture this fish is to draw ashore a portion of the weeds growing in the water and to search for it in the loose mud that is thus brought ashore.

M. pancalus breeds during the cold weather. Early in February I obtained the young of this fish in a shallow pool in the Spur tank, Egmore; they measured on an average 30 mm. in length.

Description of the immature fish. D. 24/31. A. 3/35.

Shape of body same as that of the adult.

Colour.—Pale olive along the back and sides, whitish beneath, iris red. A dark band from the tip of the proboscis to the eye and extending behind that organ over the opercles. About 31 dark transverse stripes at regular intervals on the sides of the body from behind the opercles to the root of the caudal fin. The spinous portion of the dorsal fin is placed in a yellowish groove on the back.

Uses.—A small species attaining a maximum length of seven inches and of no market value.

Mastacembelus armatus (Lacep.).

Tamil—*Kal Ārāl*.

Though it is said to occur in brackish water elsewhere in India¹, in Madras it is not known to frequent estuaries or rivers within tidal influence. *M. armatus* appears to prefer stationary to running water, and is fairly common in large tanks, where it is said to affect the neighbourhood of demersed rocks and stones. Early in February, 1910 I found mature ova in a female.

Uses.—This species attains a much larger size than *R. aculeata* which it resembles, and is highly esteemed as food.

¹ Day, *Fauna of Brit. India, Fishes*, II, p. 334.

APPENDIX.

REMARKS ON THE GENUS *HAPLOCHILUS*.

Tate Regan¹ has recently suggested a division of the genus *Haplochilus* into two genera, viz. the genus *Haplochilus* proper, represented in India by the single species *melanostigma*, and the genus *Panchax*, to include the remaining species *panchax*, *lineatum*, *rubrostigma*, *dayi* and *parvus*. He has stated the differences as follows :—

“ In the one (*Panchax*) the praemaxillaries are flattish and somewhat produced, protractile, the cleft of the mouth is rather wide, horizontal, almost semi-circular, the teeth are in bands, with an outer and a more or less distinct inner series of enlarged teeth, vomerine teeth and pseudobranchiae are present, the gill-membranes are not united, and the pectoral fins are placed low. In the other (*Haplochilus*) the mouth is small, transverse, not protractile, with the teeth in a single series, sometimes followed by a second series of minute teeth; there are no vomerine teeth or pseudobranchiae, the gill-membranes are broadly united, and the pectoral fins are placed high.”

This division of the old genus *Haplochilus* has not been generally adopted in India and further research was desired on the subject.² At the instance of Dr. Annandale I have recently examined all the Indian species save *H. rubrostigma* and *H. dayi*³ of Ceylon, with special reference to the differences between the two proposed genera, with the result that I accept Tate Regan's division of the genus but modify some of the differences he has pointed out between the two. In addition I have stated other differences, notably in the structure of the scales and in the habits of the two genera.

The praemaxilla.—The shape of this bone differs considerably in the two genera (pl. xxv, figs. 3, 4 and 5). In *Panchax*, towards the mid-dorsal line of the body where the two premaxillae meet, each gives off posteriorly a flat triangular process of considerable length; the rest of the bone is narrow, elongate and bent backwards and downwards, tapering to a spine at the extreme corner of the mouth. In *Haplochilus* the triangular process is feebly represented by a rounded extension, the rest of the bone is short and of uniform breadth, ending in two or more coarse teeth in the corner of the mouth, according to the sex.

The mouth.—The cleft of the mouth in *Panchax* is wide but in *Haplochilus* it is small: beyond this there is very little to be said by way of a difference. If it is semicircular in *Panchax*, in *Haplochilus melanostigma* too it is so to a slight degree, and as to its being horizontal in *Panchax* and transverse in *Haplochilus* the distinction to a large extent depends on the proportionate lengths

¹ Tate Regan, *Ann. Mag. Nat. Hist.* (8), VII, p. 324.

² Sewell and Chaudhuri, *Ind. Fish of Proved Utility as Mosquito Destroyers*, p. 2.

³ Steindachner, *Denkschriften der kais. Akad. Wien*, LIX, pp. 376-377 (1892).

of the two jaws. In *lineatum* the upper jaw is longer, in *panchax* the two jaws are equal, in *parvus* the lower jaw is distinctly longer and the direction of the mouth-cleft in the normal unprotruded condition is very similar to that in *melanostigma* (pl. xxv, figs. 1 and 2).

The upper jaw is protractile in *Panchax* and in the normal unprotruded condition a deep transverse fold is formed across the snout (pl. xxv, fig. 2). In *Haplochilus* the upper jaw is not protractile and there is no fold.

Teeth.—Tate Regan lays special emphasis on the difference in teeth, which he believes are present in a band in *Panchax*, while they occur in a single series sometimes followed by a second series of minute teeth in *Haplochilus*. A microscopical examination of the isolated praemaxilla and mandible of *H. melanostigma* reveals the presence of a band of teeth hardly distinguishable from that in species of *Panchax* (pl. xxv, figs. 3 and 4).

Vomerine teeth (pl. xxv, figs. 6, 7 and 8).—These are invariably present in all the known Indian species of *Panchax*, in *lineatum* as a narrow band composed of three or four rows of teeth, in *panchax* in a single or occasionally double row; in *parvus* about three vestigial teeth are borne by the vomers at their extreme anterior end, and in *rubrostigma* and *dayi* also they are said to occur. It is quite likely that all species of *Panchax* possess these teeth in various degrees of development. While they are present as a prominent band in *lineatum*, the presence of the three teeth in *parvus* can only be detected by a microscopical examination of the vomer. At least so far as Indian species are concerned, their presence or absence constitutes a safe criterion of classification.

The *pseudobranchiae* are glandular, richly supplied with blood during life, and covered by a highly pigmented mucous membrane. They are present in all the three species of *panchax* examined and probably in *rubrostigma* and *dayi*, while they are absent in *H. melanostigma*.

Gill-membranes.—These are broadly united with one another in *H. melanostigma*, while they are not united, but cleft to the chin in *lineatum*, *panchax*, *parvus* and probably in the other two Indian species of *Panchax*.

Position of pectoral fins.—In *melanostigma* these are placed high, *i.e.* nearer the mid-dorsal line of the body than the mid-ventral, whereas in species of *Panchax* they are placed low (pl. xxv, figs. 1 and 2).

Scales.—In *melanostigma* the scales possess only concentric (circular) striations, but in the three species examined and probably in all other species of *Panchax* radiating striae (basal radii) are present in addition to the concentric rings in the imbedded part of the scale (pl. xxv, figs. 9 and 10).

Vertebrae.—Their number in the various species are as follows: in *melanostigma* 29, in *lineatum* 32, in *panchax* 29, in *parvus* 26. Tate Regan seems to have supposed that the number 29 in the species *panchax* obtains in all the species of the genus *Panchax*.

