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[*N. B.*—An asterisk (*) preceding a name denotes a new variety or sub-species; a dagger (†) indicates a new species; a double dagger (‡) a new genus or sub-genus; a double asterisk (**) a new family or subfamily; synonyms are printed in italics.]

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ON A COLLECTION OF LITTORAL AND FRESHWATER FISHES FROM THE ANDAMAN ISLANDS: SUPPLEMENT.

By ALBERT W. C. T. HERRE, *Stanford University, California.*

In addition to the fishes mentioned in a previous paper[1] on fishes from the Andaman Islands, the following formed a part of the collection sent to me for study and should have been included in the original paper. In the present contribution are given additional records for 52 species, of which 17, marked with an asterix (*) in the list given below, were listed in the first paper. This leaves 35 species to be added to the 112 named in the earlier paper, or a total of 147 species in the entire collection sent to me from Calcutta. This number is probably not more than a sixth or seventh of those actually occurring in Andaman waters.

Family ELOPIDAE.

Megalops cyprinoides (Broussonet).

1782. *Clupea cyprinoides*, Broussonet, *Ichthyol. Dec. I*, table ix.

A specimen, 138 mm. long, was taken around Viper Island, Port Blair, South Andaman.

Family DOROSOMATIDAE.

Gonialosa manmina (Hamilton).

1822. *Clupanodon manmina*, Hamilton, *Fishes Ganges*, p. 247.

A typical specimen, 65 mm. long, was taken at Viper Island.

Family ENGRAULIDAE.

Thrissina baelama (Forskål).

1775. *Clupea baelama*, Forskål, *Descript. Animal.*, p. 72.

Three specimens, 90 to 94 mm. in length, were taken from a creek near South Corbyn's Cove, Port Blair.

Stolephorus heterolobus Rüppell.*

1835. *Stolephorus heterolobus*, Rüppell, *Neue Wirbelt., Fische*, p. 70, pl. xxi, fig. 4.

Eighteen specimens, 62 to 68 mm. in length, are from about Ross Island.

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[1] Herre, A. W. C. T., *Rec. Ind. Mus.* XLI, pp. 327-372 (1939).

Family MURAENIDAE.

Echidna nebulosa (Ahl).

1789. *Muraena nebulosa*, Ahl, *Dissert. Muraen. et Ophichth.*, p. 5.

One example, 375 mm. long, from East Ross Island, and one of 230 mm. from Port Blair.

Echidna zebra (Shaw).

1797. *Gymnothorax zebra*, Shaw, *Natural. Miscell.* IX, pl. cccxxii.

Two fine specimens from Port Blair; one of 415 mm. taken north-west of Ross Island and the other of 350 mm. at South Point.

Gymnothorax undulatus (Lacépède).

1803. *Muraenophis undulata*, Lacépède, *Hist. Nat. Poiss.* V, pp. 629, 644.

Three specimens were found under stones at low tide at Chatham, Port Blair, their lengths from 130 to 282 mm.

Uropterygius marmoratus (Lacépède).*

1803. *Gymnomuraena marmorata*, Lacépède, *Hist. Nat. Poiss.* V, pp. 648, 650.

A specimen, 470 mm. long, was found under coral rock at South Point, Port Blair.

Family CYPRINIDAE.

Rasbora daniconius (Hamilton).*

1822. *Cyprinus daniconius*, Hamilton, *Fishes Ganges*, p. 327, pl. xv, fig. 89.

Thirty specimens, 30 to 48 mm. in length, were obtained from a stream at Weli village, Middle Andaman.

Family PLOTOSIDAE.

Plotosus canius Hamilton.

1822. *Plotosus canius*, Hamilton, *Fishes Ganges*, p. 142.

Fifty-two specimens, only 14 to 18 mm. in length, were taken at North Bay, Port Blair. In spite of their tiny size, determination is certain.

Family CYPRINODONTIDAE.

Aplocheilus panchax (Hamilton).*

1822. *Esox panchax*, Hamilton, *Fishes Ganges*, p. 211, pl. iii, fig. 69.

Ten specimens from 16 to 40 mm. in length were taken near Bamboo Flat village, Port Blair, and 45 examples from 20 to 57 mm. from a stream west of Sipi Ghat (Bhagelsinghpura), South Andaman.

Family BOTHIDAE.

Pseudorhombus arsius (Hamilton).

1822. *Pleuronectes arsius*, Hamilton, *Fishes Ganges*, p. 128.

Three specimens, 92 to 98 mm. in length, were collected at Ross Island, Port Blair.

Family OPHICEPHALIDAE.

Ophicephalus gachua Hamilton.*

1822. *Ophicephalus gachua*, Hamilton, *Fishes Ganges*, pp. 68, 367, pl. xxi, fig. 21.

Eight specimens from 82 to 112 mm. were taken from a freshwater pool at Bamboo Flat village, Port Blair; one of 96 mm. is from a stream south of South Corbyn's Cove, Port Blair; one of 136 mm. was caught in a paddy field at Chouldari, South Andaman.

Family MUGILIDAE.

Mugil dussumieri Cuvier and Valenciennes.

1836. *Mugil dussumieri*, Cuvier and Valenciennes, *Hist. Nat. Poiss.* XI, p. 147.

A fine specimen from North Bay, Port Blair, is 170 mm. long.

Liza borneensis (Bleeker).

1851. *Mugil borneensis*, Bleeker, *Nat. Tijds. Ned. Ind.*, II, p. 201.

A specimen, 160 mm. long, is from North Bay, and two of 90 and 97 mm. are from Viper Island, Port Blair.

Liza melinoptera (Cuvier and Valenciennes).*

1836. *Mugil melinopterus*, Cuvier and Valenciennes, *Hist. Nat. Poiss.* XI, p. 146.

Three examples, from 105 to 149 mm. in length, are from about Viper Island, Port Blair.

Family SCOMBRIDAE.

Rastrelliger brachysoma (Bleeker).

1850. *Scomber brachysoma*, Bleeker, *Nat. Tijds. Ned. Ind.* I, p. 356.

A specimen, 183 mm. long, in very bad condition, is from Phoenix Bay, Port Blair.

Family CARANGIDAE.

Selar crumenophthalmus (Bloch).

1797. *Scomber crumenophthalmus*, Bloch, *Ichthyologie*, X, p. 65, pl. cccxliii.

Two specimens from Phoenix Bay are 99 and 100 mm. in length.

Caranx ignobilis (Forskål).

1775. *Scomber ignobilis*, Forskål, *Descript. Animal.*, p. 55.

Two specimens, 72 and 84 mm. in length, from South Point, Port Blair.

Caranx sansun (Forskål).

1775. *Scomber sansun*, Forskål, *Descript. Animal.*, p. 55.

Seven examples from Viper Island, Port Blair, are 42 to 163 mm. in length.

Caranx sexfasciatus Quoy and Gaimard.

1824. *Caranx sexfasciatus*, Quoy and Gaimard, *Voy. Uranie, Zool.*, p. 358, Pl. lxv, fig. 4.

Family Leiognathidae.

Gazza minuta (Bloch).

1797. *Scomber minutus*, Bloch, *Ichthyologie*, XII, p. 109, pl. ccccxxix, fig. 2.

Twenty-two specimens from 32 to 62 mm. in length were obtained about Viper Island.

Leiognathus fasciatus (Lacépède).

1803. *Clupea fasciatus*, Lacépède, *Hist. Nat. Poiss.* V, pp. 460, 463.

Nine specimens, 46 to 63 mm. in length, were secured about Viper Island.

Leiognathus splendens (Cuvier).

1829. *Equula splendens*, Cuvier, *Regne Animal.*, 2nd. ed., II, p. 212.

Eleven examples from 45 to 60 mm. in length, taken from about Viper Island.

Family Gerridae.

Gerres abbreviatus Bleeker.*

1850. *Gerres abbreviatus*, Bleeker, *Verh. Bat. Gen.* XXIII, p. 11.

Ten specimens from about Viper Island, Port Blair, are 50 to 83 mm. in length.

Family Apogonidae.

Apogon hyalosoma Bleeker.

1852. *Apogon hyalosoma*, Bleeker, *Nat. Tijds. Ned. Ind.* III, p. 63.

Three specimens, 107 to 123 mm. in length, from Viper Island,

Apogonichthys poecilopterus (Cuvier and Valenciennes).

1828. *Apogon poecilopterus*, Cuvier and Valenciennes, *Hist. Nat. Poiss.* II, p. 114.

Two specimens from South Point, Port Blair, 48 and 62 mm. in length.

Family AMBASSIDAE.

Ambassis buruensis Bleeker.*

1856. *Ambassis buruensis*, Bleeker, *Nat. Tijds. Ned. Ind.* XI, p. 396.

Forty-two specimens, 34 to 47 mm. in length, from Viper Island; occurring in abundance about Port Blair.

Ambassis urotaenia Bleeker.*

1852. *Ambassis urotaenia*, Bleeker, *Nat. Tijds. Ned. Ind.* III, p. 257.

Seventeen examples, 41 to 52 mm. in length, were taken opposite Hope Tower Jetty on Haddo Shore.

Family SERRANIDAE.

Epinephelus merra Bloch.

1797. *Epinephelus merra*, Bloch, *Ichthyologie*, VII, p. 15, pl. cccxxix.

Three specimens, 74 to 140 mm. in length, from North Bay, Port Blair.

Family PRIACANTHIDAE.

Priacanthus hamrur (Forskål).

1775. *Sciaena hamrur*, Forskål, *Descript. Animal.*, p. 45.

A specimen from South Point, Port Blair, is 105 mm. long.

Family PLESIOPIDAE.

Plesiops nigricans (Rüppell).*

1828. *Pharopteryx nigricans*, Rüppell, *Atlas Fische rothen Meeres*, p. 15, pl. iv, fig. 2.

A specimen, 75 mm. long, was taken near Jones Point, Sound Island, North Andaman. Five specimens from 44 to 99 mm. in length were found under rocks on the east coast of Long Island, Middle Andaman.

Family LUTIANIDAE.

Lutianus fulviflamma (Forskål).

1775. *Sciaena fulviflamma*, Forskål, *Descript. Animal.*, p. 45.

One specimen, 137 mm. long, from South Corbyn's Cove, Port Blair.

Family POMADASYIDAE.

Pomadasys hasta (Bloch).

1797. *Lutjanus hasta*, Bloch, *Ichthyologie*, VIII, p. 187, pl. ccxlvi, fig. 1.

Two specimens, 91 and 95 mm. in length, from South Corbyn's Cove.

Family MULLIDAE.

Upeneus vittatus (Forskål).

1775. *Mullus vittatus*, Forskål, *Descript. Animal.*, p. 31.

One example, 75 mm. long, from Viper Island, Port Blair.

Family TOXOTIDAE.

Toxotes jaculator (Pallas).

1766. *Sciaena jaculatrix*, Pallas, *Philosoph. Trans. London*, LVI, p. 186.

Two specimens taken about Viper Island are 55 and 62 mm. in length.

Family TEUTHIDIDAE.

Teuthis striolata Günther.

1861. *Teuthis striolata*, Günther, *Cat. Fishes Brit. Mus.* III, p. 319.

A specimen, 136 mm. long, was taken at South Corbyn's Cove, Port Blair.

Teuthis vermiculata (Cuvier and Valenciennes).

1835. *Amphacanthus vermiculatus*, Cuvier and Valenciennes, *Hist. Nat. Poiss.* X, p. 92.

An example from Phoenix Bay, Port Blair, is 90 mm. long.

Family SCORPAENIDAE.

Scorpaenopsis venosa (Cuvier and Valenciennes).

1829. *Scorpaena venosa*, Cuvier and Valenciennes, *Hist. Nat. Poiss.* IV, p. 317.

A specimen, 150 mm. long, was taken at South Point, Port Blair.

Pterois radiata Cuvier and Valenciennes.

1829. *Pterois radiata*, Cuvier and Valenciennes, *Hist. Nat. Poiss.* IV, p. 369.
1835. *Pterois cincta*, Rüppell, *Neue Wirbelt., Fische*, p. 108, pl. xxvi, fig. 3.
1873. *Pterois radiata*, Günther, *Fische der Südsee*, I, p. 81, pl. lvi, fig. A.
1875. *Pterois cincta*, Day, *Fishes India*, p. 154, pl. xxxvii, fig. 3.

A specimen, 145 mm. long, from North Cinque Island, Andamans.

Family ELEOTRIDAE.

Butis butis (Hamilton).

1822. *Cheilodipterus butis*, Hamilton, *Fishes Ganges*, p. 367.
1876. *Eleotris butis*, Day, *Fishes India*, p. 315, pl. lxvii, fig. 3.

A specimen, 73 mm. long, was collected around Viper Island.

Family GOBIIDAE.

Bathygobius fuscus (Rüppell).*

1828. *Gobius fuscus*, Rüppell, *Atlas Fische rothen Meeres*, p. 137.

Three specimens taken around South Point, Port Blair, are 33 to 66 mm. in length.

Glossogobius giurus (Hamilton).

1822. *Gobius giurus*, Hamilton, *Fishes Ganges*, p. 366, pl. xxxiii, fig. 15.

Two examples, 78 and 115 mm. in length, were obtained from a creek near Aberdeen, Port Blair.

Oxyurichthys ophthalmonema (Bleeker).

1856-57. *Gobius ophthalmonema*, Bleeker, *Nat. Tijds. Ned. Ind.* VIII, p. 208.
1876. *Gobius tentacularis*, Day, *Fishes India*, p. 291, pl. lxiv, fig. 4.
1927. *Oxyurichthys ophthalmonema*, Herre, *Gobies, Philippines*, p. 257, pl. xx, fig. 3.

A specimen, 64 mm. long, was taken at Ross Island, Port Blair.

Family PERIOPHTHALMIDAE.

Periophthalmus barbarus (Linnaeus).*

1766. *Gobius barbarus*, Linnaeus, *Syst. Nat.* ed. XII, p. 450.

In addition to those listed in the previous paper, the following were taken at Port Blair, their lengths 44 to 106 mm. :—5 from a creek flowing into Sesostris Bay, Aberdeen, and 9 from a creek near South Corbyn's Cove. A specimen 90 mm. long is from Curlew Island, Stewart Sound, North Andaman. Ten others from 59 to 105 mm. in length are merely labelled " Andamans "

Periophthalmodon schlosseri (Pallas).*

1769. *Gobius schlosseri*, Pallas, *Spicilegia*, VIII, p. 3, pl. i, figs. 1-4.

Besides those listed in the first paper, 7 specimens from 42 to 48 mm. in length were taken around Ross Island, Port Blair.

Family BLENNIIDAE.

Salarias raoi HERRE.*

1876. *Salarias alboguttatus*, Day, *Fishes India*, p. 334. Name preoccupied; not *Salarias alboguttatus* Knor.

In addition to those described in my previous paper on Andaman fishes, 85 specimens (many in rather poor condition) from 20 to 44 mm. in length were collected around South Point, Port Blair.

Salarias edentulus (Bloch and Schneider).*

1801. *Blennius edentulus*, Bloch and Schneider, *Syst. Ichth.*, p. 172.

A good specimen, 55 mm. long, and 2 juvenile examples, 20 and 25 mm. in length, are from South Point, Port Blair.

Family Tetraodontidae.

Tetraodon fluviatilis Hamilton.

1822. *Tetraodon fluviatilis*, Hamilton, *Fishes Ganges*, pp. 6 and 362, pl. xxx, fig. 1.
1878. *Tetraodon fluviatilis*, Day, *Fishes India*, *p.* 707, pl. clxxxiii, fig. 1.

A specimen, 67 mm. long, was obtained from a creek northwest of the coconut plantation on Long Island, Middle Andaman.

Five others, taken at Port Blair, are 45 to 61 mm. in length.

Tetraodon immaculatus Bloch and Schneider.*

1801. *Tetraodon immaculatus*, Bloch and Schneider, *Syst. Ichth.*, p. 507.

Two specimens, 102 and 106 mm. in length, were secured at Viper Island, Port Blair.

Tetraodon nigropunctatus Bloch and Schneider.

1801. *Tetraodon nigropunctatus*, Bloch and Schneider, *Syst. Ichth.*, p. 507.
1878. *Tetraodon nigropunctatus*, Day, *Fishes India*, p. 704, pl. clxxx, fig. 4.

A specimen from South Cinque Island, Andamans, measures 252 mm.

Chelonodon patoca (Hamilton).*

1822. *Tetraodon patoca*, Hamilton, *Fishes Ganges*, p. 7, pl. xviii, fig. 2.
1878. *Tetraodon patoca*, Day, *Fishes India*, p. 703, pl. clxxxiii, fig. 4.

In addition to those listed in the previous paper, 9 more from 47 to 90 mm. in length were caught about Viper Island, Port Blair.

ON A SMALL COLLECTION OF FISH FROM THE MERGUI ARCHIPELAGO.

By ALBERT W C. T. HERRE, *Stanford University, California.*

Very little collecting of fishes has been done in the little known Mergui Archipelago. It is of interest therefore to present a memorandum on a small collection made in the fish markets at three localities in the Archipelago. The fishes thus obtained are nearly all common species found generally along the shores and among the islands of the Bay of Bengal. The collection comprises 51 species, of which 37 were secured in the Mergui market. Fourteen were obtained at La-c-ala or Julia Island, which is 35 miles southwest of the town of Mergui and about 5 miles west of King Island. Six species were taken at Kmachang, a small village on the east coast of Doung Kyein Island or Ross Island.

The following were secured at Kmachang :—

1. *Tylosurus strongylurus* (van Hasselt).
2. *Zenarchopterus beauforti* Mohr.
3. *Liza macrolepis* A. Smith.
4. *Liza vaigiensis* (Quoy and Gaimard).
5. *Ambassis urotaenia* Bleeker.
6. *Tetraodon fluviatilis* Hamilton.

The following species were obtained at La-c-ala or Julia Island :—

1. *Chirocentras dorab* (Forskål).
2. *Dussumieria hasselti* Bleeker.
3. *Ilisha ditchela* (Cuv. and Val.).
4. *Sardinella fimbriata* (Cuv. and Val.).
5. *Opisthopterus macrognathus* Bleeker.
6. *Thrissocles dussumieri* (Cuv. and Val.).
7. *Hemiramphus georgii* Cuv. and Val.
8. *Hemiramphus unifasciatus* Ranzani.
9. *Scomberomorus kuhli* (Cuv. and Val.).
10. *Trichiurus muticus* Gray.
11. *Pampus cinereus* (Bloch).
12. *Atule djedaba* (Forskål).
13. *Scomberoides tol* (Cuv. and Val.).
14. *Leiognathus insidiator* (Bloch).

The species secured at the Mergui market were as follows :—

1. *Chirocentrus dorab* (Forskål).
2. *Dussumieria hasselti* Bleeker.
3. *Clupeoides lile* (Cuv. and Val.).
4. *Ilisha ditchela* (Cuv. and Val.).
5. *Anadontostoma chacunda* (Hamilton).
6. *Setipinna taty* (Cuv. and Val.).
7. *Scutengraulis mystax* (Bl. and Schn.).
8. *Thrissocles setirostris* (Broussonet).
9. *Stolephorus heterolobus* (Rüppell).
10. *Coilia dussumieri* Cuv. and Val.
11. *Coilia ramcarti* (Hamilton).
12. *Arius caelatus* Cuv. and Val.
13. *Arius truncatus* Cuv. and Val.
14. *Harpodon nehereus* Hamilton.
15. *Hemiramphus gaimardi* Cuv. and Val.
16. *Bregmaceros atripinnis* Tickell.
17. *Cynoglossus macrolepidotus* (Bleeker).
18. *Polynemus sextarius* Bl. and Schn.
19. *Scomberomorus kuhli* (Cuv. and Val.).
20. *Trichiurus haumela* (Forskål).
21. *Pampus cinereus* (Bloch).
22. *Pampus niger* (Bloch).
23. *Atule kalla* (Cuv. and Val.).
24. *Citula armata* (Forskål).
25. *Leiognathus equulus* (Forskål).
26. *Leiognathus insidiator* (Bloch).
27. *Leiognathus splendens* (Cuvier).
28. *Gerres öyena* (Forskål).
29. *Gerres punctatus* Cuv. and Val.
30. *Apogon quadrifasciatus* Cuv. and Val.
31. *Therapon theraps* Cuv. and Val.
32. *Upeneus sulphureus* Cuv. and Val.
33. *Johnius carutta* Bloch.
34. *Otolithes argenteus* (Cuv. and Val.).
35. *Pseudosciaena sina* (Cuv. and Val.).
36. *Sillago sihama* (Forskål).
37. *Spheroides lunaris* (Bl. and Schn.).

Family Chirocentridae.

Chirocentrus dorab (Forskål).

Two examples, each 180 mm. long, from the Mergui market, and a specimen 255 mm. long from Julia Island.

Family Dussumieridae.

Dussumiera hasselti Bleeker.

Scales 50-52 ; gill rakers on lower arch 22. Six specimens, 70-104 mm. in length, from Mergui, and 7 from 96 to 104 mm. from Julia Island.

Family Clupeidae.

Clupeoides lile (Cuv. and Val.).

Three specimens, 66 to 68 mm. long, from the Mergui market.

Ilisha ditchela (Cuv. and Val.).

Anal II—32 to 34 ; preventral scutes 18 to 20, and 9 or 10 behind the ventral origin. Two specimens, 71 and 103 mm. in length, from the Mergui market, and two, 78 and 80 mm. in length, from Julia Island.

Sardinella fimbriata (Cuv. and Val.).

One specimen, from Julia Island, is 111 mm. long.

Opisthopterus macrognathus Bleeker.

An example, 110 mm. long, was secured at Julia Island

Family Dorosomatidae.

Anodontostoma chacunda (Hamilton).

Two specimens, 91 and 98 mm. long, from Mergui.

Family Engraulidae.

Setipinna taty (Cuv. and Val.).

One example from Mergui, 96 mm. long.

Scutengraulis mystax (Bl. and Schn.).

Two specimens, 92 and 102 mm. long, from Mergui.

Thrissocles dussumieri (Cuv. and Val.).

An example, 63 mm. long, is from Julia Island.

Thrissocles setirostris (Broussonet).

One specimen of 94 mm. from Mergui.

Stolephorus heterolobus (Rüppell).

Twenty-eight specimens, 40 to 50 mm. in length, from the Mergui market.

Coilia dussumieri Cuv. and Val.

One specimen from Mergui, 130 mm. long.

Coilia ramcarti (Hamilton).

One specimen from Mergui, 135 mm. long.

Family ARIIDAE.

Arius caelatus Cuv. and Val.

Two specimens, 215 and 228 mm. in length, from Mergui.

Arius truncatus Cuv. and Val.

One example, 85 mm. long, from Mergui.

Family HARPODONTIDAE.

Harpodon nehereus Hamilton.

A specimen, 170 mm. long, from Mergui.

Family BELONIDAE.

Tylosurus strongylurus (van Hasselt).

Three specimens, 230 to 265 mm. in length, from Kmachang.

Family HEMIRAMPHIDAE.

Hemiramphus gaimardi Cuv. and Val.

Four examples, 94 to 105 mm. in length, from Mergui.

Hemiramphus georgii Cuv. and Val.

Three specimens, 78 to 104 mm. in length, from Julia Island.

Hemiramphus unifasciatus Ranzani.

Five examples, 101 to 117 mm. in length, from Julia Island.

Zenarchopterus beauforti Mohr.

One specimen from Kmachang, measuring 120 mm., agrees with Dr. Mohr's description of this rare and little known species in all essentials. The types, presumably collected by Dr. Duncker, are from the Muar river, Jahore, and Kuala Selangor, Selangor, in the Malay Peninsula. Its occurrence in the Mergui Archipelago is therefore a very notable extension of its range. It probably occurs in river mouths, estuaries, and sheltered waters about islands all over the whole western coast of the Malay Peninsula and northward over an unknown distance along the Burmese coast. The presence of but 8 (rarely 9) anal rays will serve to distinguish it from other members of the genus found in Indian waters.

Family BREGMACEROTIDAE.

Bregmaceros atripinnis Tickell.

Two specimens, 56 and 66 mm. in length, of this rather rare and very interesting little fish were secured at Mergui.

Family CYNOGLOSSIDAE.

Cynoglossus macrolepidotus (Bleeker).

One example, 202 mm. long, from Mergui.

Family MUGILIDAE.

Liza macrolepis A. Smith.

Nine specimens, 75 to 130 mm. in length, from Kmachang. This is the *Mugil troscheli* of Bleeker.

Liza vaigiensis (Quoy and Gaimard).

One example, 65 mm. long, is from Kmachang.

Family POLYNEMIDAE.

Polynemus sextarius Bloch and Schneider.

Four specimens, 62 to 73 mm. in length, from Mergui.

Family SCOMBRIDAE.

Scomberomorus kuhli (Cuv. and Val.).

Dorsal XVIII/V/17+viii; anal IV/18+vii. The lateral line forms a very long gentle curve.

Three specimens, 56 to 85 mm. in length, from Mergui, and one of 65 mm. from Julia Island.

Family TRICHIURIDAE.

Trichiurus haumela (Forskål).

Three specimens, 275 to 345 mm. in length, from Mergui.

Trichiurus muticus Gray.

Eleven specimens, 145 to 545 mm. in length, from Julia Island.

Family PAMPIDAE.

Pampus cinereus (Bloch).

Two specimens, 62 and 80 mm. in length, from Mergui, and one of 122 mm. from Julia Island.

Pampus niger (Bloch).

Five specimens from 71 to 102 mm. in length were secured at the Mergui market.

Family CARANGIDAE.

Atule djedaba (Forskål).

Two specimens, 114 and 150 mm. in length, from Julia Island.

Atule kalla (Cuv. and Val.).

One example of this common carangid was obtained at the Mergui market; its length 76 mm.

Citula armata (Forskål).

Two juvenile examples, 52 and 53 mm. in length, from Mergui.

Scomberoides tol (Cuv. and Val.).

A young but typical example, 75 mm. long, is from Julia Island.

Family LEIOGNATHIDAE.

Leiognathus equulus (Forskål).

One specimen of 67 mm. from Mergui.

Leiognathus insidiator (Bloch).

Common in the markets. Four specimens, 48 to 53 mm. in length, from Mergui and 4 from 35 to 50 mm. from Julia Island.

Leiognathus splendens (Cuvier).

Two specimens from Mergui are 70 and 77 mm. in length.

Family GERRIDAE.

Gerres öyena (Forskål).

Two examples, 67 and 70 mm. in length, were taken at Mergui.

Gerres punctatus Cuv. and Val.

Two specimens, measuring 60 and 63 mm., are from Mergui.

Family APOGONIDAE.

Apogon quadrifasciatus Cuv. and Val.

Four poor specimens, 27 to 44 mm. in length, from the Mergui market.

Family AMBASSIDAE.

Ambassis urotaenia Bleeker.

Three specimens in bad state, and largely lacking the characteristic caudal bands, from Kmachang, evidently belong here; their lengths 51 to 55 mm.

Family Theraponidae.

Therapon theraps Cuv. and Val.

Two specimens, each 82 mm. long, are from Mergui.

Family Mullidae.

Upeneus sulphureus Cuv. and Val.

Six examples, 46 to 84 mm. in length, from Mergui.

Family Sciaenidae.

Johnius carutta Bloch.

One specimen of 77 mm. from Mergui.

Otolithes argenteus (Cuv. and Val.).

Dorsal X/I/26; scales in lateral line 51. An example, 126 mm. long, is from Mergui.

Pseudosciaena sina (Cuv. and Val.).

Three small specimens from Mergui measure 72 to 81 mm.

Family Sillaginidae.

Sillago sihama (Forskål).

Six specimens, 76 to 89 mm. in length, from Mergui.

Family Tetraodontidae.

Spheroides lunaris (Bl. and Schn.).

Four specimens of this very common puffer, 100 to 121 mm. in length, from Mergui.

Tetraodon fluviatilis Hamilton.

Three examples, 60 to 69 mm. long, from Kmachang.

ON A COLLECTION OF GOBIOID FISHES FROM THE ANDAMANS.

By F. P. KOUMANS, *D.Sc., Rijksmuseum van natuurlijke Historie, Leiden (Holland).*

Early in 1939 I received through the courtesy of Drs. B. Prashad and S. L. Hora a small collection of Gobioid Fishes from the Andaman Islands for identification.[1] The collection had been made by Dr. H. S. Rao and Mr. K. S. Misra in the course of their work on the shell fisheries in the Andaman Islands and consists of 165 specimens belonging to 16 recognisable species. It consists for the greater part of young specimens, which, owing to the absence of important diagnostic characters, such as the non-development of scales, etc., are not possible of specific identification. A number of such young forms could only be named provisionally, while in two cases specific identification was not at all possible. Though the collection does not contain any new species, it is of great interest from a zoogeographical point of view as the Andamans are located between India and the Indo-Australian Archipelago.

Acentrogobius bontii var. **triangularis** (M. Weber).

Muddy creek near South Corbyn's Cove, Port Blair, 27-iii-1935 .. .. 2 specimens.

Acentrogobius ornatus (Rüpp.).

South of Sound Island, North Andaman, 29-xii-1933 2 specimens.
South coast of Long Island, Middle Andaman, 20-i-1935 .. .. 1 specimen.
Between corals in sandy parts, Curlew Island, Stewart Sound, North Andaman, 6-iii-1935 .. .. 1 specimen.
Muddy creek near South Corbyn's Cove, Port Blair, 27-iii-1935 .. .. 3 specimens.

Acentrogobiis reichei (Bleeker).

Muddy creek near South Corbyn's Cove, Port Blair, 27-iii-1935 .. .. 22 specimens.

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[1] Attention may also be invited to the following species of Gobioid fishes found by Dr. Albert W. C. T. Herre in the material of Andaman fishes reported upon by him recently (*Rec. Ind. Mus.* XLI, pp. 327-372, 1939; *ibid* XLII, pp. 1=8, 1940) :—

Bathygobius fuscus (Rüppell).
Chonophorus ocellaris (Broussonet).
Glossogobius biocellatus (Cuv. & Val.).
Glossogobius celebius (Cuv. & Val.)
Glossogobius giuris (Ham.).
Gobiodon quinquestrigatus (Cuv. & Val.).
Oxyrichthys ophthalmonema (Bleeker).
Periophthalmodon schlosseri Pallas.
Periophthalmus barbarus (Linn.).
Sicyoopterus garra Hora.
Taenioides caeculus (Bl. & Schn.).
Vaimosa koumansi Mukerji.
Vaimosa hoeveni Bleeker.—*Editor.*

Ctenogobius criniger (C. & V.).

On sandy bottom near shore, W. of cocoanut plantation, Long Island, Middle Andaman, 22-i-1935 ..	3 specimens.
Sticking to sandy bottom near shore, W. of cocoanut plantation, Long Island, Middle Andaman, 22-i-1935	6 specimens.
Muddy creek near South Corbyn's Cove, Port Blair, 27-iii-1935	7 specimens.

Bathygobius fuscus (Rüpp.).

Freshwater stream, South of creek near South Corbyn's Cove, Port Blair, 15-xii-1934	2 specimens.
Near Murdakhari Bay, Port Blair, 29-xii-1934 ..	2 specimens.

Glossogobius giuris (Ham.).

Freshwater stream north of Wireless Station, Port Blair, 27-xi-1934	1 specimen.
Freshwater stream near bridge at Beadonabad, Port Blair, 25-xii-1934 ..	1 specimen.

Glossogobius biocellatus (C. & V.).

In sandy parts, W. coast of Long Island near cocoanut plantation, Middle Andaman, 22-i-1935 ..	1 specimen.

Zonogobius semidoliatus (C. & V.).

South of Sound Island, North Andaman, 29-xii-1933	1 specimen.

Stigmatogobius neglectus (Bleeker MS.) Kuomans.

In stream W. of Sipi ghat Bhagelsinghpura, South Andaman, 5-xii-1934	1 specimen.
From a freshwater stream near Rangat Camp, Middle Andaman, 19-i-1935	2 specimens.
Dhanikara stream near junction of Maymyo-Manglutan roads, South Andaman, 21-ii-1935 ..	29 specimens.
Stream near Weli village, Base Camp, Middle Andaman, 2-iii-1935	7 specimens.
Stream below Machchaligaon, Port Blair, 6-ii-1936 ..	3 specimens.

It is possible that *Stigmatogobius neglectus* is the female of the species of which the male has been described as *Pseudogobiopsis rõmeri* (M. Weber). The species as described are pretty different in their physiognomy. *P. rõmeri* has a large mouth, the maxillary extends to far behind the eye, nearly to the posterior border of preopercle. In *S. neglectus* the maxillary is short and extends to the middle of the eye. It was not till recently that all the specimens on which *S. neglectus* was based were found to be males, while those of *P. rõmeri* are all females. In certain other species of Gobioid Fishes sexual dimorphism of this kind is known to occur, and it is possible that the same is the case in this species as well. If this surmise proves correct, the species should bear the name *Stigmatogobius rômeri* (M. Weber).

Stigmatogobius sp.