Breeding Habits.—There is a wide difference between the Indian representatives of the two genera in spawning habits. *H. melanostigma* as stated above has the remarkable habit of carrying the extruded cluster of eggs suspended from a cord attached to the genital opening of the female, probably till they are hatched. Species of *Panchax* however show no such parental care, and according to the only observer Thomas,¹ who has recorded oviposition in this genus, *Panchax (parvus?)* extrudes a single egg at a time which is soon deposited. The eggs of both genera, however, are adhesive and demersal and are very similar in structure.

In addition there are a number of minor differences which separate *H. melanostigma* from species of *Panchax*. From all this it is clear that Tate Regan's division of the genus *Haplochilus* of Günther and Day is amply justified and quite natural and necessary. The diagnostic characters of the two genera and a key to the Indian species may be drawn up as follows:—

Genus *Panchax*.

Praemaxillae flat, elongate and protractile, a deep transverse fold on the snout, mouth wide, vomerine teeth and pseudobranchiæ present, gill-membranes not united, pectoral fins placed low, and scales with concentric and radiating striæ.

- | | | | |
|---|-----|-----|----------------------|
| A. With a prolonged ventral ray— | | | |
| Spotted with red | ... | ... | <i>rubrostigma</i> . |
| Body with vertical dark bands or blotches— | | | |
| 32 to 34 scales on L. line | ... | ... | <i>lineatum</i> . |
| 29 to 30 scales on L. line | ... | ... | <i>dayi</i> . |
| B. No prolonged ventral ray— | | | |
| Numerous vomerine teeth; greenish or olive in colour; size large (3" to 3½") | | | |
| | ... | ... | <i>panchax</i> . |
| 3 vomerine teeth; body greenish, with peacock-blue and sometimes Italian pink dots; size small (1½" to 1¾") | | | |
| | ... | ... | <i>parvus</i> . |

Genus *Haplochilus*.

Mouth small, not protractile, no fold on the snout, neither vomerine teeth nor pseudobranchiæ present, gill-membranes broadly united, pectoral fins placed high, and scales with concentric striations only. A single species, *H. melanostigma*.

I have classed *P. dayi* as a distinct species from *P. lineatum*, only provisionally, as it is very likely that further research will prove them to be conspecific. Steindachner in his description distinguishes *dayi* from *lineatum* by the intense sexual dimorphism of the former, the most conspicuous differences between the sexes in *dayi* consisting chiefly in the dark vertical bands of the female and in the elongation of the anal rays of the male. From an examination of a large collection of *P. lineatum* from Coorg and Cochin, I venture to state that the above-mentioned sexual dimorphism is exhibited by this species also, though Day fails to record it.²

¹ Thomas, *Tank Angling*, p. 112 (1887).

² In his *Fishes of Malabar*, p. 222, Day states that the colours vary according to the sex and that the vertical black stripes are absent in some specimens.

Apart from sexual dimorphism no salient anatomical feature has been stated in the description of *P. dayi* save the reduced number of scales on the lateral line mentioned in the above key to the species.

History.—McClelland in 1839 founded the genus *Aplocheilus*, in which he included the two Indian species *melanostigma* and *panchax*. In 1846 Valenciennes made *Panchax* a generic name and included under it the species *panchax* and *lineatum*. Later Bleeker distinguished the two genera, restricting the genus *Panchax* to those species possessing vomerine teeth and the genus *Aplocheilus* to those destitute of them. Günther protested against this differentiation and included all the known species under the genus *Haplochilus*, on the ground that "the vomerine teeth of *panchax* are minute and rudimental, not offering a character on which a genus may be founded. In one out of three specimens they are entirely absent." Day stated that the latter statement was not true of his numerous specimens. No such variation is shown by the species I have examined. Tate Regan in the paper cited above remarks that vomerine teeth are not invariably present in *Panchax*, probably on the authority of Günther. At least so far as Indian species are concerned, vomerine teeth are always present.



EXPLANATION OF PLATE XXV

Structural differences between the genera *Haplochilus* and
Panchax.

FIGS. 1 and 2.—Heads of *Haplochilus melanostigma*, McClelland
and *Panchax parvus*, sp. nov., showing the position of
the mouth and pectoral fin. Note the fold over the
snout of the latter.

FIG. 3.—Right premaxilla of a female *H. melanostigma*, McClelland.