Amidst stones at the junction of the freshwater stream and the creek near cocoanut plantation, Long Island, Middle Andaman, 22-i-1935 .. .. 3 specimens.

It is not possible to identify these specimens with certainty, but they may belong to *S. neglectus.*

Pseudogobiopsis römeri (M. Weber).

In stream W. of Sipi ghat, Bhagelsinghpura, South Andaman, 5-xii-1934 .. .. .. 2 specimens.

Dhanikara stream near junction of Maymyo-Manlutan roads, South Andaman, 21-ii-1935 .. 1 specimen.

Sicyopterus microcephalus (Bleeker).

From a muddy stream S. W. of Golf course, Aberdeen, Port Blair, 12-ii-1934 .. .. .. 2 specimens.

Stream near Weli village, Base Camp, Middle Andaman, 2-iii-1935 .. .. 1 specimen.

Stream below Machchaligaon, Port Blair, 6-ii-1936 .. 8 specimens.

On examining the type-specimens of *Sicyopterus garra* Hora (*Rec. Ind. Mus.* XXVIII, p. 35, pl. ii, figs. 2-5, 1925) from Birchgunge, South Andaman, I found the species to be a synonym of *S. microcephalus.* This species therefore occurs in the Andamans, Java, Celebes and Timor.

Periophthalmus koelreuteri kalolo Lesson.

Murdakhari, Port Blair, 17-ii-1936 .. .. 1 specimen.

Taenioides cirratus (Blyth).

On mud bank, exposed at low tide, of a creek near South Corbyn's Cove, Port Blair, 27-iii-1935 .. 1 specimen.

Eleotris fusca (Bl. & Schn.).

Roadside pool or tank P. W. D. Godown, Port Blair, 14-iii-1934 .. .. 2 specimens.

Machchi line, Port Blair, 20-v-1934 .. .. 1 specimen.

Freshwater stream south of creek near South Corbyn's Cove, Port Blair, 15-xii-1934 .. .. 9 specimens.

Freshwater stream N. of Wireless Station, Port Blair, 26-27-xi-1934 .. .. .. 1 specimen.

From a freshwater stream near Rangat Camp, Middle Andaman, 19-i-1935 .. .. .. 1 specimen.

In creek amidst rocks, near cocoanut plantation, Long Island, Middle Andaman, 22-i-1935 .. .. 1 specimen.

In creek N. of South Corbyn's Cove, Port Blair, 15-ii-1935 .. .. 2 specimens.

Freshwater stream with muddy and sandy bottom near Weli village, Base Camp, Middle Andaman, 2-iii-1935 .. .. 1 specimen.

Stream below Machchaligaon, Port Blair, 6-ii-1936 .. 1 specimen.

Ophiocara aporos var. **hoedtii** (Bleeker).

From a stream close to Rangat Camp, Middle Andaman, 19-i-1935 .. .. .. 4 specimens.
In creek N. of South Corbyn's Cove, Port Blair, 15-ii-1935 .. .. 2 specimens.
Stream below Machchaligaon, Port Blair, 6-ii-1936 .. 19 specimens.

Ophiocara porocephala (C. & V.).

In creek N. of South Corbyn's Cove, Port Blair, 15-ii-1935 .. .. .. 4 specimens.

Butis sp.

From a freshwater stream near Rangat Camp, Middle Andaman, 19-i-1935 .. .. .. 1 specimen.

This specimen is too young for specific identification.

ON A NEW TREMATODE GENUS *PROACETABULORCHIS* AND A NEW SPECIES OF THE GENUS *PROCRASSIPHIALA* VERMA 1936 FROM RANGOON.

By B. S. GOGATE, *Biological Department, University of Rangoon.*

Proacetabulorchis prashadi, gen. *et* sp. nov.

Location.—Liver.

Description.—Body very elongated, 3-4×0·3-0·5[1]; maximum breadth in the region of ventral sucker; cuticle smooth. Oral sucker subterminal 0·15-0·18×0·18, with moderately developed musculature. Ventral sucker 0·4-0·448×0·41-0·5, with stronger musculature than the oral, and close to the oral. Mouth subterminal; prepharynx indistinct; pharynx 0·07-0·077×0·08-0·09; oesophagus 0·1-0·12 long; caeca reaching the end of the middle third of body length, almost all their way covered by uterine coils and vitellaria.

Testes moderate sized, oval, smooth margined, directly preacetabular, partially overlapping, and one behind the other: Anterior testis 0·21-0·23×0·106-0·12; Posterior testis 0·17-0·18×0·13-0·14, partly overlapped posteriorly by ventral sucker. Cirrus sac small, 0·14-0·15× 0·07-0·08, median, enclosing a very much coiled vesicula seminalis and opening along with the uterus close to the base of pharynx.

Ovary roundish, 0·16-0·18×0·18-0·19, dextral, postacetabular separated by some distance from ventral sucker. Shell gland near posteromesial margin of ovary. Receptaculum seminis and Laurer's canal indistinct in whole mount. Uterus very much coiled, occupying whole of the body behind ventral sucker masking almost all other anatomical details from view. Vitellaria composed of moderately sized follicles, lateral, and usually extra and overcaecal but occasionally intercaecal, commencing from behind the ventral sucker to about 1·49 of total body length, thus occupying a little more than the middle third of body length in anterior part of body. Eggs, yellow, operculate, 0·031-0·0315×0·016-0·0175. Excretory bladder Y-shaped, excretory pore at posterior tip of body.

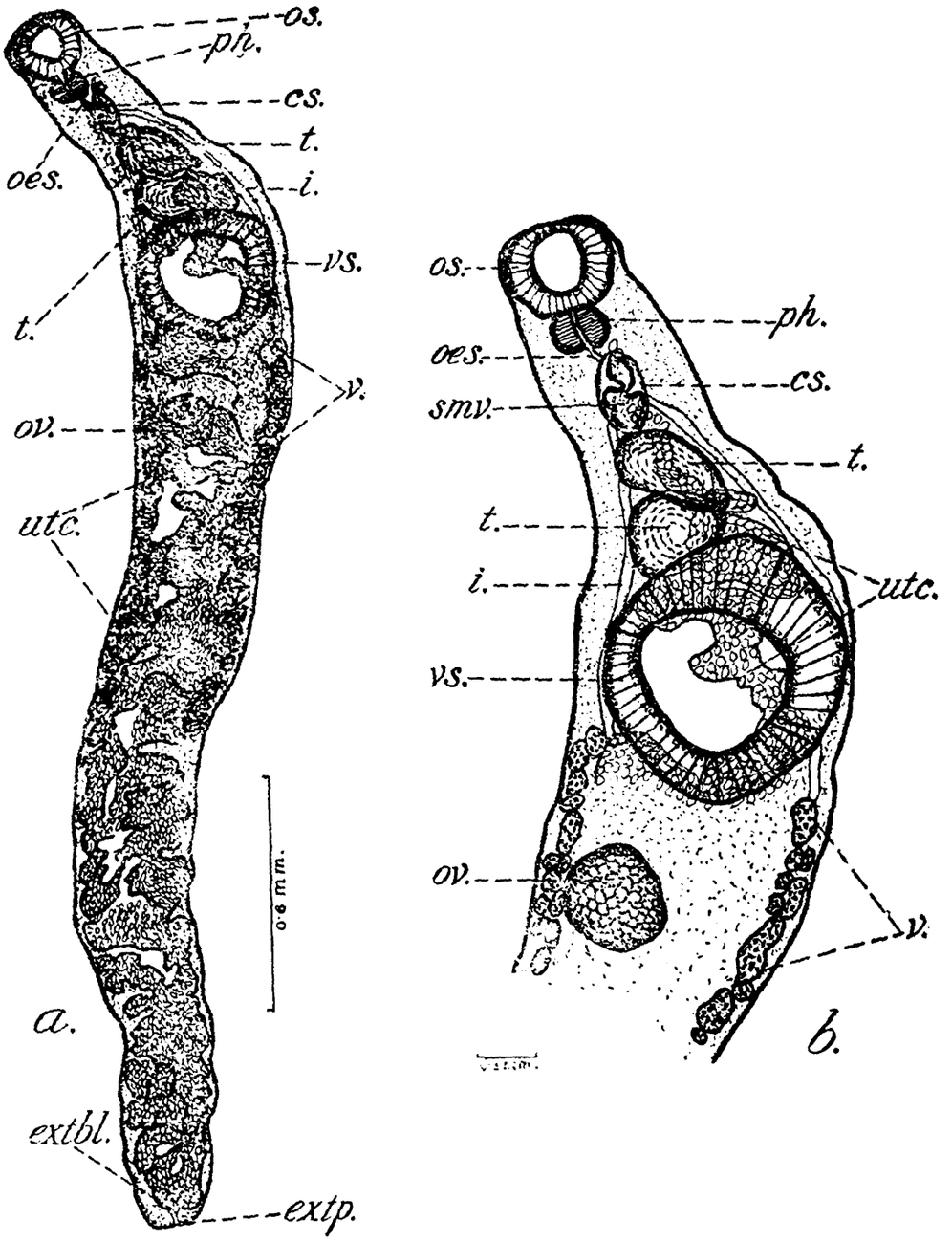
Remarks.—There are only two genera in the subfamily Dicrocoeliinae Looss 1899, in which both the testes are preacetabular, namely, *Platynotrema* Nicoll 1914 and *Euparadistomum* Tubangui 1931. From both of these genera *Proacetabulorchis* differs in having:—

(*a*) narrow elongated body,
(*b*) position of ventral sucker close to the oral,
(*c*) genital pore at base of pharynx,
(*d*) obliquely situated partially overlapping testes,
(*e*) dextral position of ovary much separated from ventral sucker,
(*f*) commencement of vitellaria from behind ventral sucker, and
(*g*) distribution of uterine coils.

[1] All measurements in mm.

These characters are utilized in drawing up the following diagnosis of *Proacetabulorchis*:

Dicrocoeliinae with, narrow elongated body; smooth cuticle; ventral sucker larger than the oral and close to oral; genital pore at base of



TEXT-FIG. 1.—*Proacetabulorchis prashadi*, gen. *et* sp. nov., *a*. Entire, ventral view. *b*. Anterior portion of body, ventral view.

pharynx; testes, asymmetrical, preacetabular, and partially overlapping each other; ovary roundish, dextral, situated in anterior half of the body and widely separated from ventral sucker; uterus occupying whole body behind ventral sucker, masking all other details from view; vitellaria lateral, commencing behind ventral sucker, extra, over and occasionally intercaecal.

Parasitic in liver of birds.

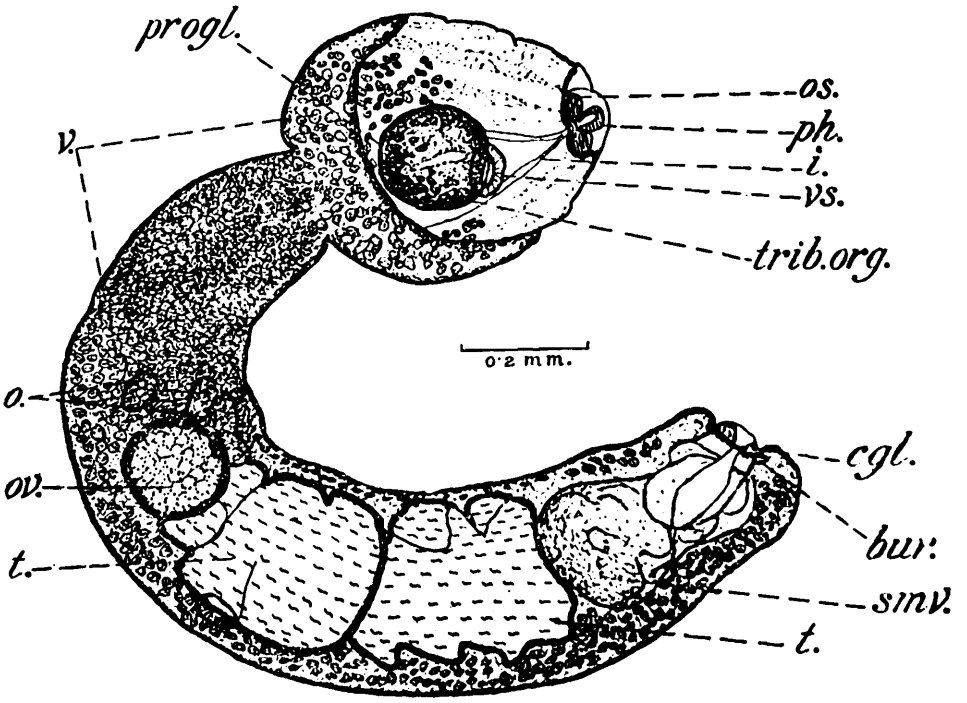
Genotype.—Proacetabulorchis prashadi, sp. nov.[1]

The species is dedicated to Dr. Baini Prashad in recognition of the facilities afforded to the author during his stay in Calcutta in connection with the study of helminth literature in the library of the Indian Museum.

Procrassiphiala halcyonae, sp. nov.

Location.—Intestine of the kingfisher *Halcyon smyrnensis* (Linn. 1758).

Description.—Total length 2·229. Anterior body segment 0·598× 0·440, short, flat, with lateral folds more prominent posterolateral to tribocytic organ. Anterior tip of anterior body segment ventrally curved, with the result that pharynx appears anterior to oral sucker. Ventral sucker 0·0557×0·0901, transversely elongated, and approximately half overlapped by tribocytic organ. Tribocytic organ ellepticcal, with a long median furrow, without marginal papillae, and with distinct proteolytic glands situated at its posterior margin. Oral sucker approximately 0·1 in diameter; prepharynx indistinct; pharynx 0·045 ×0·037, communicating with a short oesophagus indistinct because of the folding of the anterior tip of body. Caeca distinct upto the region of tribocytic organ. Posterior body segment cylindrical, curved, 1·631×0·345, separated from the preceding segment by a constriction.



TEXT-FIG. 2.—*Procrassiphiala halcyonae*, sp. nov., Entire, ventral view.

Testes very large, lobed structures, situated one behind the other and partially overlapping, occupying posterior half of body. Anterior testis 0·370×0·278, a little overlapped by ovary. Posterior testis 0·370×0·287. Vesicula seminalis coiled, voluminous. Ovary 0·172,

[1] Type-specimen (No.W. 3431/1) in the Collection of the Zoological Survey of India, Indian Museum, Calcutta.

spherical, situated in middle of body approximately 0·49 from intersegmental constriction. Genital opening on a cone lodged in bursa copulatrix which is not very deep. Ova few, 0·073-0·082×0·047-0·051. Vitellaria in both segments of body, not passing anterior to tribocytic organ, very thick between ovary and anterior segment, and continued behind ovary upto posterior tip of body.[1]

Remarks.—Characteristically large testes, 2·72 times longer posterior body segment, elleptical tribocytic organ, approximately one third in length to that of anterior body segment, absence of prepuce and muscular structure in the walls of bursa copulatrix, bring this form under the genus *Procrassiphiala* Verma 1936. Verma's diagnosis of the genus is very brief and is not supplemented by any figure. Of the two species allotted to this genus by Verma, *P. cuckooai* Verma 1936 has because of anatomical considerations been transferred by Dubois (1938) to the genus *Neodiplostomum* Railliet 1919. Dubois has further added *Neodiplostomum fungiloides* Semenov 1927 to Verma's genus. Thus there are two species under the genus *Procrassiphiala* from which the present form is separated by the combination of characters given in the following table :—

—	*P. titricum* Verma 1936.	*P. fungiloides* (Semenov 1927) Dubois 1938.	*P. halcyonae*, sp. nov.
Length of posterior segment. / Length of anterior segment.	1·35-1·39	2·07	2·72
Ventral sucker	separated from tribocytic organ.	?	half overlapped by tribocytic organ.
Tribocytic organ	0·336×0·250-0·290	0·342×0·365	0·180×0·172
Testes	0·67×0·42	0·480	0·370×0·278
	0·63×0·46		0·370×0·287
Ovary	0·126×0·168	0·114×0·205	0·172
Eggs	0·1008-0·1009×0·050-0·058	0·081-0·088×0·055	0·073-0·082×0·047-0·051
Host	*Sarcogrammus indicus* Bodd. (Charadriiformes)	*Scolopax rusticola* L. (Charadriiformes)	*Halcyon smyrnensis* (Linn. 1758). (Coraciformes)

[1] Type-specimen (No. W. 3432/1) in the Collection of the Zoological Survey of India, Indian Museum, Calcutta.

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EXPLANATION OF LITTERING IN TEXT-FIGURES.

bur., bursa copulatrix ; ***cgl.***, genital cone ; ***cs.***, cirrus sac ; ***extbl.***, excretory bladder ; ***extp.***, excretory pore ; ***i.***, intestine ; ***o.***, ova ; ***oes.***, oesophagus ; ***os.***, oral sucker ; ***ov.***, ovary ; ***ph.***, pharynx ; ***progl.***, proteolytic gland ; ***smv.***, seminal vesicle ; ***t.***, testis ; ***trib. org.***, tribocytic organ ; ***utc.***, uterine coils ; ***v.***, vitellaria ; ***vs.***, ventral sucker.

ON A BLIND ROHU FISH, *LABEO ROHITA* (HAM.).

By K. KRISHNAN NAIR, *B.A., Officiating Gallery Assistant, Zoological Survey of India, Calcutta.*

CONTENTS.

INTRODUCTION.

On September 9, 1939, Mr. R. M. Chatterji, Cashier, Geological Survey of India, presented the head of a blind Rohu fish, *Labeo rohita* (Ham.), to the Zoological Survey of India, and very kindly supplied the following particulars about it :—

"The head was purchased by me this morning from the Dum Dum market. The fish weighed 1 seer and 3 chataks (about 2·4 lbs) and was caught at Bagjola, in a marshy fishery about half a mile east of Dum Dum Railway Junction on the Eastern Bengal Railway."

After consulting the literature regarding such abnormalities in fishes and a superficial examination of the specimen, Dr. S. L. Hora considered it of exceptional interest and very kindly handed over the specimen and the relevant literature to me for detailed study.

I have to record my grateful thanks to Dr. Baini Prashad, Director, Zoological Survey of India, for allowing me full facilities to carry out the investigation and for his valuable criticism. I am also grateful to Dr. Hora for affording me an opportunity to study such an interesting and rare abnormality, and for his constant help and guidance in the course of my work. My thanks are also due to Mr. R. M. Chatterji who showed unusual interest in nature study by presenting this specimen to the Zoological Survey of India and later accompanying me to the fishery and the market whence the blind Rohu was procured.

HISTORY OF THE SPECIMEN.

As indicated above, the specimen under report was caught at Bagjola near Calcutta. I visited the area on the 12th October, 1939, and found that the fishery consists of an extensive, intercommunicating, marshy region situated about half a mile east of the Dum Dum Junction Railway Station between the Dum Dum Road on the south and the Dum Dum-Khulna railway track on the north. The entire fishery, with the exception of a narrow strip of clear water about 30 feet broad connecting the culverts of the bridges, was practically covered with

aquatic vegetation. The water was stagnant and foul smelling, except in the clear portion where a slow current was noticeable. The average depth of water was stated to be about 5 feet. The bottom was covered with loose, soft mud to a depth of about 2 feet. This marshy area drains towards the south-west where it is continuous with a "jheel", which was stated to extend as far as the Jessore Road. The blind fish was caught from the clear piece of water in a fixed bamboo trap, locally known as *Atol*. According to the local fishermen, fish move from one side of the marsh to the other across the clear strip of water and invariably good catches are made with fixed traps and similar contrivances.

Several fishermen were questioned regarding the occurrence of the blind Rohu in this fishery, but no such abnormalities had been seen or heard of before. The fisherman, who caught the blind fish, stated that he was not aware of the blindness of the fish till a customer, after purchasing the fish noticed the abnormality and returned it to him. When for a long time he found it impossible to sell the blind fish, he cut off its head, and the fish was then readily sold. Mr. Chatterji observed the abnormal head and out of curiosity purchased it, and presented it to the Zoological Survey of India.

A study of the literature has shown that cases of blindness in fishes, excepting the normally blind fishes of caves, etc., are very rare. However, a similar case was recorded by von Baer (1862, pp. 215-220) of *Cyprinus gibelio* [*Carassius carassius* (Linn.)] about four inches in length ; I refer to this case later.

Description of the Specimen.

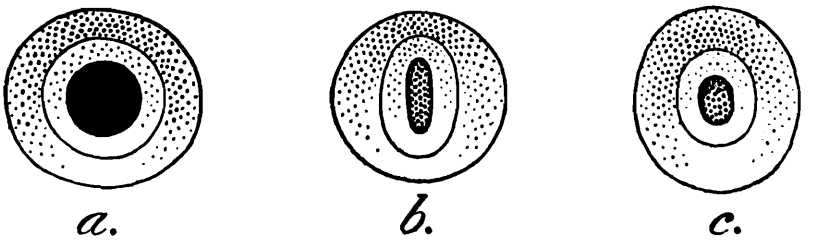
The length of the abnormal head was 80·7 mm. With the exception of the eyes, which were covered over with skin, the head of the blind Rohu seemed to be more or less normal in all respects (text-fig. 1 *a*, *b*) ; the sensory papillae on the head and the snout were, however, more numerous than in normal specimens.

Text-fig. 1.—Head of the blind Rohu, *Labeo rohita* (Ham.). $\times \frac{2}{3}$
(*a*) Right side ; (*b*) Left side.

Left eye :—In the specimen (text-fig. 1 *b*), which had been preserved in spirit, the position of the eye was indicated ventrally by the row of sensory papillae and dorsally by the orbital bone. The lower half of this area, which was lunate in outline, was somewhat transluscent and slightly bluish in colour. The upper portion of the eye region and the

dorsal surface of the head were uniform deep grey. There was an unmistakable shallow depression in the place where the eye is normally situated, and in the centre of this concavity there was a small dull white patch. Under a low magnification, low, narrow ridges of the skin were seen to radiate from this dull whitish patch.

The thick skin covering was reflected backwards by longitudinal slits and the eye was exposed. The space between the outer skin and the eye was filled with a fatty tissue which had to be removed to expose the eye. The postero-ventral side of the eye was rigidly attached by a muscle to the bone below ; I have not found any such structure in a normal eye of this species. On account of the muscular attachment noted above, the eyeball was turned posteriorly at an angle of somewhat more than 45 degrees so that what was exposed, after the removal of the fat, was a portion of the white of the eye. The eyeball was hard to the touch and the cornea was not punctured. Even if this eye had not been covered by the skin, it could have been of no use to the fish, inasmuch as it was partly turned posteriorly and was immovably fixed to the bone in this position. All the six muscles, which help in moving the eyeball, were present, but the Superior Rectus and the External Rectus were fused together to form a broad muscle near their attachment to the eyeball, while they were quite distinct near their attachments to the bones.



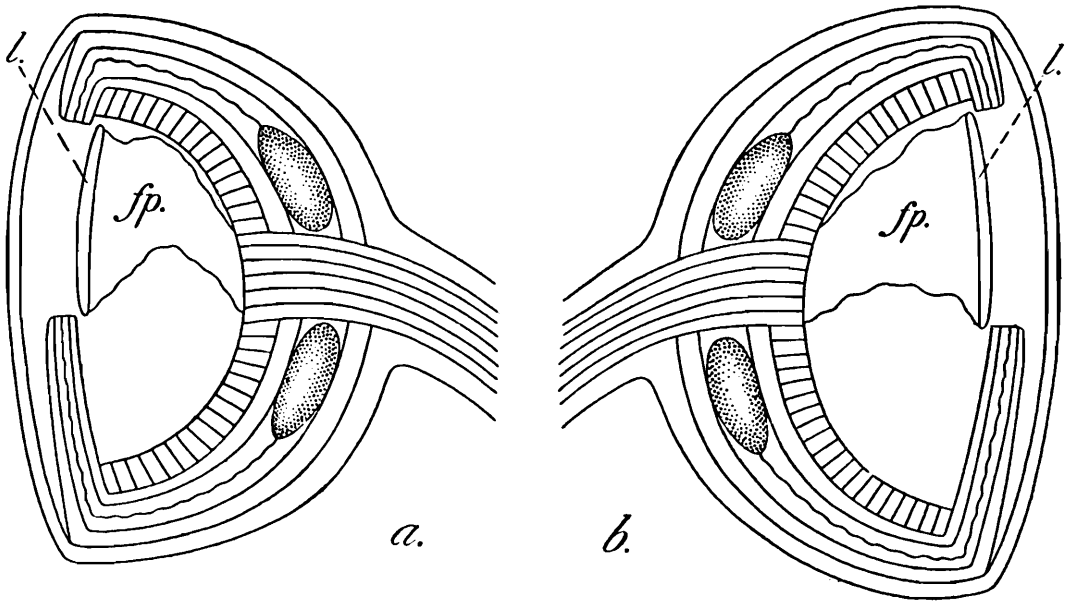
TEXT-FIG. 2.—Diagrammatic representation of the front view of the eyes of *Labeo rohita* (Ham.) showing the form of the iris in (*a*) a normal specimen, (*b*) the right eye of the abnormal specimen and (*c*) the left eye of the same. × ½.

The eye (text-fig. 2 *c*) was of a comparatively small size and in shape represented a vertically placed oval with an iris of the same shape. A normal eye (text-fig. 2 *a*) on the other hand, is circular with a circular iris and is comparatively much larger. For comparison the measurements of the head, eyes, etc., of a normal and the blind specimen are given below :—

Specimen.	Size of Head.	Left eye.				Right eye.			
		Eyeball		Iris.		Eyeball.		Iris.	
		Length.	Breadth.	Length.	Breadth.	Length.	Breadth.	Length.	Breadth.
Normal	78	15	14	11	11	15	14	11	11
Blind	80·7	15	13	11	7	12	15	9	7

All measurements are in millimetres.

Microtome sections of the eye could not be prepared as the specimen was poorly preserved, but the gross anatomy of the eye and the related structures was studied so far as possible. The eye was divided into two symmetrical halves by a median vertical cut and all the internal structures exposed. It was found that the normal globular lens only was absent, but all other structures were represented (text-fig. 3*b*).



TEXT-FIG. 3.—Sections of the eyes of the abnormal *Labeo rohita* (Ham.). Diagrammatic. *a*. Right eye ; *b*. Left eye.
l. lens ; *fp*. Falciform process.

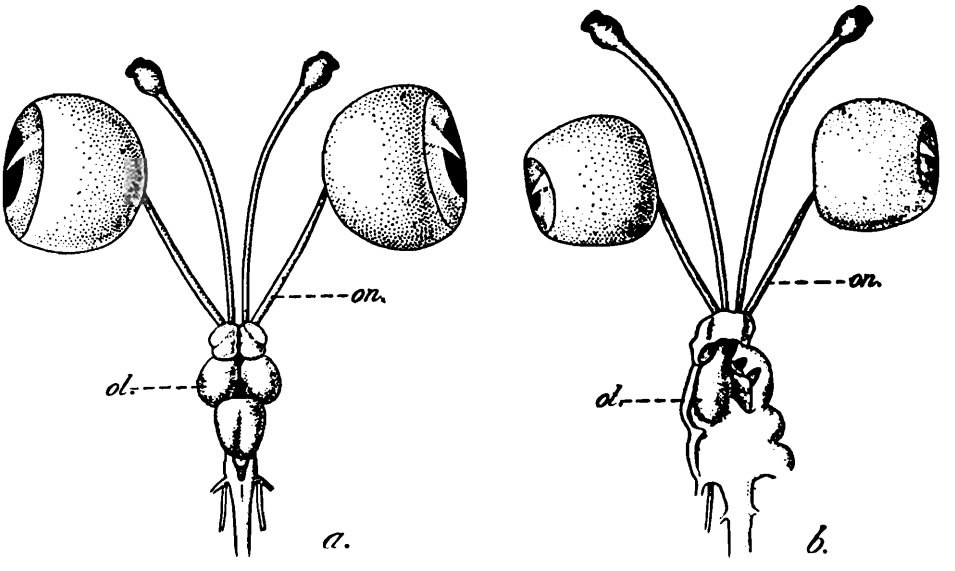
Under a binocular a hard, flat, leaf-like structure (text-fig. 3 *b*, *l*.) could be noticed occupying a part of the space where the lens is normally situated. On its posterior surface the relatively large *Campanula Halleri* end of the falciform process (text-fig. 3 *b*, *fp*.) was attached. The flat structure noted above, probably represents a degenerate lens. The lens in a normal specimen is large, globular and very hard to the touch.

Right eye :—The condition of the right eye (text-fig. 1 *a*) was similar to that of the left eye, but it was not completely covered by the thick skin and there was a small oval aperture in the centre, 2·5 mm. long and 1·5 mm. broad. Externally the boundary of the eye was marked ventrally by a few sensory papillae, while dorsally the supra-orbital bone had grown to such an extent as to cover the dorsal half of the area containing the eye. The area of the eye not covered by the bone was semilunar in appearance. There were several low ridges of skin radiating outward from the periphery of the aperture. The white structure visible through the small hole was slightly raised and uneven, indicating a superficial fibrous growth. The orbital area was bluish black above and below, but triangular dirty white areas were present along the sides.

On dissection it was found that the supra-orbital bone had grown over in a latero-ventral direction, so that it partially covered the eye. Besides, the eye was turned posteriorly by almost 90 degrees, so that the white structure visible through the aperture was only a portion of the white of the eyeball. Below the thick outer skin covering of the eye there was another layer of thin skin with a small perforation

corresponding in position to the one in the outer layer of the skin. The space between the two layers was filled up by a fatty tissue. The iris was not circular, as in a normal specimen, but appeared as a narrow vertical oval slit. Though there was no special muscle on the ventral side of the eye fixing it to the bone below, as was the case in the left eye, the hypertrophy of the supra-orbital bone presumably did not allow any kind of movement of the eyeball. The cornea was very thick, fibrous and opaque.

The right eye (text-fig. 2 *b*) was pressed dorso-ventrally to a greater extent than the left, and the iris was slightly smaller. This is clear from the measurements given in the table above. The condition of the internal structures (text-fig. 3 *a*) was similar to that of the left eye, but the degenerate lens (text-fig. 3 *a*, *l.*) was still smaller in size.

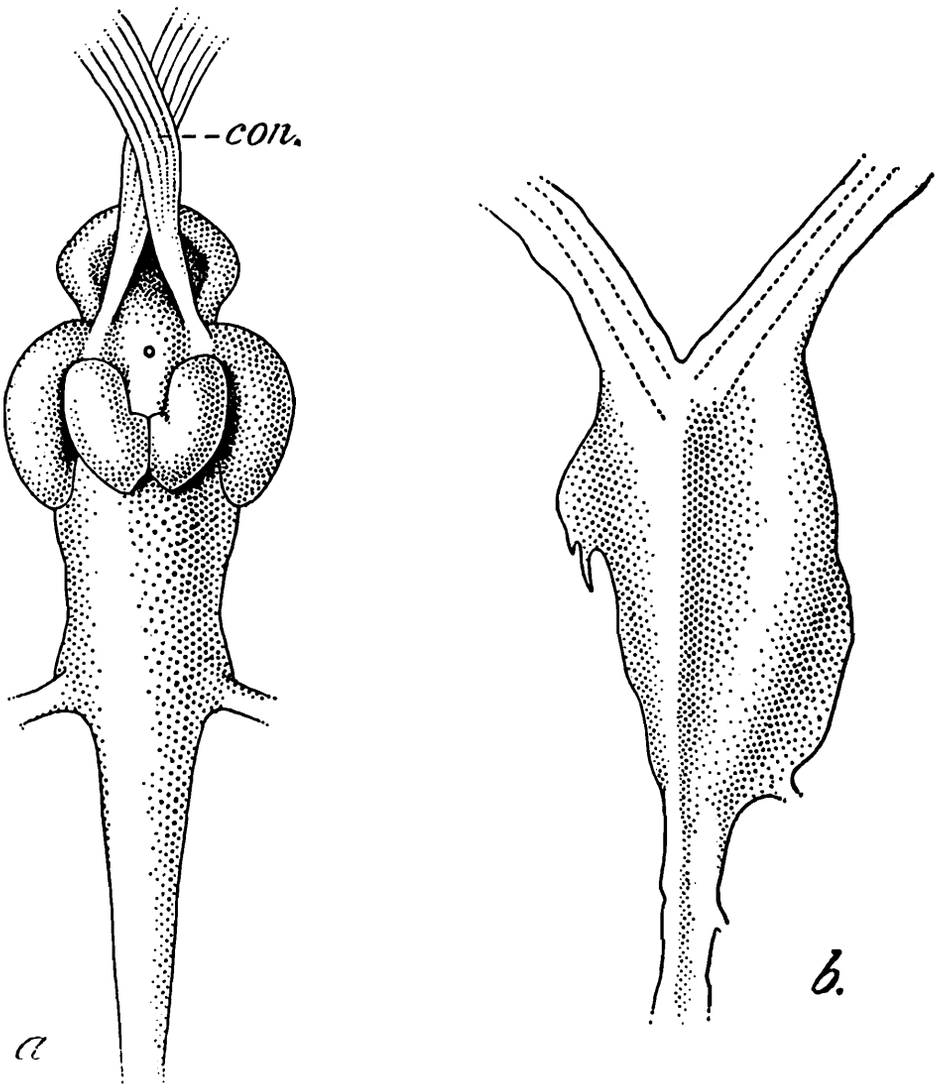


TEXT-FIG. 4.—Dorsal view of the brain, eyes and olfactory organs of a normal and the abnormal Rohu, *Labeo rohita* (Ham.).

a. Normal specimen. *ca*. Nat. size ; *b*. Abnormal specimen. *ca*. Nat. size.
ol. Optic lobe ; *on*. Optic nerve.