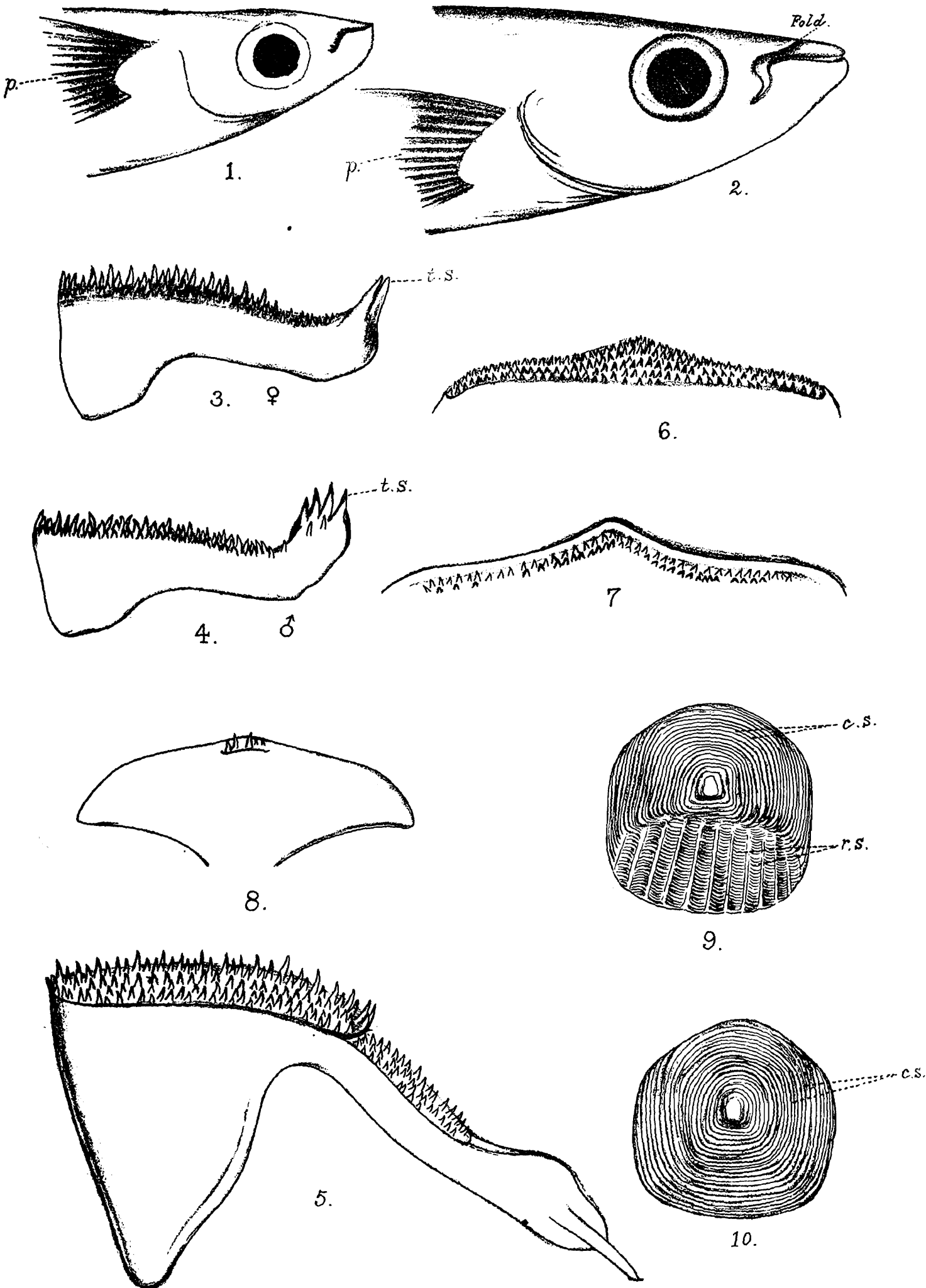
„ 4.— „ „ „ male „ „

„ 5.— „ „ of *Panchax lineatum*, C.V.

FIGS. 6, 7 and 8.—Vomerine teeth of *Panchax lineatum*, C.V., *P.*
panchax (H. B.) and *P. parvus*, sp. nov.

„ 9 and 10.—Scales of *Panchax panchax* (H. B.) and *Haplo-*
chilus melanostigma, McClelland.

C. S. = circular striations ; P. = pectoral fin ; R.S. = radiating striations ;
T.S. = *terminal spines* ("teeth").



B. Sundara Raj, del.

A. Chowdhary, lith.

EXPLANATION OF PLATE XXVI.

FIG. 11.—Ovum of *Panchax parvus*, sp. nov.

Haplochilus melanostigma, McClelland.

FIG. 12.—A cluster of eggs with their long filaments twisted together.

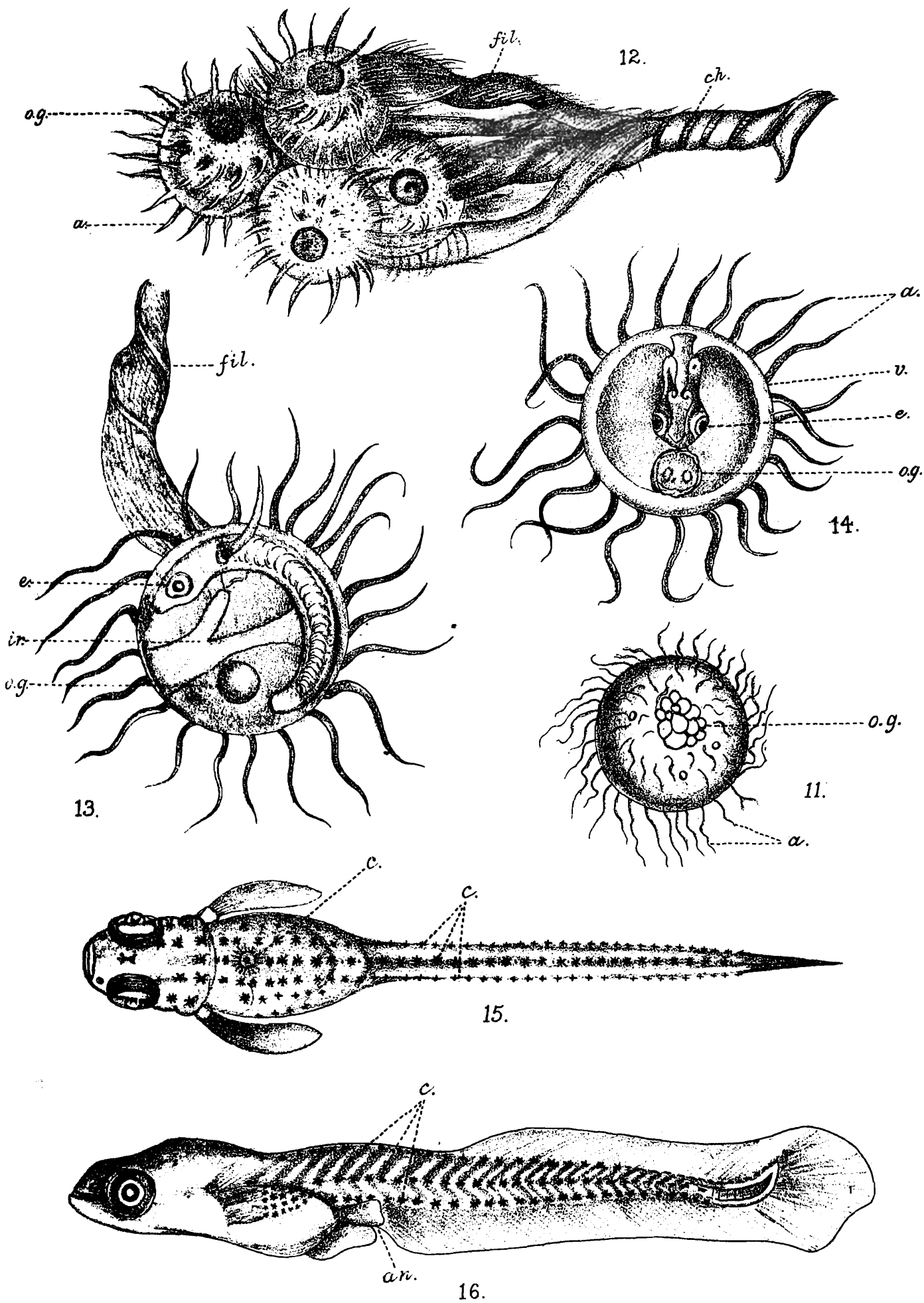
„ 13.—Lateral view of embryo inside the egg-membrane.

„ 14.—Dorsal view of embryo inside the egg-membrane.

„ 15.—Larva just hatched from the egg (dorsal view).

„ 16.— „ „ „ „ (lateral view).

A. = adhesive threads; An. = anus; C. = pigment cells (chromatophores); Ch. = cord formed by twisted filaments from eggs; Cir. = circulation in the yolk-sac; E. = eye; Fil. = filaments; O. G. = oil globule; V. = egg-membrane.



B. Sundara Raj, del.

A. Chowdhary, lith.

EXPLANATION OF PLATE XXVII.

Ophiocephalus punctatus, Bloch.

FIG. 17.—Egg floating in water.

„ 18.—Enlarged view of an egg.

„ 19.—Lateral view of embryo inside the egg-membrane.

„ 20.—Dorsal view of embryo inside the egg-membrane.

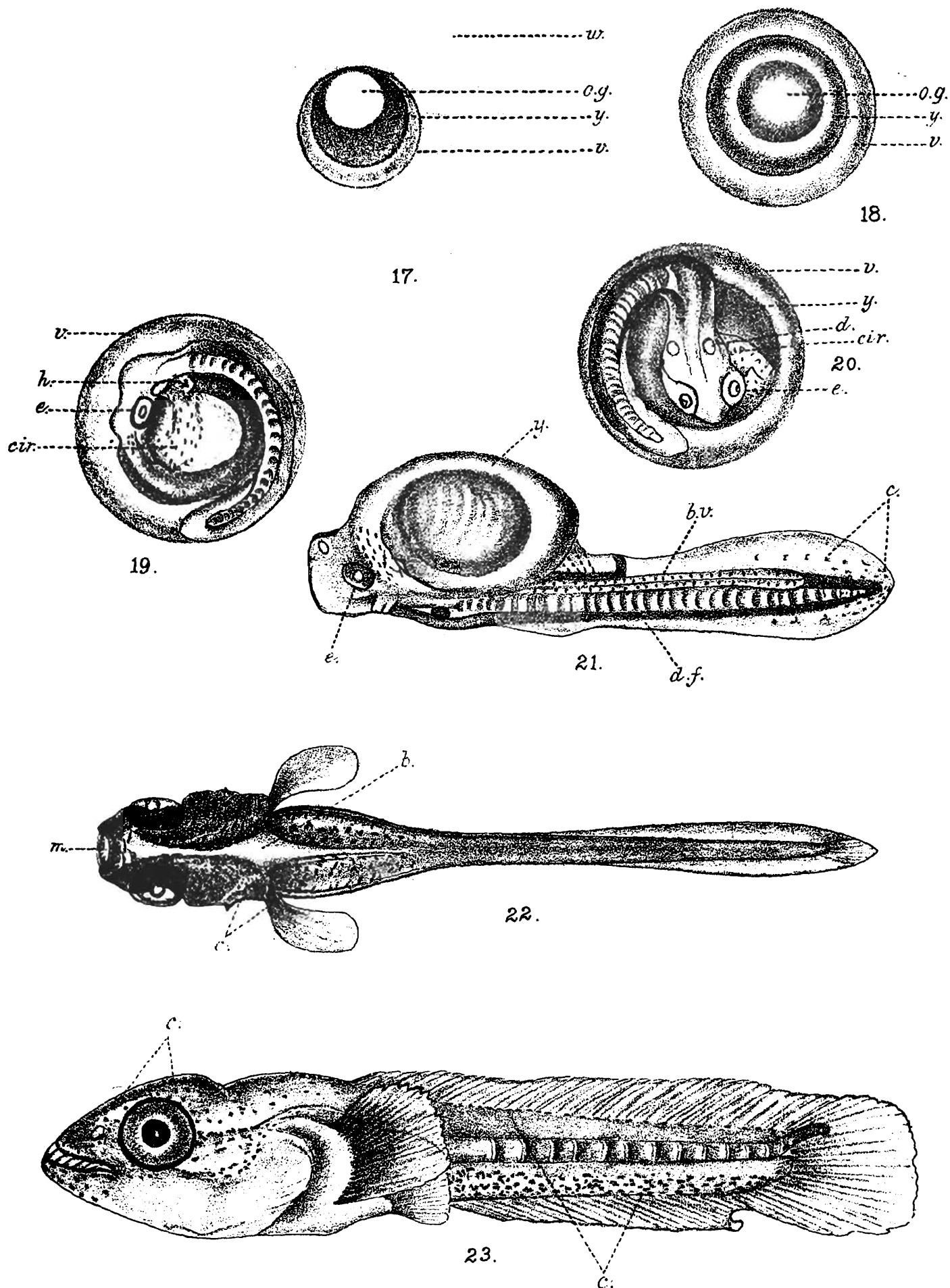
„ 21.—Larva just hatched from the egg.

„ 22.—Larva 5 mm. long. Note the first appearance of the mid-dorsal streak (*b*) with its two spindle-shaped enlargements.

Ophiocephalus gachua, H. B.

FIG. 23.—Larva 7 mm. long.

B. = mid-dorsal band; B. V. = blood vessel; C. = chromatophores; Cir. = circulation in the yolk-sac; D. = ear; D. F. = dorsal fin; E. = eye; H. = heart; O.G. = oil globule; V. = egg-membrane; W. = water; Y. = yolk.



EXPLANATION OF PLATE XXVIII.

Ambassis (miops?), Gunther.

FIG. 24.—Lateral view of a young fish.

„ 25.—Dorsal view of the same.

Etroplus maculatus (Bloch).

FIG. 26.—Egg attached to a plant filament.

„ 27.—Larva just hatched from the egg, $4\frac{1}{2}$ mm. long.

„ 28.—Larva on the second day, 5 mm. long.

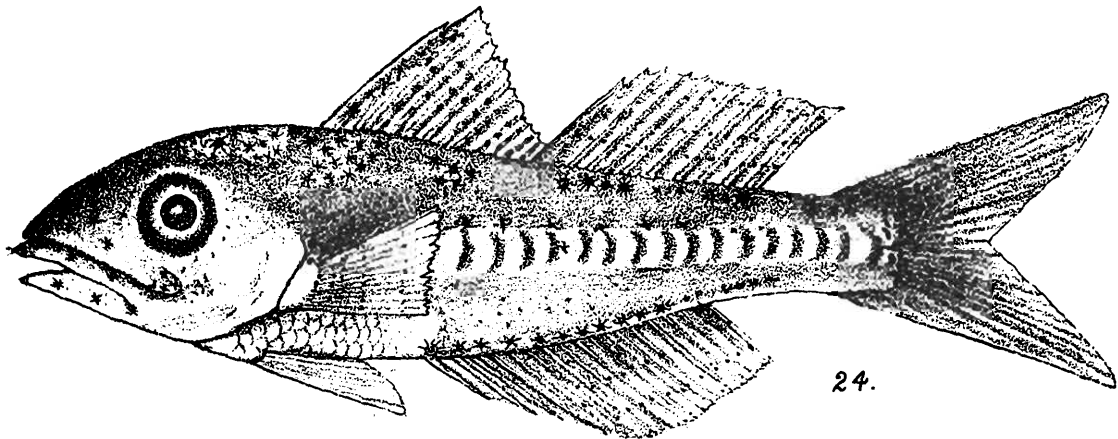
„ 29.—Larva a fortnight old.

„ 30.—Young fish 9 mm. long.