Brain.—To examine the brain and the nerves, ths skull was dissected from dorsal side. The brain (text-fig. 4 *b*) was very abnormal. The optic lobe (text-fig. 4, *ol.*) of the left side only was feebly developed, while that of the right side was not at all developed. The optic nerves were thick and rounded. All other cranial nerves were more or less normal. The ventral aspect of the brain (text-fig. 5 *b*) exhibited its abnormal nature more distinctly. It was quite flat but separate areas of the different regions of the brain could be distinguished as in a normal specimen. In the blind specimen there was no crossing of the optic nerves as is normally the case, but the two nerves originated from a forked stump which was a forward elongation of the optic lobe of the left side. The vagal region of the medulla oblongata was fairly distinct on the left side, but completely suppressed on the right. Even in a normal brain of *L. rohita* the vagal and facial lobes are comparatively much reduced ; and differ materially from those of the European Carp (*Cyprinus carpio*) as described by Evans (1931). According to Evans large vagal and facial lobes occur in species which obtain their

nourishment mainly from muddy bottoms. The enlarged left vagal lobe of the blind Rohu may indicate its excessive feeding on the bottom



TEXT-FIG. 5.—Ventral view of the brain of a normal and the abnormal Rohu, *Labeo rohita* (Ham.).

a. Normal specimen. ×3½; *b*. Abnormal specimen ×2⅕.

con. Crossing of the optic nerves.

mud and in this connection it may perhaps be mentioned that the fisherman, who caught this fish, had noticed that its alimentary canal was more bulky and contained a large quantity of mud.

GENERAL DISCUSSION.

It has been remarked above that the case of the abnormal Rohu corresponds to some extent to that of the blind Carp described by von Baer (1862). In both cases the head was well developed and the eyes were covered over by skin though their outlines were indicated. Both the abnormal specimens had been obtained from muddy waters where individuals with well developed eyes were always caught. Though von Baer hinted at the probable absence of light as a cause for the blindness of the fish, he did not possess sufficient data to support his hypothesis. In the case of Rohu, however, I am definitely of the opinion that, in view of a large number of normal individuals being daily caught

from the Bagjola fishery, the absence of light in the bottom layers of certain parts of the fishery cannot be a factor in producing the abormality reported above. The teratological condition of the blind Rohu is probably an outcome of the defective disposition of the brain. The brain must have become defective at a very early stage, and this must have influenced the development of the eyes which make their appearance at a fairly early stage of development. It is probable that the dislocation of various nerve centres in the brain caused the growth of the accessory structures of the abnormal eyes, namely, an extra muscle in the left eye, and the hypertrophy of the normal circular eye-lids which had become almost continuous, and completely covered the left eye and incompletely the eye of the right side, while the hypertrophy of the supra-orbital bone of the right eye may also have been responsible for inhibiting its normal development. The overgrown supra-orbital bone on the right side and the extra muscle on the left side had pushed the respective eyes posteriorly and had rendered them useless as organs of sight, while the circular eye-lids grown over the twisted eyeballs had made it impossible for any light to reach the retinal layers. The lens might have atrophied through disuse, while the hypertrophy of the falciform process resulted in its development into an unusually large structure attached to the entire posterior surface of the degenerate lens. The weight of the fish, the size of the head and the fact that it was caught while migrating from one part of the fishery to another indicate that the fish, though blind, was probably leading a more or less normal life. Probably the loss of the sense of sight had been compensated for by the development of a larger number of sensory papillae on the head. It is also probable that the lateral line organs may have been better developed in the blind fish. In any case the absence or reduction of eye in a fishery like that of Bagjola could not be a factor of very great importance in the life of the fish provided the loss of sight was compensated by a greater development of tactile organs.

Captain S. C. Dutt, Ophthalmic Surgeon, Mayo Hospital, was approached for an explanation of the ocular abnormality reported above, and after examining my preparations and report very kindly favoured me with the following note. I am greatly indebted to Capt. Dutt for the interest shown by him in this matter.

"The ocular condition discussed by Mr. K. K. Nair is obviously congenital and may be due to a more or less combination of the following factors of developmental errors, occurring at that period of Embryonic Life when the Primary Optic Vesicles begin to differentiate :—

"1. Imperfect development of the anterior part of the Neural Tube, resulting in the original cells, from which the two Optic Vesicles sprout out, to become fully and distinctly differentiated into two distinct separately growing areas in the early life of the embryo. This probably accounts for the irregular and abnormal sizes of the Optic Lobes of the fish under investigation. At a later stage, a certain amount of Dual Differentiation appears to have taken place resulting in the development of two separate, abnormal and irregular eyes. If the differentiation into two growing areas had not occurred at all, the condition of the eyes of this fish might have been what is called Complete

Synophthalmia or Cyclopia—One-eyed or United-eyed. Stockard[1] has shown that it is possible to induce such developmental irregularities by subjecting eggs of fishes to the action of magnesium salts dissolved in sea water.

" 2. Failure of the Primary Optic Vesicle in the embryo to bud out normally. When this is complete, it produces Anophthalmia, but when this is partial the result, as in the case of the fish under discussion, is an imperfect ocular growth.

" 3. Failure of the invagination of the Primary Vesicle of the developing embryo. If this failure is absolute, a cystic sort of imperfectly developed eyeball results, but an incomplete failure in invagination during the process of early embryonic development results in an irregular sort of eye structure.

" The abnormal eyes of the blind Rohu represent, in my opinion, a condition of developmental irregularities in the early embryonic life of the organism, *viz.*, irregular and partial arrest of growth of the developing Neural Canal, improper sprouting out of the Primary Optic Vesicles from the original embryonic cells and a certain amount of arrest in the process of normal invagination in the Primary Optic Vesicles in the developing embryo.

" The exact aetiology of the causation of the abnormality under review, is not capable of being clearly explained. We can surmise that, factors like Trauma, Chemical Irritants or some sort of Photo-Chemical Stimulus from surroundings in the embryonic stage of the developing organism's life might have been the agencies which determined the production of the abnormal condition cited.

" Following the lines adopted by Gemmill[2] in discussing the probable causation of Cyclopia, I would place the aetiology of the abnormal ocular manifestation discussed above under one of the following heads :—

" (1) *Mechanical.*—" Trauma " or pressure in a very limited area of the developing embryonic cells, which provoked a minimal degree of interference with the development of other structures.

" (2) Some sort of Chemical or Photo-Chemical substance in the immediate surroundings of the developing egg exerting irritation in some particular sets of growing cells concerned with ocular development, and thereby preventing the normal development of the eyes. As noted already, magnesium chloride and lithium salt experiments of Stockard (*loc. cit.*) and Herbst[3] have proved that certain chemicals specifically influence along these lines the developing eggs of fishes and sea-urchins respectively.

" (3) *Autogenetic* or *Spontaneous origin.*—This is doubtful as a causative factor for the type of abnormality in question. In abrupt spontaneous variations, one is prone to find multiple or at least more than one specimen exhibiting the same kind of perverted development."

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[1] Stockard, C. R., *Journ. Exp. Zool.* VI, pp. 285-337 (1909).

[2] Gemmill, J. F., *Teratology of Fishes*, p. 44 (1912).

[3] Herbst, C., *Zeitsch. f. wissensch. Zool.* IV, pp. 446-518 (1892); *Mittheil. aus der Zool. Station zu Neapel* XI, pp. 136-220 (1893).

SUMMARY.

The abnormal structure of the eyes of a blind Rohu fish, *Labeo rohita* (Ham.) and the provenance of the specimen are described in detail. The eyes were found to be completely or partially covered by skin, while the eyeballs were turned at an angle from their normal position ; the left eye was found to be fixed to its new position by means of a muscle, not present in normal specimens, and the right eye was kept in its new position by a hypertrophied growth of the supra-orbital bone. The brain was found to be defective and asymmetrical in several respects. It is presumed that the brain had probably become abnormal at a very early stage of development, and the normal development of the eyes had thus been inhibited. Reference is made to a similar case of Carp reported by von Baer in 1862. From the size of the specimen it is presumed that the lack of eyes did not affect the normal mode of life of the fish in the Bagjola fishery.

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Baer, K. E. von. 1862.—Ein Wort über einen blinden Fisch als Bildungs-Hemmung. *Bull. de Academie Imperiale des Sciences de Saint-Petersbourg* IV, pp. 215-220.

Evans, H. Muir. 1931.—A comparative study of the Brains in British Cyprinids in Relation to their habits of Feeding, with special reference to the Anatomy of the Medulla Oblongata. *Proc. Royal Soc. London* B. vol. CVIII, pp. 233-257.

FURTHER OBSERVATIONS ON THE BIONOMICS AND FISHERY OF THE INDIAN SHAD, *HILSA ILISHA* (HAMILTON), IN BENGAL WATERS.

By SUNDER LAL HORA, *D.Sc., F.R.S.E., F.N.I., Assistant Superintendent, and* K. K. NAIR, *B.A., Officiating Gallery Assistant, Zoological Survey of India, Calcutta.*

CONTENTS.

INTRODUCTION.

In a recent article one of us[1] recorded preliminary observations on the spawning grounds and bionomics of *Hilsa* in the river Hooghly and adduced evidence to show that the fish breeds over an extensive period, though the peak period of breeding occurs during the rainy season. It was also indicated that the fish can flourish well in confined fresh waters and even attain maturity. Reference was made to the probable rate of growth and life-history of the species, and from the discovery of a regular fishery of young *Hilsa* in cold weather at Nawabgunge near Calcutta it was suggested that more attention should be paid to the conservation of the *Hilsa* fisheries rather than to the establishment of hatcheries for the artificial breeding of this fish.

In reviewing Hora's article under the title "Spawning of *Hilsa*", Jenkins[2] made some valuable observations, mainly based on his personal experience of *Hilsa* investigations in Bengal, and suggested several useful lines of work for a proper elucidation of the life-history of the species. Devanesen[3] in his note "Research Work on the *Hilsa*" directed particular attention to the work of the Madras Fisheries Department on the life-history of the species and stated that "The collection and hatching of Hilsa eggs continues as a routine at Madras" but probably the rearing of the delicate fry has yet to be attempted as was stated by Sundara Raj[4] as early as 1917. Owing to the continuation of biological investigations at the Pulta Water-works by the Zoological Survey of India, we have been able to collect a considerable amount

[1] Hora, S. L., *Rec. Ind. Mus.* XL, pp. 147-158 (1938).
[2] Jenkins, J. T., *Curr. Sci.* VII, pp. 251, 252 (1938).
[3] Devanesen, D. W., *Curr. Sci.* VIII, p. 126 (1939).
[4] Raj, B. Sundara, *Journ. Proc. As. Soc. Bengal* (N. S.), XIII, p. clxxxiv (1917).

of additional information about the bionomics of *Hilsa*[1]. Dr. Baini Prashad, Director, Zoological Survey of India, very kindly permitted Mr. M. N. Datta to carry out an enquiry on *Hilsa* in East Bengal in February 1939, and as a result of Mr. Datta's work considerable light has been thrown on the breeding of the species in the rivers of Eastern Bengal. Valuable material was also received from Allahabad through the kindness and courtesy of Professor D. R. Bhattacharya. These additional data make it possible to give further details regarding the life-history and bionomics of the fish.

INVESTIGATIONS AT THE PULTA WATER-WORKS.

Breeding season and growth rate during early stages.—The authorities of the Water-works at Pulta very kindly permitted the use of the *Pucca* Settling Tank No. 4 for recording monthly observations on the breeding of *Hilsa* and other fish of the river Hooghly. This is an isolated tank, 500 ft. long, 250 ft. broad and on an average about 8 ft. deep. It is occasionally charged with river water, but when the water in it becomes sufficiently settled, upper half or more, depending upon the suitability of water, is drawn off to the filter beds, and the tank is filled up again with river water. This process is repeated from 2 to 8 times in a month depending upon the weather conditions and the amount of suspended matter in the river water at different seasons. As already explained by one of us[2], only eggs or larvae of fish can pass from the river through the centrifugal pumps to the Settling Tanks. In the observations recorded here advantage was taken of this fact and by dewatering the tank almost completely once a month the young of the various species of fish developed from eggs or larval forms received from the river during the month were collected. It was, however, too costly to dewater the tank completely and to clean it up properly every month, so some young forms received in the tank during the earlier months usually got mixed up with the stock that came in later, but they could be readily eliminated on account of their larger size. The material thus collected for one year (first collection was made on December 28, 1937), has furnished valuable data regarding the season of breeding and the probable rate of growth of a number of species found in the river Hooghly. This article is confined only to the *Hilsa* investigations.

Young specimens of *Hilsa* ranging in length between 20 mm. and 40 mm. were found in the Settling Tank every month thereby definitely proving that the fish breeds in the river throughout the year. The largest number of young specimens, over four thousand (797 between 20 to 29 mm.; 660 between 30 to 39 mm.; 2,896 between 40 to 49 mm.; 16 between 50 to 59 mm. and 13 between 60 to 99 mm.), were collected on the 26th of August, 1938. There can hardly be any doubt, therefore, that August represents the peak period of breeding of the species in the river Hooghly. During September, October and November the

[1] Attention may here be directed to a recent paper " On some early stages in the development of the so-called Indian Shad, *Hilsa ilisha* (Hamilton) " by Nair (*Rec. Ind. Mus.* XLI, pp. 409-418, 2 text-figs. 1 pl., 1939). The early stages of *Hilsa* described in this article were collected from the *Pucca* Settling Tank No. 4 of the Pulta Water-works.

[2] Hora, S. L., *Rec. Ind. Mus.* XL, p. 150 (1938).

species was found to be still actively breeding for the number of young *Hilsa* collected at the end of November exceeded 2,000. The rate of breeding slowed down during the winter months, but another low peak occurred in May after the nor'westers of March and April. There is thus reason to believe that the flows of greater volume of fresh water down the river after the rains incite the *Hilsa* to migrate upstream for breeding purposes. It may be mentioned that, as is well known, there is a close association between the flooding of the rivers, either as a result of heavy rains or the melting of snows, and the *Hilsa* fishery.

On October 30, 1938, after making a collection of young fish, the *Pucca* Settling Tank No. 4 was completely dewatered and even flushed to drain away all young fish of the previous months into the river. On 29th November, 1938, the young fish were collected from this tank, and as many as 2,029 juvenile specimens of *Hilsa*, which could easily be recognised, were obtained. These specimens are arranged according to their lengths in the table below :—

TABLE I.

Young Hilsa *collected on 29. xi. 1938, from* Pucca *Settling Tank No. 4.*

Length in mm.	No. of specimens.	Length in mm.	No. of specimens.
21	31	29	157
22	60	30	51
23	125	31	66
24	203	32	41
25	267	33	27
26	396	34	18
27	382	35	8
28	197		

During the period from the 30th October, 1938, to the 29th November, 1938, the tank was filled with the river water on the following days and the quantity of water introduced into the tank on each occasion can be judged from the number of hours that were taken to fill the tank on each occasion :—

30th October, 1938.—10 a.m. to 9 a.m. on 31. *x.* 38. *23 hours.*
2nd November, 1938.—12 night to 2 p.m. *14 hours.*
5th November, 1938.—6 p.m. to 9 a.m. on 6. xi. 38. *15 hours.*
13th November, 1938.—3 p.m. to 12 night. *9 hours.*
18th November, 1938.—12 night to 9 a.m. on 19. xi. 38. *9 hours.*
20th November, 1938.—3 p.m. to 9 a.m. on 21. xi. 38. *18 hours.*
26th November, 1938.—12 night to 3 p.m. on 27. xi. 38. *15 hours.*

Supposing that every time the tank was filled eggs and larval froms of *Hilsa* were introduced into it, it would be reasonable to believe that after hatching *Hilsa* can attain a maximum size of 35 mm. in one month under the conditions prevailing in November. In summer months the growth is more rapid for during July and August the majority of the specimens collected had attained a size of about 50 mm. in one month. Referring to the data already published by one of us (Hora, *loc. cit.*) on the probable rate of growth of *Hilsa* it appears that the brood of July and August may attain a size of 140 to 150 mm. in total length up to about the third week of November—a period of 4 to 5 months.

Thus the growth rate is fairly rapid in the young of *Hilsa*. We are reliably informed that at the end of December the young *Hilsa* in the Sunderbans are about 7 to 9 inches long, and are extensively fished in the estuaries and on the foreshore[1].

As the collections made from the *Pucca* Settling Tank No. 4 from December, 1937, to February, 1938, were not very satisfactory, the tank was dewatered on the 2nd of March, 1939, and the young fish collected. The tank had been thoroughly cleaned and washed, and afterwards filled on the 20th December, 1938. Thus the tank had been in commission for 73 days when the fish were collected. Young *Hilsa* 273 in number and ranging from 16 mm. to 83 mm. in total length were obtained. These specimens are arranged according to their lengths in the table given below :—

TABLE II.

Young Hilsa *collected on 2. iii. 1939, from* Pucca *Settling Tank No. 4.*

Length in mm.	No. of specimens.	Length in mm.	No. of specimens.
16	3	37	1
17	4	39	1
18	12	40	1
19	25	44	1
20	77	46	2
21	84	53	1
22	26	62	1
23	11	63	1
24	4	64	1
25	2	65	1
26	2	71	3
31	1	74	1
32	3	79	2
34	1	83	1

The above figures show that (i) in 2½ months, under winter conditions, the young of *Hilsa* attain a size of about 83 mm., (ii) very few individuals breed in the river during the winter months of December and January, for the number of young over 30 mm. in length is represented by 23 out of a total of 273 specimens, and (iii) the breeding of *Hilsa* is accelerated in February, for the number of young specimens between 18 to 23 mm. is fairly large. The paucity of the very young specimens, below 18 mm., may be accounted for by the fact that, as in the European Herring, *Clupea harengus* Linn., the eggs and larvae with the yolk sac attached live at the bottom, and only the post-larval forms seek higher layers. This is borne out by the fact, which has been observed by several workers, that the eggs of *Hilsa* fall to the bottom after fertilisation. Our specimens were always collected from the upper and mid-water layers and not from the bottom layers, and for this reason it seems probable that we missed to collect the earliest larval stages of *Hilsa*.

Growth of Hilsa *in Confined Waters*.—There are two series of connected Settling Tanks at the Pulta Water-works—a series of 5 *Pucca* tanks and a series of 4 *Kachha* pre-settling tanks connected with a large lake-like area about ½ mile long and ½ mile broad. The tanks of both the

[1] Howard, S., *The Statesman*, Town Ed., (7th Nov., 1938); and Mazumdar, C. H., *Science and Culture*, V. pp. 219-221 (1939).

series are cleaned once a year and the silt deposited in them removed. The lake-like area or the Final Settling Tank has not been cleaned since its construction about 12 years ago. In the case of the *Kachha* tanks the fish can move about freely between them and the lake-like area and some of them can thus live up to their maximum age. In the case of the *Pucca* Settling Tanks, however, the connections are near the surface, so the bottom-living and the mid-water forms have practically no chance to move from one tank to another. As *Hilsa* is not a surface species, it can safely be presumed to be confined to the tank in which it came as an egg or a larval form. Very favourable conditions of life prevail in these tanks, on account of the constant flow of river water through them, which not only keeps the water aerated but also fully stocked with food consisting of microscopic life or of crushed bits of larger forms. The *Kachha* Pre-Settling Tanks are far more extensive and provide more congenial conditions of life for fishes.

On the 31st August, 1938, the *Kachha* Pre-Settling Tank No. 4 was fished and 31 specimens of *Hilsa*, ranging from 262 mm. to 413 mm. in total length, were netted. There were only 3 specimens under 300 mm. in length and 3 above 400 mm., while the average length of the specimens was 335 mm. These specimens were obtained in two hauls, 24 in the first haul comprised 11 males and 13 females, while all the specimens taken in the second haul were males. For fishing the net was spread across the tank and dragged along the bottom. At the surface the net was floating, but there were portions where it lay under the surface of the water so that the fish could swim or jump over it. Fair numbers of *Mugil corsula* (Ham.) and some *Labeo rohita* (Ham.) were noticed to leap over it, and it appears that some males of *Hilsa* also escaped the net during the first dragging. Owing to the absence of hatchery facilities artificial fertilisation was not attempted though 12 fully ripe males, with the milt flowing out and 9 more or less ripe females were obtained. In two cases the eggs, which were free from one another and about 0·5 mm. in diameter, were found to come out on the application of slight pressure. It would thus appear that the fish readily adapts itself to confined fresh waters, and can attain sexual maturity in such surroundings. Whether the fish actually breed under these conditions we are unable to say.

On the 21st of February, 1939, 69 specimens of *Hilsa* were netted from the *Kachha* Pre-Settling Tank No. 2; they ranged in length from 171 to 423 mm., 3 between 200-300 mm. and 8 above 400 mm. in length; the average size of the specimens was 356 mm. If the rings on the scales are any index to the age of the fish in the case of *Hilsa* then the majority of the specimens were 3 to 4 years old. The scales of the smallest specimen, 171 mm. long, had indications of just one ring.

The presence of only large specimens in the *Kachha* Pre-Settling Tanks shows that the adult fish generally move against the current, for the water flows out from these settling tanks to the final settling tank and thence to the filter-beds. The young, on the other hand, move down with the current and are found in large numbers in the filter-beds. We have never found an adult *Hilsa* in the filter-beds, though large-sized specimens of the catadromouseel, *Anguilla bengalensis* Gray, are not uncommon in them at a certain season of the year.

The *Pucca* Settling Tank No. 3 was dewatered completely for cleaning on the 9th May, 1938. It had been charged after thorough cleaning on the 3rd April, 1937, so the tank was constantly in use for a period of little over 13 months. A large number of young *Hilsa* were collected from the tank, and of these 142 specimens, ranging between 157 mm. and 305 mm. in total length, were measured. They are arranged in 10 mm. difference groups in the table below :—

TABLE III.

Young Hilsa *collected from* Pucca *Settling Tank No. 3 on 9th May, 1938, arranged in 10 mm. difference groups.*

Length in mm.	No. of specimens.	Length in mm.	No. of specimens.
150-159	1	240-249	22
170-179	2	250-259	24
180-189	4	260-269	25
190-199	2	270-279	21
210-219	2	280-289	19
220-229	8	290-299	2
230-239	7	300-309	3

In considering the above data it must be remembered that very young specimens were not collected. From the table it is clear that the majority of the specimens, which must have entered the tank during the peak period of breeding of the species in July-August, were between 240 to 290 mm. in total length, and this length of about a foot probably represents the size attained by *Hilsa* during the first 10 to 12 months of its growth.

The *Pucca* Settling Tank No. 5 was completely dewatered on the 1st March, 1939, after having been in commission for exactly 10 months. A random sample of 122 young *Hilsa* collected from this tank was measured and the results are arranged in 10 mm. difference groups in the table below :—

TABLE IV.

Young Hilsa *collected from* Pucca *Settling Tank No. 5 on the 1st March, 1939, arranged in 10 mm. difference groups.*

Length in mm.	No. of specimens.	Length in mm.	No. of specimens.
160-169	7	190-199	35
170-179	29	200-209	8
180-189	42	231	1

If it be taken for granted that the majority of the specimens came as larval forms during the peak period of breeding then it will be clear that in 7 to 8 months *Hilsa* attains a size of 170 to 200 mm. in total length.

From the data hitherto collected from the material obtained from the *Pucca* Settling Tanks the rate of growth of *Hilsa*, starting with the monsoon months, seems to be as follows :—

During the first month a size of about 40 to 50 mm. is reached. Two months old young are approximately between 80 mm. to 89 mm. in total

length. At the end of the 3rd month the fish are about 100 mm. but after 4 months the maximum size attained is about 130 mm. By the end of the 5th month a size of 160 mm. is reached and thereafter the fish grow at the rate of about 20 mm. a month so that 10 months to a year old specimens are just about a foot in length. It should be borne in mind that the growth rate given above is based on the material collected from the particularly favourable conditions prevailing in the waterworks at Pulta, but it is not materially different from what little is already known from the investigations of the Madras Fisheries Department about the growth rate of the fish under natural conditions.

INVESTIGATIONS IN THE RIVER HOOGHLY.

Attempts were again made to collect eggs and larval forms of *Hilsa* from the river during July-August 1938, but without any success. Probably the eggs and young are found near the bottom in deeper waters in the middle of the river where, with the appliances available to us, we could not make any collections.

The collection of young *Hilsa* was continued from the Nawabgunge Fish Market and it was generally found that the numbers available were relatively much smaller than those of 1937-38. Good samples were taken in October, November and February-March, and their lengths are given below in 10 mm. difference groups :—

TABLE V

Length in mm. of young Hilsa *collected at Nawabgunge.*

Date of collection of samples.	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
30th October, 1938	204	153	3			..	..	..
13th to 15th November, 1938	5	42	78	4	2	..	..	..
27th February and 1st March, 1939.	..	..	8	45	22	3	3	1

The above figures are very significant and illustrate clearly the following points :—

(i) The numbers of young *Hilsa* in the river decrease considerably month by month after the cessation of the monsoon. Towards the end of March only one or two young *Hilsa* were found in the catches.

(ii) The size of young *Hilsa* found in the river increases from October onwards and by about the end of March a few young *Hilsa* of about 136 mm. were collected. It may also be noted that occasionally very young specimens of *Hilsa*, between 50 mm. and 60 mm. in total length, were also obtained towards the end of March.

As there is considerable evidence to believe that the young of *Hilsa* move down the river to the estuaries it is reasonable to assume that the young caught at Nawabgunge are the progeny of the individuals that must have spawned considerably above that place. The specimens collected on the 30th October represent under one month's growth, while the specimens collected about the middle of November were more than one month old. By about February and March 2 months old or older specimens were to be found at Nawabgunge, which means that they have to be regarded as the progeny of specimens that spawned a considerable distance above Nawabgunge—a distance that can be covered by the young in their movement downstream in two months' time.

The occurrence of very young specimens of *Hilsa* in March and April indicates the extended period of spawning of the species in the river, but the paucity of such individuals indicates that they are the progeny of some late spawners.

INVESTIGATIONS IN EAST BENGAL.

In his review of Hora's paper Jenkins[1] observed that

"Another point to be cleared up is what is really the fish known to the fishermen as *Jatka* or *Jatkya*? According to Mr. K. C. De the *Jatkya* is the smallest of the herring family (*Clupea fimbriata*) and is found in the estuaries as high up as Goalundo from February to April. It is a pretty fish with a rather dark back and silvery sides shot with gold. From the similarity in shape, appearance and taste, the fishermen describe it as the young of the *Hilsa*.

"According to Mr. Finlow, 'The fingerling of the *Hilsa* has been identified as the *Jatka*, a small fish less than 6" long, found in the Buriganga, Lakhya and Meghna rivers in Eastern Bengal in February-March.'"

In order to elucidate the points raised in the above statements Mr. M. N. Datta was sent to East Bengal in February 1939 to make enquiries and to collect young Clupeids of all descriptions. He was out in the field from the 16th to the 25th February and visited Barisal, Patuakhali, Galachipa, Chandpur, Narayangunj and Goalundo. The name *Jatka* was not known to the fishermen of the first three localities, while at the last three places the fishermen knew the fish as a close ally of *Hilsa* but quite distinct from it. According to them *Jatka* comes up the river towards the end of March and is to be found even during the *Hilsa* season. It is stated to be a much smaller fish, not as tasty as the *Hilsa* and with comparatively smaller scales. Among the Clupeids collected by Mr. Datta we found a large number of young *Hilsa* and a few specimens of *Gudusia chapra* (Ham.). Mr. Datta found that the name *Chapli* was commonly used to denote both *G. chapra* and the young of *Hilsa*. At Patuakhali the young of *Hilsa*, as well as of other Clupeid fishes were known as *Malanda*. At Chandpur, Narayangung and Goalundo Mr. Datta found large quantities of young *Hilsa*, ranging in size from 7 to 11 inches, being caught from the river, and learnt that full-grown specimens with eggs were to be found in October and November.

[1] Jenkins, J. T., *Curr. Sci.* VII, p. 252 (1938).

The specimens of young *Hilsa* brought back by Mr. Datta are listed below in 10 mm. difference groups :—

TABLE VI.

Young Hilsa *from East Bengal collected in February 1939.*

Length in millimetres.	Number of specimens collected at			
	Gazalia (River).	Galachipa (River).	Patuakhali (Market).	Narayangunge (Market).
30-39	..	..	3	..
40-49	..	..	20	..
50-59	..	1	30	..
60-69	..	..	29	6
70-79	..	..	33	3
80-89	1	..	6	2
90-99	..	1	2	..
100-109	4	3	4	..
110-119	10	7	18	..
120-129	2	11	17	..
130-139	1	2	4	..

From the Chandpur Market Mr. Datta obtained 5 mature males measuring 235 mm., 249 mm., 256 mm., 268 mm. and 279 mm. in total length respectively. From the presence of very young specimens at Patuakhali, it seems probable that *Hilsa* breeds there in February, as has been noted above in the case of the Hooghly river (*vide supra*, p. 42). The presence of mature males at Chandpur in the month of February also points to the same conclusion.

From the material and other data collected by Mr. Datta it is now clear that *Hilsa* breeds extensively in the rivers of East Bengal and that there are in places extensive fisheries of young *Hilsa*. The *Hilsa* of 7 to 11 inches in length of which Mr. Datta found extensive fisheries at Goalundo, Narayangung and Chandpur, are probably the early breeders. In the Hooghly river also specimens of about this size are sometimes netted in February-March. These, as judged by the observations recorded above on the growth-rate of the species, are young fish less than one-year old.

UP-RIVER MIGRATION OF *Hilsa*.

Though our knowledge of the seaward migration of *Hilsa* and its life in the sea is very meagre, there can be no doubt whatever regarding its ascent up all the principal rivers of India and Burma, since extensive fisheries of the species depend on this anadromous habit.

Hamilton[1] recorded the occurrence of *Hilsa* at Cawnpore and Agra, while Day[2] found it to ascend as high as Delhi. Through the courtesy of Prof. D. R. Bhattacharya we have examined several specimens of *Hilsa* collected at Allahabad. The Allahabad examples were received in four lots; the first lot of 5 specimens, ranging in length from 300 mm. to 307 mm. (average length 304 mm.), was received on the 13th October, 1938; the second lot of 6 specimens ranging in length from 180 mm. to 219 mm. (average length 197 mm.), was received on the 17th December, 1938; the third lot of 6 specimens, ranging in length from 213 mm. to 251 mm. (average length 230 mm.), was received on the 17th April, 1939, and the last lot of 5 specimens ranging in length from 193 mm. to 235 mm. (average length 215 mm.), was received on the 10th May, 1939. The specimens of the first two and the last lots were eviscerated so no details of the maturity of the gonads or their feeding habits can be given. All the specimens of the April lot were mature males. The stomach was empty in four cases while in the remaining two specimens Copepods and a few Ostracods formed the bulk of the food, though a few bits of some filamentous alga and the remains of one insect were also found among their stomach contents. In all the specimens, however, the intestine contained some pulpy, digested matter, showing thereby that, though sexually mature, *Hilsa* were feeding in the rivers near Allahabad.

The scales of the October specimens were provided with four, rarely three, rings and the structure of the edges of the scales indicated that growth was still taking place (Dahl's 'Summer edge')[3]. From among the December lot scales of specimens up to 200 mm. in length showed only one, rarely two, rings, while in the case of the other two examples 2 to 3 rings were present. The edges of these scales also showed a growing phase. In the April examples, the three smaller specimens up to 225 mm. in length showed two rings on their scales, while older specimens had three. In a majority of the scales of these specimens 'A' phase (Dalh's[4] 'Winter edge') had just started, though in the case of the two larger examples the edges of the scales still showed a growth phase. In the May examples also the scales were marked with 2 to 3 rings and there was an indication of the commencement of the 'A' phase in a number of scales.

In considering the above data, attention may specially be directed to the fact that the October specimens were on an average 100 mm. longer than those obtained in December. This means that larger specimens, which presumably mature earlier, are the first to ascend soon after the flooding of the rivers (*vide infra*, p. 46) while the younger specimens ascend later and constitute the late breeders. It is also significant that, as judged from the nature of the scale-edges, the growth of *Hilsa* at Allahabad stops during the hot and dry months when the waters fall low, and presumably the food is scarce.

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[1] Hamilton, F., *Fish Ganges*, p. 244 (Edinburgh, 1822).
[2] Day, F., *Fish. India*, p. 640 (London, 1877).
[3] Dahl, K., *Rept. Norwegian Fish. and Marine Investigations* II, No. 6, pp. 6-7 (1907).
[4] Hodgson, W. C., *Fishery Investigations*. Ser. 2, VII, No. 8, p. 13 (1925).