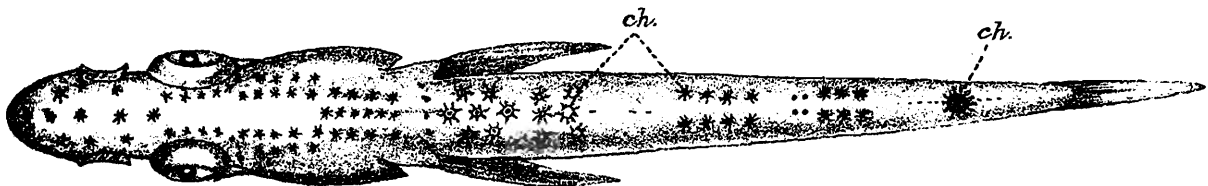
Gobius (Glossogobius) giuris, H. B.

FIG. 31.—Two clusters of eggs attached to the root of a plant.

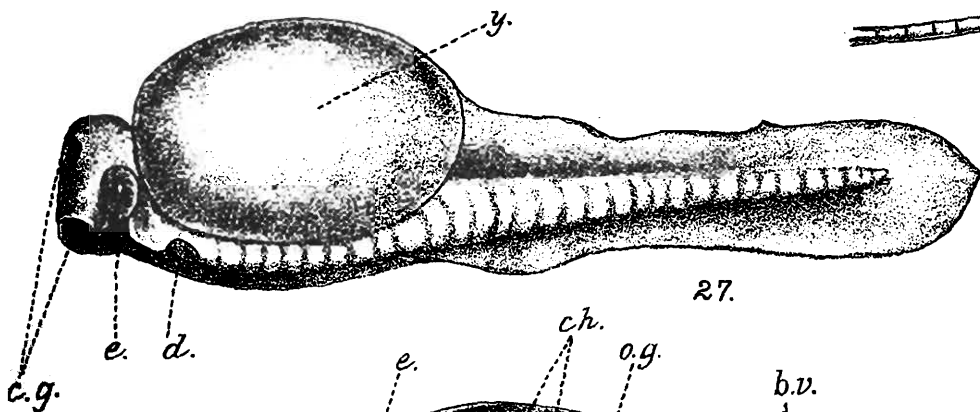
An. = anus; B. = white band on the nape; B.V. = blood vessel; Ch. = chromatophores; C.g. = cement organs; C. E. = cluster of eggs; D. = ear; E. = eye; H. = heart; O. G. = oil globule; P. = stalk; P.F. = plant filament; V. = egg-membrane; Y. = yolk.



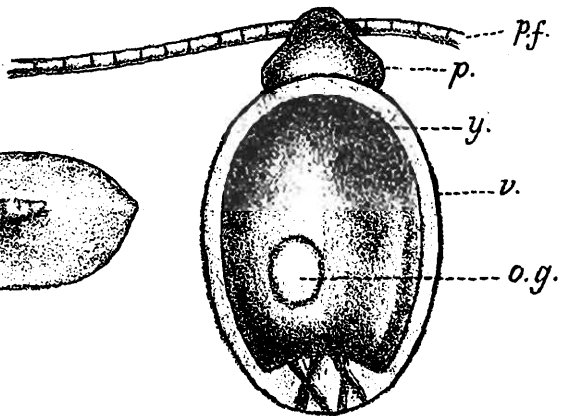
24.



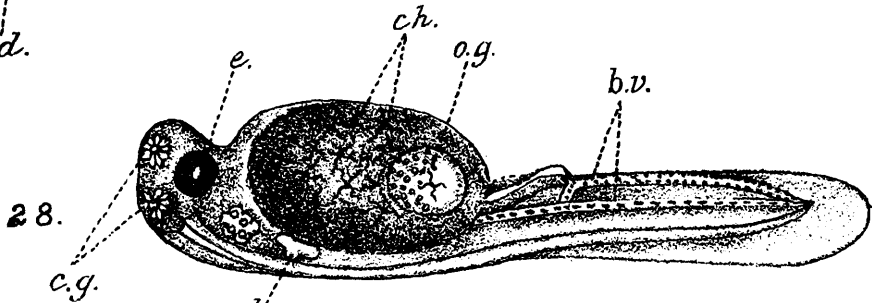
25.



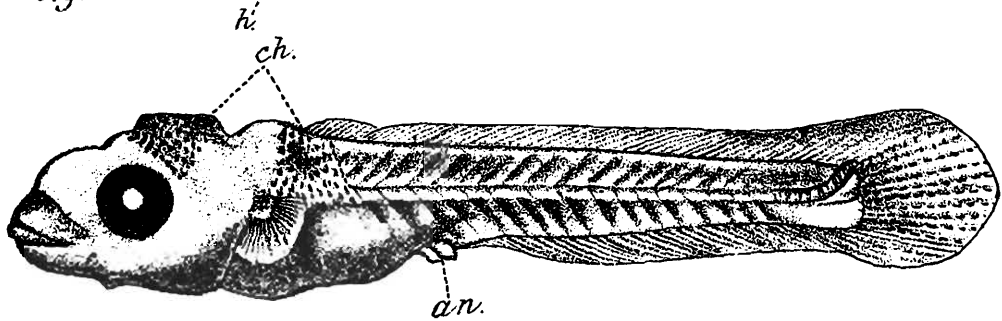
27.



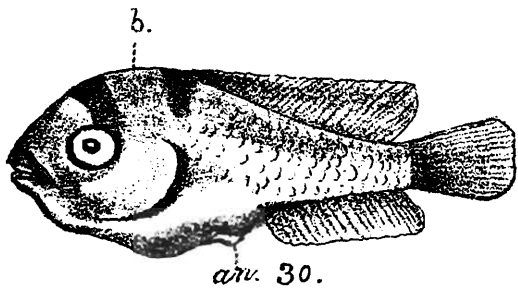
26.



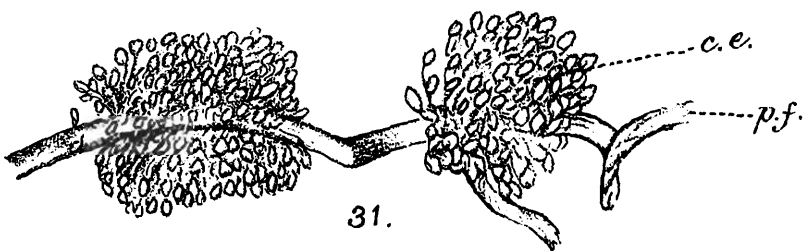
28.



29.



30.



31.

B. Sundara Raj, del.

A. Chowdhary, lith.

EXPLANATION OF PLATE XXIX.

Gobius (Glossogobius) giuris, H. B.

FIG. 32.—Enlarged view of two eggs attached to a root.

„ 33.—Lateral view of embryo within the egg-membrane.

„ 34.—Dorsal view of the same.

„ 35.—Lateral view of a more advanced embryo still within the egg-membrane. The tail is uncoiled and the embryo now faces the free distal end of the egg.

„ 36.—Larva just hatched from the egg, 2.25 mm. long.

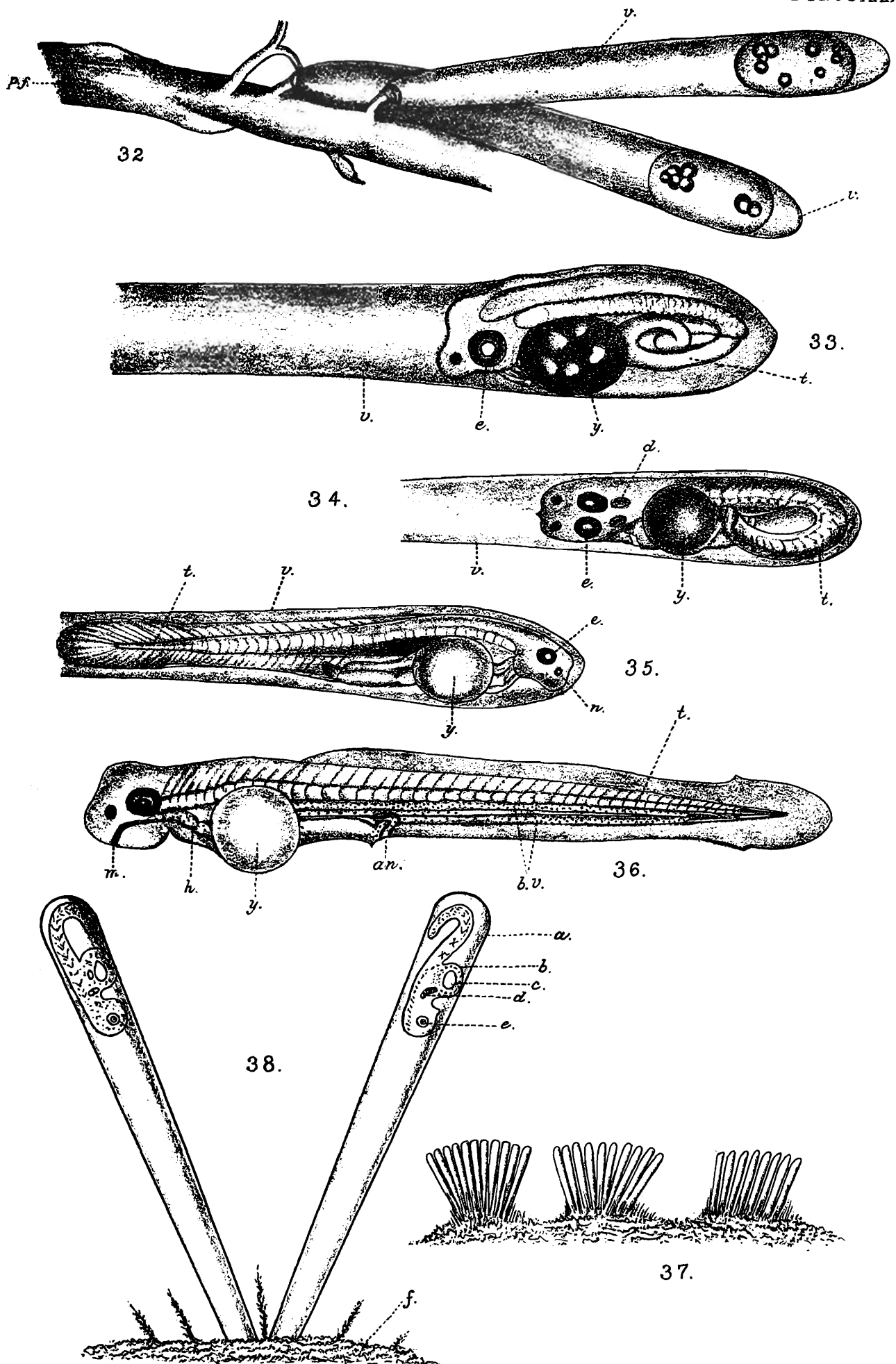
An. = anus; B. V. = blood vessel; D. = ear; E. = eye; H. = heart; M. = mouth; N. = nasal organ; T. = tail; V. = egg-membrane; Y. = yolk.

Gobius (Oxyurichthys) striatus (Day).

FIG. 37.—Outline of three clusters of eggs attached to a rock.

„ 38.—Enlarged view of two eggs with embryos in an advanced stage of development.

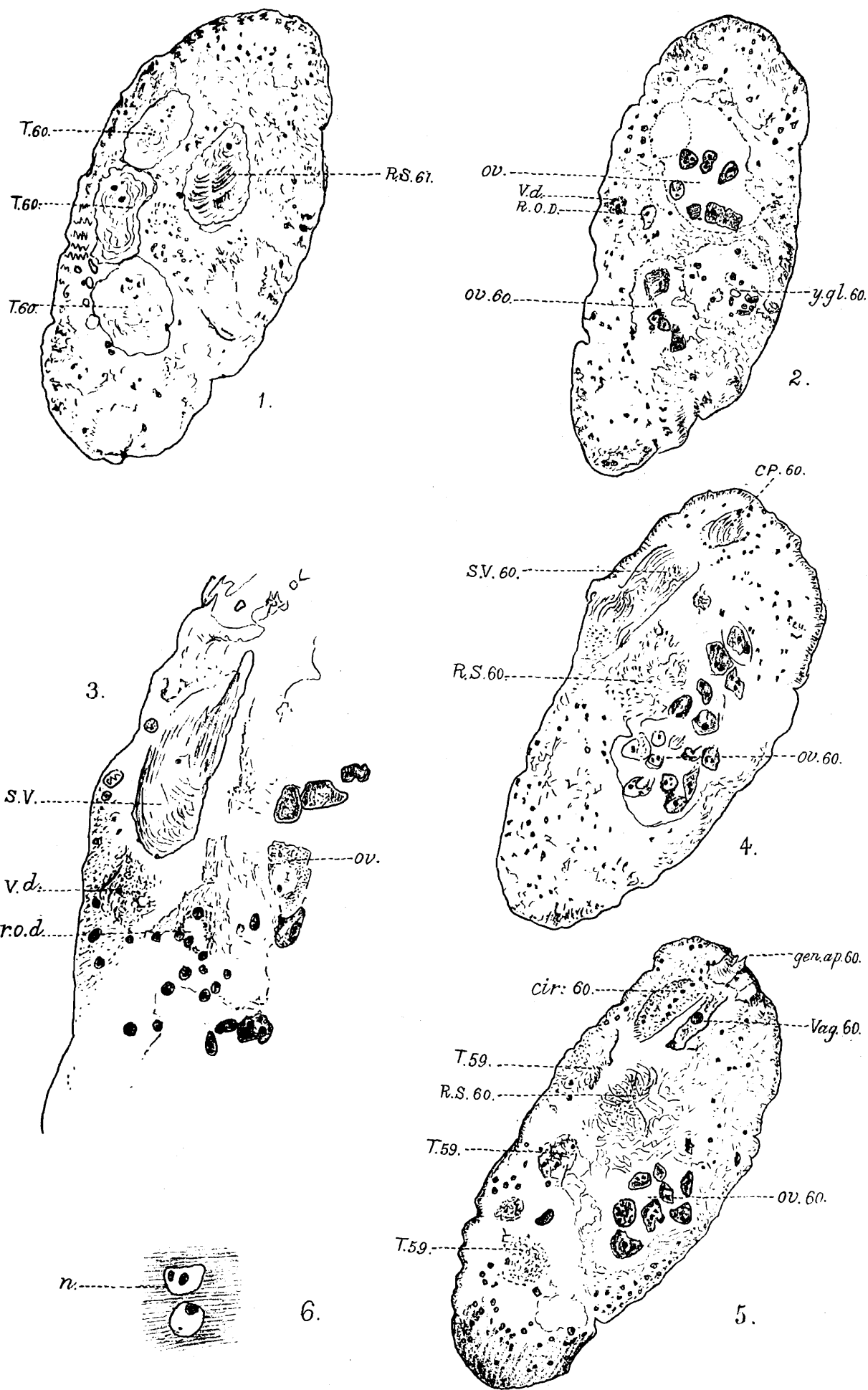
a. = egg-membrane; b. = yolk; c. = oil globule; d. = heart; e. = eye.