Regarding the object of the up-river migration of *Hilsa* Jenkins (*loc. cit.*) enquires

" Why does the *Hilsa* migrate up the Ganges as far as Bhagalpur and Monghyr and even up the Sone to Dehri ? Is this migration for food and is it essentially a spawning migration ? "

So far as the lower reaches of the *Hilsa* rivers are concerned our investigations have definitely established that migration is for spawning purposes, but to be able to answer Jenkins' questions regarding the movements of the fish in the middle and higher reaches it is necessary to collect a considerable amount of data about the seasonal occurrence of *Hilsa* at certain selected up-country stations and to study among large samples the conditions of their gonads and the nature of their stomach contents month by month. The evidence available so far, however, seems to show that the upward migration is primarily for spawning purposes, though the individuals must continue to feed as they migrate upstream for long distances.

In an effort to locate the spawning grounds of the species the Bengal Fisheries Department made the following interesting observations (*vide* Ahmad's Report, dated 16th March, 1910, pp. 13-15) :—

In the 3rd week of June the *Hilsa* at Damukdia and Saraghat were not yet ripe, though the specimens of the latter locality were very near maturity.

In the 1st week of July the *Hilsa* at Rajmahal were quite immature.

On the 27th of September many ripe males with milt streaming from their abdomen were found at Monghyr, but of the 14 females examined one was spent and the rest were immature.

In November no ripe or unripe *Hilsa* was obtained from Monghyr, Arrah, Buxar, Digha Ghat, Dinapore and Dehri-on-Sone, while plenty of spent ones were collected.

Towards the end of September Jenkins[1] obtained a young *Hilsa*, 6 cm. long, from the market at Monghyr.

The above observations show that the up-river migration of *Hilsa* is mainly for spawning purposes. In this connection Day[2] observed that

" There seem to be two classes of this fish which ascend the large rivers : those below one year of age, and which do not appear to breed, or if they do, it is at the very end of the year, or commencement of the succeeding one ; secondly, there are those that breed at the commencement of, or during the monsoon."

Day's observations are borne out by the fact that the October specimens, over 300 mm. in total length, obtained from Allahabad were over a year old and had probably migrated for breeding purposes, while the December specimens, under 200 mm. in total length, must be regarded as young that had migrated in a preparatory stage to breeding. One may not, therefore, be far from wrong in stating that the main swarms of this fish that ascend up the larger rivers are for the purpose of breeding while the comparatively few young specimens that move up with the main swarms undertake the journey for feeding purposes. The

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[1] Jenkins, J. T., *Rec. Ind. Mus.* V, p. 140 (1910).

[2] Day, F., *Report on the Freshwater Fish and Fisheries of India and Burma*, p. 22 (Calcutta : 1873).

young specimens must travel considerable distances before they become sexually mature and it is probably for this reason that up-country specimens of *Hilsa* are usually not as large as those found in the lower reaches. The reverse of what Southwell[1] believed to be the spawning grounds of old and young *Hilsa* would thus seem to be true.

Though it is generally true that *Hilsa* are available practically at all times of the year in the rivers and in the Gangetic Delta, it is also a fact that the fish are most abundant during the monsoon months. Our investigations on the breeding of *Hilsa* in the river Hooghly show that with the exception of November to March, when the rainfall in the provinces drained by the Ganges is low, the fish breeds, fairly profusely in all other months. There would thus seem to be a definite correlation between the up-river swarming of the species and the flooding of the river. We give below in a tabular form the average monthly rainfalls of the areas drained by the Ganges and its tributary rivers.

TABLE VII.

Table of Monthly Normals of Rainfall in inches from records up to 1920.

—	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Assam	0·67	1·53	4·00	9·00	12·08	18·23	18·74	16·83	12·50	5·66	0·90	0·34
Bengal	0·34	0·95	1·67	3·25	7·64	14·62	15·14	14·28	10·89	5·08	0·79	0·16
Chota Nagpur	0·77	1·15	0·93	0·70	2·13	8·97	12·91	13·77	8·10	2·92	0·39	0·14
Bihar	0·42	0·62	0·47	0·60	2·27	7·78	12·36	12·51	8·80	2·32	0·29	0·09
U. P. East	0·63	0·55	0·32	0·19	0·67	4·78	11·55	11·33	6·87	1·87	0·19	0·22
U. P. West	0·96	0·89	0·61	0·30	0 68	4·06	11·47	11·14	5·96	0·88	0·15	0·36
C. I. East	0·56	0·63	0·33	0·22	0·43	4·50	12·04	12·49	6·36	1·17	0·35	0·21

From table VII it is clear that the flooding of the Bengal river starts from April while the rivers in the United Provinces get an appreciable quantity of rain water only from June onward to September. It follows, therefore, that though *Hilsa* may ascend the lower reaches in April, May and June, their upward migration mainly depends on rains in up-country provinces. For this reason the *Hilsa* fishery in the United Provinces starts in September-October whereas in Bengal it is generally in full swing as early as July.

In his review of Hora's article Jenkins remarked " It is possible that there are two, or more, races or varieties of *Hilsa* with different spawning grounds and habits " So far as the form of *Hilsa* in the Ganges is concerned we have found that there is no difference in the specimens collected in the river Hooghly and those obtained from the Ganges at Allahabad. The specimens from Eastern Bengal are somewhat deeper and it is quite possible that in other large rivers different races of the species occur. At present, however, we have not the material to discuss this question.

[1] Southwell, T., *Bull. Dept. Fisheries, Bengal, Bihar and Orissa*, No. 4, p. 5 (1914).

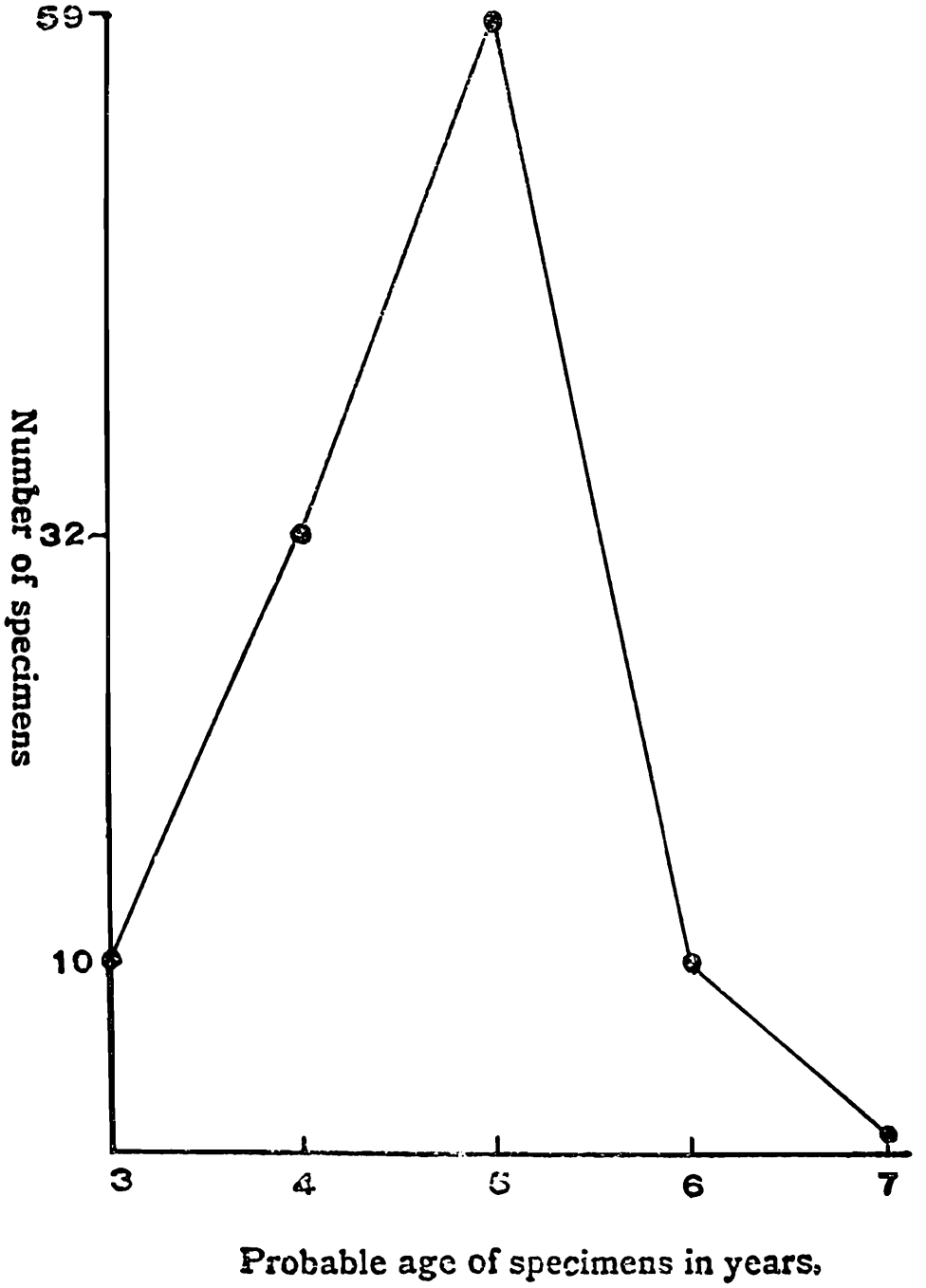
HILSA FISHERY IN BENGAL.

The reports of the Department of Fisheries, Bengal and Bihar and Orissa, and earlier reports dealing with the fisheries of the province bear ample testimony to the fact that, following Sir K. G. Gupta's recommendations, serious attempts were made for a period of about 15 years, from 1908 to 1923, to discover the breeding grounds of *Hilsa* and to propagate the species artificially, but unfortunately, all efforts resulted in failure. To our mind the main reason for this failure was that all investigations connected with *Hilsa* were conducted on the analogy of the Shad fishery in America. For instance, search for its breeding grounds was made in the river near Bhagalpur and Monghyr, whereas Hora (*loc. cit.*) discovered them in the river Hooghly not very far from Calcutta. Further, it has now been shown that *Hilsa* breeds practically throughout the year and that its breeding grounds extend over a very wide range both in East Bengal and in the Ganges. It can also be inferred from the data presented above that the upward migrating stock of any particular year comprises individuals of different ages or, at any rate, at different stages of sexual maturity, for some spawn after a short journey from the sea whereas others go higher up for hundreds of miles before they become sexually mature for spawning.

Fortunately for the continuance of *Hilsa* fishery from year to year the eggs of the species are demersal, and sink to the bottom soon after fertilisation. After hatching the young start their downstream journey to the sea, and as the data (*vide supra*, p. 41) regarding the size of the specimens obtained at Nawabgunge week after week from November to March show there is a distinct increase in size of the young with the march of time. This shows that the young passing down the river near Nawabgunge in February must be regarded as the progeny of fish that spawned a few months earlier in the middle reaches of the Ganges. The real feeding grounds of the young are the estuaries or the shallow waters at the mouth of the rivers or in their neighbourhood. By December the young attain a size of 7 to 9 inches and move about in such great shoals that they give rise to big fisheries, both in the Sunderbans and along the Balasore and Chittagong Coasts. From all the records of the occurrence of *Hilsa* in the sea it seems probable that the range of the fish does not extend to depths exceeding 10 fathoms and we have been definitely informed that *Hilsa* have neither been seen nor caught from the pilot vessels stationed at the Sandheads. In the estuaries and on the mud-flats at the mouths of rivers the fish feed and grow till the urge of sweet waters and sexual maturity goad them to enter the rivers and to start their upward journey. Such, in brief, is the life-cycle of *Hilsa* and though we now know, with fair amount of certainty, its main outlines, many details still remain to be worked out.

The upstream movement of *Hilsa* seems to be largely dependent on two main factors—monsoon and the state of sexual muturity of the migrating individuals. The monsoon, as we are all aware, is very erratic both in its intensity during certain months and in its total precipitation during any particular year. These variations in the monsoon are probably responsible for the usual fluctuations in the annual crop of the species, and especially for variations in catches at definite places, but a

large range fluctuation such as witnessed in 1939 is presumably due to the age of maturity of the fish. In this connection it may be mentioned that early in 1939 Mr. C. Cleghorn, who has been engaged in the fishery business in the Sunderbans for over 20 years, came to see one of us and in the course of conversation on fishery matters stated that in his experience there is a 5-year cycle in the fishery of *Hilsa* and predicted that 1939 will be a bumper-crop year for *Hilsa* fishery. As this prediction came true we set to work to find out the causes of this long range fluctuation in the fishery of the species. Scales of 112 specimens of the 1939



Graphical representation of the probable age of 112 specimens of *Hilsa* imported into Calcutta from Goalundo during June-July, 1939.

crop were studied with a view to determine their ages and it was found that a great majority of the fish were 5 years old. Against this, of the 15 specimens examined during 1938, 12 were only 3 years old. This seems to indicate that though some individuals, generally males, become mature at the age of 2 to 3 years the normal age of maturity of the species

is 5 years. According to this presumption the bulk of the progeny of the 1939 stock will become mature in 1944 and will give rise to a bumper-crop that year. A few stray individuals will, however, migrate in between this period, either as a result of early maturity or excitement through contact with fresh water and give rise to the normal fishery for the four lean years.

Unfortunately no published records of the fluctuations in the numbers of *Hilsa* from year to year are available, but the little evidence we have been able to collect from the available sources lends support to the 5-year cycle in the fishery of the species. For instance, it may be recalled that 1934, the Bihar Earthquake year, produced a bumper-crop of *Hilsa*. Again it may be noticed that the years 1906-1908, during which Sir K. G. Gupta carried out his investigations, were lean years so that the general complaint that the supply of *Hilsa* was on the decline was justified. Presumably as a result of the 1914 bumper-crop Southwell[1] in that year remarked that " In spite of the enormous numbers of *hilsa* which are caught going up river, before they have shed their spawn, there seems little support for the statement that *hilsa* are becoming scarce " By 1918, however, Southwell having experienced lean crops of *Hilsa* had reason to modify his view on the relative abundance of the species in Bengal rivers. Unfortunately there is no record of the yield of the *Hilsa* fishery during 1919 though in the Annual Reports of the Department of Fisheries, Bengal and Bihar and Orissa, there are definite statements ot the scarcity of the fish during 1919 and 1920. The scarcity in each case is attributed to the irregularity and erratic nature of the monsoon.

It may be of interest to mention that the European Herring also shows a 5 years period of maturity and like *Hilsa* it also spawns under widely different conditions of salinity. Kemp, in 1938, in his address at the Meeting of the British Association on " Oceanography and the fluctuations in the abundance of marine animals " stated that

> " Annual fluctuations in the abundance of a fish may be very great. One year may be exceptionally favourable, with production far above normal, to be followed perhaps by several years of scarcity ; and it is not uncommon to find that fish belonging to one year class are fifty times as numerous as those of another. These great fluctuations, which are the foundation on which fishery prediction is based, are for the most part to be attributed to events which happened in the early months of the fish's life ; and when we consider the manifold perils, meteorological, physico-chemical and biological, to which the eggs and larvae of a marine animal are subject, it is little wonder that there may be such great differences from one year to another, nor is it a matter for surprise that the precise reasons for good and bad spawning seasons are as yet unknown."

SUMMARY.

The breeding season and the growth rate of *Hilsa* during the early stages are discussed ; all the observations made in this connection are based on the material collected at the Pulta Water-works during 1938-39. It is indicated that the fish breeds in the river throughout the year, the peak period being about July-August and a second low peak in May. These peak periods are correlated with the flooding of the river owing to the monsoon and the nor'westers respectively. Evidence is

[1] Southwell, T., *Bull. Dept. Fisheries, Bengal, Bihar and Orissa.* No. 4, p. 5 (1914).

adduced to show that the rate of growth starting with the monsoon period is fairly rapid. A size of about 40 to 50 mm. is reached during the first month, while the two months old young are approximately 80-89 mm. in total length. At the end of the 3rd month the fish grow to about 100 mm., while after 4 months a maximum size of about 130 mm. is attained. By the end of the 5th month the fish grow to 160 mm. and thereafter the rate of growth is about 20 mm. a month, so that 10 months to a year old specimens are just about a foot in length. It is pointed out that the breeding is almost inhibited and the growth rate considerably slowed down during the winter months of December and January.