EXPLANATION OF PLATE XXXIV

Hymenolepis nana, Siebold.

- FIG. 1.—Transverse section through the posterior end of the 60th segment. $\times 400$.
- „ 2.—Transverse section 24 microns anterior to the above. $\times 400$.
- „ 3.—Part of a transverse section 20 microns in front of section 2. $\times 1050$.
- „ 4.—Transverse section 8 microns anterior to section 3. $\times 400$.
- „ 5.—Transverse section 3 microns anterior to section 4. $\times 400$.
- „ 6.—Section of the ovary of the 50th segment. $\times 1360$.



F.H.S. del.

HYMENOLEPIS NANA, Siebold.

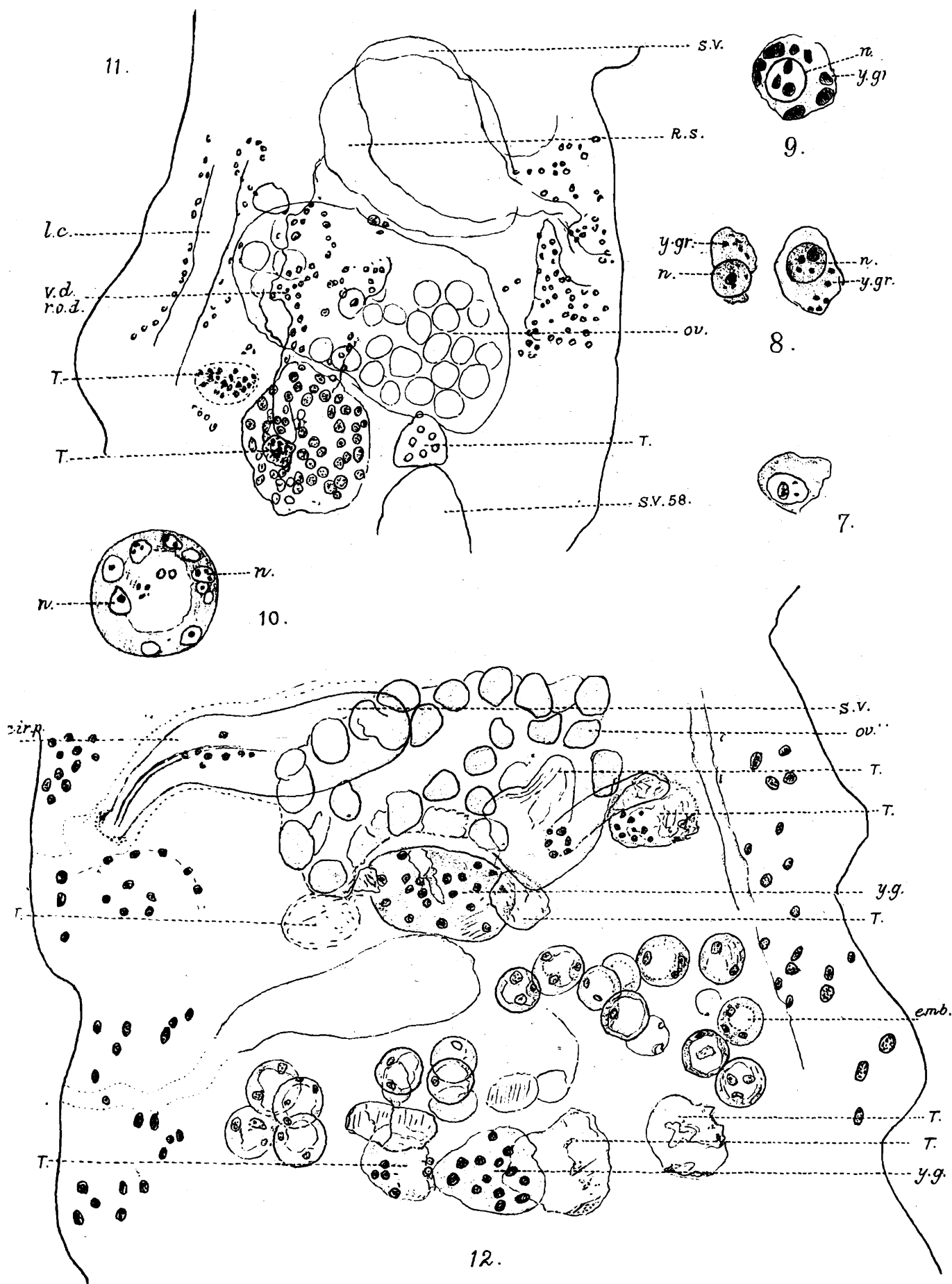
A. Chowdhary, lith.

EXPLANATION OF PLATE XXXV

Hymenolepis nana, Siebold.

- FIG. 7.—Section of the ovary of the 53rd segment. × 1360.
,, 8.—Section of the ovary of the 54th segment. × 1360.
,, 9.—Section of the ovary of the 60th segment. × 1360.
,, 10.—Section of an embryo in the 62nd segment. × 1360.
,, 11.—The 57th segment, stained with borax-carmin. × 680.
,, 12.—The 62nd and 63rd segments, stained with haematoxylin.
 × 680.

Reference letters.—cir. p. = cirrus pouch ; emb. = embryo ; gen. ap. = genital aperture ; l.c. = longitudinal canal ; n. = nucleus ; ov. = ovary ; r.o.d. = receptaculo-ovarian duct ; r.s. = receptaculum seminis ; s.v. = seminal vesicle ; t. = testis ; vag. = vagina ; v.d. = vas deferens ; y.g. = yolk-gland ; y.gr. = yolk-granule.



F.H.S. del.

HYMENOLEPIS NANA, Siebold.

A Chowdhary, lith.

XVIII STUDIES IN INDIAN HELMINTHOLOGY

No. III.

ON AN UNSUCCESSFUL ATTEMPT TO INFECT *MUS DECUMANUS* WITH *HYMENOLEPIS NANA*, SIEBOLD, AND ON THE SECTIONAL ANATOMY OF THAT PARASITE.

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Indian Museum.

(Plates XXXIV—XXXV).

The question of the specific identity or distinctness of *Hymenolepis nana*, Siebold, and *H. murina*, Duj., is a matter of practical as well as of scientific interest. Grassi, Calandruccio, and Rovelli (1, 2 and 3) consider that the two species are identical and that *H. nana* is only a dwarfed variety of *H. murina*. Moniez (7) and Linstow (5) have maintained on anatomical grounds that they are two valid species. Grassi and Rovelli (3) state that on feeding rats aged between one and three months with ripe proglottides of *H. murina* the contained onchospheres developed to cysticercoids in the intestinal villi of the rat, and further that the cysticercoids ultimately rupture into the lumen of the intestine and there become adult. They apparently did not attempt to infect man with the tapeworm from the rat or to perform the reverse experiment. Grassi (1) had previously administered to a boy ripe proglottides of *H. nana* and had found proof of the subsequent existence of the parasite in the bowel. He did not, however, consider this to be conclusive proof of direct transmission from man to man as *Hymenolepis nana* is very frequent in the district where the experiment took place.

If the two species are identical and if the development in the rat is direct as described by Grassi and Rovelli, it is clear that infection in man will as a rule be due to contamination of food by rats. To prove or disprove the transmissibility of *H. murina* to man or of *H. nana* to the rat would therefore be of considerable practical importance. It is also clear that when such eminent zoologists differ on anatomical grounds as to whether the species are one or two, the scientific question can only be decided by feeding experiments.

The experiment which the present paper records could unfortunately be conducted on a small scale only and as it proved negative would require to be repeated on a larger scale to be

conclusive. It is, however, of considerable value in consideration of the statement of Grassi and Rovelli that they obtained infection in every rat employed which was between the ages of one and three months.

On the 19th of January two young white rats (*Mus decumanus albino*) were obtained which were stated to be twenty days old and which appeared to be about that age. Their faeces were examined and no eggs of parasites found. On the 10th of February they were presumably 42 days old. Five specimens of *H. nana* were obtained on that day from an Indian soldier after the administration of *Ol. Chenopodii*. One specimen was stained and mounted and proved to contain onchospheres. The remaining four were given, two each, to the two young rats and were actually swallowed by them. On the 10th of March and 5th of April the faeces of these animals were examined and found not to contain any ova. One rat died on the 12th of April, the second was killed on the 17th. No tapeworms were found in their intestines.

The experiment¹ therefore tends to prove that *Hymenolepis nana* and *H. murina* are two distinct species and that the rat is not the source of infection of man.

ON THE SECTIONAL ANATOMY OF *HYMENOLEPIS NANA*, SIEB.

The anatomy of *Hymenolepis nana*, Sieb., has been described by Leuckart (4, pp. 832, 995), Linstow (5), Miura and Yamasaki (6), Railliet (9), and other authors. A full account of the literature is given by Ransom (10). None of the authors mentioned above have illustrated their papers with figures of sections except diagrammatic figures. The present writer therefore considers it desirable to publish drawings of the actual sections together with some pictures of the undissected animal and a short account of the anatomy of the reproductive system.

The female reproductive organs are fully developed from the 50th segment; fertilisation takes place between the 62nd and 66th (fig. 12). It takes place abruptly; thus in the 61st segment all the eggs are unsegmented; in the 62nd, if this is the first fertilised segment, the left lateral and ventral half of the egg-mass is segmented, the right lateral and dorsal half unsegmented; in the 63rd segment all the eggs with the exception of one or two near the yolk-gland are segmented. Fig. 12 shows this transition between the 62nd and 63rd segments, it also shows the commencing atrophy of the yolk-gland in the fertilised segments and the testes, seminal vesicle and cirrus sac.

Figs. 1-5 are drawn from sections of the 60th segment. They show the yolk-gland, the bilobed ovary, the receptaculo-ovarian duct, the receptaculum seminis and vagina. The receptaculo-ovarian duct has not been described previously in this species. It leads from the receptaculum in the direction of the ovary, but its

¹ I understand that the experiment was carried out at Hong Kong.—Ed.]

exact lower connection cannot be determined. A uterus is not recognisable apart from the cavity of the ovary. The tissues of the animal are, however, so loose that it is impossible either to prove or to disprove the homology of some of the spaces with the uterus of larger forms. On passing from the unfertilised to the fertilised segments (fig. 12) the egg-mass broadens out. This may be due to a change of situation of the eggs or merely to an increase in size.

The present writer has not been able to recognise a shell-gland.

The yolk-gland atrophies at the 65th segment, having decreased in size from the 63rd.

Development of the ova.—The ova in the 50th segment have no cell outlines, the nuclei being embedded in a syncytium (fig. 6). At the 53rd segment irregular cell outlines appear (fig. 7). In the 54th segment yolk granules occur in the protoplasm (fig. 8), which increase markedly in size up to the 60th segment (fig. 9). Fig. 10 shows the segmented egg of the 62nd segment. The embryos develop double-contoured shells in the 90th segment and embryonic hooks in the 91st.

Male reproductive organs in the 60th segment.—The three testes lie near the posterior margin of the segment close to the dorsal surface (fig. 1). The vas deferens (figs. 2 and 3) leads forward to the base of the seminal vesicle. The seminal vesicle (fig. 4), a sausage-shaped thin-walled structure, runs from the midline toward the left side to become continuous with the cirrus pouch. The walls of the latter (fig. 5) are markedly thicker than those of the former and contain muscle fibres. A definite cirrus has not been recognised by the present writer.

The seminal vesicle can first be observed to contain spermatozoa in the 44th segment. The testes are progressively compressed behind the 63rd segment and disappear about the 67th or 68th.

Fig. 11 represents the 57th segment of an undissected preparation seen from the ventral surface. It shows the three testes, the vas deferens and seminal vesicle, the ovary, yolk-gland and receptaculum seminis.

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