A study of the collections of young *Hilsa* made from the river Hooghly at Nawabgunge showed that (i) the numbers decrease considerably month by month after the cessation of the monsoon and (ii) the size of young *Hilsa* increases from October onwards. As the young are known to move down the river to the estuaries, it is presumed that the young of *Hilsa*, 50 mm. to 70 mm. in total length, obtained in February and March at Nawabgunge are probably the progeny of specimens that spawned above Nawabgunge at a distance that can be covered by the young in their movement downstream in about two months' time.

The *Hilsa* investigations carried out in East Bengal by Mr. M. N. Datta in February, 1939, are discussed. Though he was unable to obtain specimens of the fish locally known as *Jatka* and often confused with the young of *Hilsa*, he obtained sufficient material of young *Hilsa* to show that the fish breeds extensively in the waterways of East Bengal.

As a result of an examination of the material received from Allahabad through Prof. D. R. Bhattacharya and the work carried out by the Bengal Fisheries Department in up-country stations, the probable cause of the up-river migration of *Hilsa* is discussed. In dealing with the *Hilsa* fishery in Bengal a brief account of the probable life-history of the species is given and reference is made to the winter fishery of young *Hilsa* in the estuaries and along the foreshore of Bengal and Orissa. The upstream movement of *Hilsa*, on which the main fishery of the species depends, is attributed to the monsoon and the state of sexual maturity of the migrating individuals. A brief account of the fluctuations in the year to year *Hilsa* fishery is given and from the meagre data available and the reports received from certain people interested in the fish trade, it is surmised that a 5-year cycle exists in the fishery of the species. Attention is directed to an interesting fact that the European Herring, a fish closely allied to *Hilsa* in its general habits and fishery, also shows a 5-year period of maturity.

ON THE BREEDING AND DEVELOPMENT OF INDIAN "MOSQUITO-FISH" OF THE GENERA *APLOCHEILUS* McCLELLAND AND *ORYZIAS* JORDAN & SNYDER.

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CONTENTS.

INTRODUCTION.

Mosquito-control by the use of fish has long been recognized, though much controversial literature has appeared in regard to the practical efficiency of individual species. Of the numerous Indian fishes listed as mosquito-consumers, the most important are the indigenous Killifishes[1] of the genera *Aplocheilus* McClelland[2] and *Oryzias* Jordan and Snyder. The former genus is represented in India by three or four

[1] Jordan (1923, pp. 158, 159) includes under the term "Killifishes" the oviparous Cyprinodonts with the anal fin not modified in the male, while the term "Top Minnows" is restricted by him to viviparous Cyprinodonts having the anal fin in the male modified into an intromittent organ.

[2] For nomenclature see Smith, 1938, p. 165.

species *viz.*, *A. panchax* (Ham.), *A. blockii* (Arnold), *A. lineatus* (Cuv. and Val.) and *A. dayi* ? (Steind.), and the latter by a single widely distributed species, *O. melastigma* (McClelland). These Killifishes have been found to be of immense value in the biological control of mosquitoes. The bionomics of the mosquitoes in the Tropics have been studied in fair detail, but as Prashad and Hora (1936, p. 643) have observed, our knowledge of the ecology and biology of the Indian fishes is still " very meagre ", and " for control measures to be successful it is essential that not only the ecology and biology of the pest should be known in all possible detail, but similar information should also be available in regard to the natural enemy which it is proposed to employ for control work "

The larvicidal habits of the North Indian Killifish, *Aplocheilus panchax* have been discussed by various workers such as Brahmachari (1909, p. 320), Chaudhuri (1909, p. 36), Sewell and Chaudhuri (1912, p. 34), Southwell (1920, p. 183), Covell (1927, p. 39), Hora (1927, p. 188), Prashad and Hora (1936, p. 639), Sen (1937, p. 358) and Roy (1938, p. 405) ; its practical utility for mosquito-destruction has also been estimated (Hora and Nair, 1938 ; Job, unpublished work). In view of these observations *A. panchax* has been recognized as one of the best of the indigenous larvicidal fish which can be effectively used in natural pieces of water as well as wells, cisterns and other artifical containers. As for its congener, *A. lineatus* of Peninsular India, writers like Aitken (1902, cited by Bannerman, 1910, p. 525), Bentley (1910, p. 417), Southwell (*loc. cit.*), Sewell and Chaudhuri (*op. cit.*, p. 5), Fraser (1938, p. 97) have all testified to its larvivorous propensities. Analysis of the gut-contents and field observations made in the year 1938 by the present writer at Cheranellore and at the Karamana Entomological station in Travancore, in the suburbs of Ernakulam in Cochin, and at Bandra and Mahim in Bombay point to its being of special value in anti-malarial campaigns, especially in the Deccan. Stoye's (1935, p. 84) remark that the fish " will thrive on a heavy diet of earthworms during the breeding season ", Innes's (1939, p. 150) statement that " its favourite live food is fish " and Moody's (1933, p. 187) observation of a fish suddenly disposing " of a full grown male guppy " are with reference to artificial conditions in aquaria only, and in its natural environment it is seen to feed mainly on insects such as ants like *Camponotus compressus, Solenopsis geminata*, etc., water beetles and small quantities of Dipterous larvae, Ostracods, etc. Rai Bahadur Dr. S. L. Hora has informed the writer that this form has recently been studied in detail by Dr. C. C. John of the University of Travancore in collaboration with the Health Officer, Dr. C. T. George, and that these workers have adduced sufficient experimental evidence regarding its value as an efficient larvivore. The other species, *A. blockii* and the related *Oryzias melastigma*, the writer has reasons to believe, both from previous records and from personal observations made in Madras and Calcutta, are also valuable in checking the numbers of larvae.

The utility of the indigenous Killifishes in the biological control of mosquitoes being thus obvious, it was felt that a detailed knowledge of their breeding and development under natural conditions would be of

value for the culture and dispersal of these efficient larvivores in anti-mosquito campaigns. Willey (1910, p. 120) has emphasised that methods of pisciculture "should be based upon a knowledge of the breeding habits of fishes under natural conditions", and Prashad and Hora (*op. cit.*, p. 646) have pointed out the urgent need for definite sources of supply of larvicidal fish in various provinces of India. Further, in the light of Kemp's statement made in 1938 at Cambridge in his presidential address to the Zoological Section of the British Association that "throughout almost the whole of the vast stretch of the Indo-Pacific region there is scarcely a fish whose life history is fully known and whose various stages from egg to adult can be recognized", the academic value of such developmental studies is obvious.

As the breeding habits and development are believed to be more or less similar in allied species, *Aplocheilus panchax*, the *tri-choki* or *three-eyed fish* of Bengal was taken up for study as the type of Killifishes. Important differences wherever present are, however, pointed out in the consideration of the different forms.

ACKNOWLEDGMENT.

I am deeply indebted to Dr. Baini Prashad, Director, Zoological Survey of India for kindly affording me the necessary facilities for conducting this work and for his valuable criticism. To Rai Bahadur Dr. S. L. Hora, under whose direction the work was conducted, I offer my heartfelt thanks for his kind guidance, useful suggestions and constant help. I am grateful to the Lady Tata Memorial Trust for the award of a scholarship to conduct these researches.

BREEDING AND DEVELOPMENT OF INDIAN "MOSQUITO-FISH".

Aplocheilus panchax (Hamilton).[1]

General.—Aplocheilus panchax is an oviparous Cyprinodont, native of India, the Dutch Indies and the Malay Archipelago, and inhabits clear, shallow fresh and brackish waters at low altitudes. The fish has been reported also from the Andamans, and according to Annandale and Hora (1925, p. 34) "it does not appear to have been introduced artificially as its occurrence in the Andamans was mentioned by Day in 1870" Herre (1939, p. 331) also reports it to be native of the Andaman waters. Mukerji (1935, p. 260), however, presumed that it has probably been introduced there along with *Oryzias melastigma* and other fishes by human agency. Since the penal settlement was opened in the Andamans as early as 1858 (Portman, 1888, p. 8) Mukerji's surmise may not be altogether impossible, though there is no positive evidence for artificial introduction. In India the fish has been recorded from Bengal, Behar, Orissa, Assam, Punjab, the United Provinces, Sind, Cutch and the Central Provinces as also from Burma and Siam, and its bionomics reveal that it can easily be introduced into most places at low altitude. The fish is said to grow to a maximum size of four inches

[1] *Panchax panchax* of Cantor (1849, p. 1234); *Haplochilus panchax* of Günther (1866, p. 311).

in length (Mellen and Lanier, 1935, p. 134); but the average size of the adult common in Bengal is only about two inches though individuals of three inches are often met with. Breeding commences when the fish reaches about an inch and a half in length.

Breeding.—No adequate account of the breeding and development of *A. panchax* in nature is available; but casual references have been made by Day (1878), Chatterjee (1934) and the American aquarists, *viz.*, Innes (1935), Stoye (1935), Mellen and Lanier (1935) and Norlund (1936). It may be observed here that the "*Haplochilus panchax*" mentioned by Thomas (1887, p. 112) was actually *Aplocheilus blockii* (Arnold) (=*Panchax parvus* Sundara Raj).[1] Chatterjee (*op. cit.*, p. 13) writes that *Panchax panchax* (=*A. panchax*) "breeds throughout the year in confined waters of tanks" Innes (*op. cit.*, p. 266) remarks that the fish is "fairly peaceful and a good breeder", and puts down the spawning temperature as 70-84° Stoye (*op. cit.*, p. 84) observes that it is "not as prolific as most others of the group, but quite hardy" Day (*op. cit.*, p. 523) refers to the "very large ova" of the species. Mellen and Lanier (*op. cit.*, p. 134) state that the "eggs are not heavy" and add that the "species matures when half grown, in about four months" According to Norlund (*op. cit.*, p. 60) the eggs take 10-25 days to hatch and "when the young are about 1½ cm. a black spot will appear in the dorsal fin of all of them; when they have grown to a size of about 2½ cm. this spot will disappear on some; these fishes are males"

The sexes in *A. panchax* can be distinguished in the adult usually by a slight difference in size and colour. It has to be mentioned that the colour in the species is variable, and the three types formerly recognized as the blue, the red and the yellow varieties have, as Stoye (*op. cit.*, p. 83) observes, been established as not breeding true to colour. Besides, specimens have been found to adapt their colour, within limits, to varying surroundings. However, the ground colour is usually olive green above, passing to milky white below. But it may vary from a greenish grey to a light olivaceous brown above and may be silvery white below. The fins, which are hyaline, yellowish or greenish grey have orange or sometimes bluish margin, and the caudal is clearly edged with black. Besides minute spots of different colours on body and fins, an ocellus on the lower third of the dorsal fin and above all an oval silvery spot on the occiput, so characteristic of these fish make it possible to distinguish the species without difficulty. The colours of large males are, as Stoye (*op. cit.*, p. 84) says, "richer and more vivid" Further, the dark border along the margin of the caudal fin is wider and more prominent in males, and in them the ventrals and even the anal are usually more of a beautiful canary yellow shade than orange. Norlund's (*loc. cit.*) remark about the disappearance of the black spot on the dorsal fin in males when 2½ cm. long does not hold good for the fish observed by the author. The spot, on the other hand, is seen to persist in both males and females, and it occurs, as Chaudhuri (1916, p. 452) has remarked, in all normal individuals irrespective of sex. Usually the males are of a slightly larger size than the females.

[1] *See* Sundara Raj, 1916, p. 269.

As Innes has noted about the genus in general, the males of *A. panchax* "are vigorous drivers, capable of courting several females at one time" In the aquarium, the chased female stops at intervals, and as Norlund mentions "puts herself in a slanting position against leaves" or other submerged objects, and the male "stops at her side and the pair make some vibratory movements" In response to these the female lays an egg, which is usually fertilised immediately by the male. But the male is not always so successful. Sometimes the female shows resistence and repeatedly avoids the male, which thereupon gives up chase in favour of another female. A strong male may, however, chase and overpower the female, and often the partner is won over by caressing movements with the snout and the body. Spawning usually takes place at dawn though it is often continued into the day.

Dissection of gravid females showed that the ovaries, which are of the cystovarian type, are paired, club-shaped structures, the right one being slightly larger than the left. They are suspended by a thin mesovarium, which is continued backward to form a very short oviduct opening out a little behind and independently of the anus. On an average, there are about a thousand well-formed ova, varying in size from 0·2 mm. up to 1·5 mm. in diameter. Of these, however, only about a dozen are fully developed, while the others are seen to be at various stages of growth. About another thousand minute ova below 0·2 mm. are also discernible besides microscopic egg cells. Thus if Stoye's (1935, p. 82) surmise of 500 eggs for three months is taken into account, there are enough eggs in the adult to lay for a whole year or more, and the fish has been found to be a perennial breeder. The ovarian ova (text-fig. 1*a*) are mostly spherical or subspherical, some being pressed out of shape by the adjoining eggs. Surface threads are differentiated even in the 0·2 mm. eggs and are apparent as peculiar sculpturings, the pattern recalling the ovarian eggs of *Tylosurus strongylurus* described and figured by Jones and the writer (Job and Jones, 1938, p. 245). In the egg of *A. panchax*, however, the threads radiate from around a tiny free spot, and on the rest of the egg the threads are small and scanty, though the folds of the major threads seem to cover the entire egg. The pattern is carried through the older stages until in the oldest ovarian ova the filaments are clearly formed, though they ramain in close apposition to the egg-surface, packed in a wavy pattern. The threads, however, can be easily freed and they stand out from the surface on teasing out an egg.

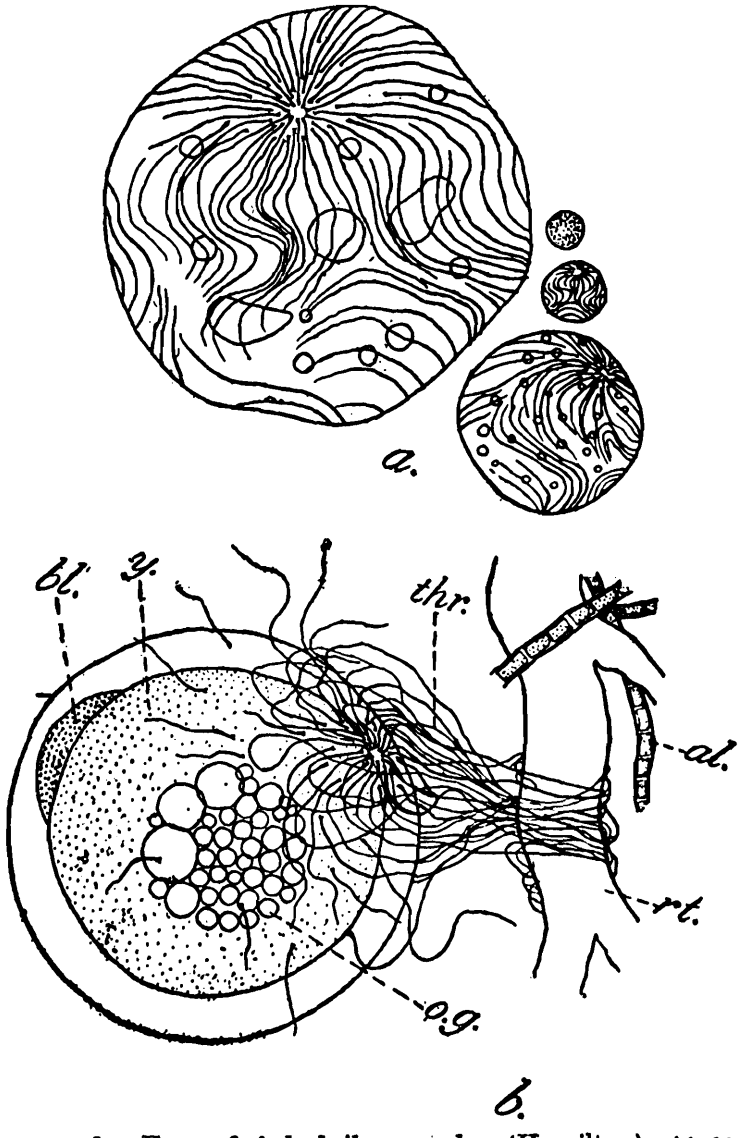
Several eggs of *A. panchax* were collected by the writer on the 1st of May, 1939, long before the monsoon had broken out, from the Municipal drain running along the eastern border of the Superintendent's private compound outside the temple gate of the Pulta water-works in the 24 Perganas. The drain, which is a *semi-pucca* one is practically *cutcha* when overgrown with vegetation as it was in May, but the few inches of water in it was quite clear and there was a very gentle flow. The main source of the water was underground seepage and drainage from a *cutcha* drain running along the north of the compound. Thus while the water was by no means pure, it could still be classed as 'sweet' or fresh. Of the submerged vegetation, the filamentous alga, *Tribonema*

was the most important. Roots of *Mikania scandens* Willd.[1] which crept along the sides, dipped themselves freely in the water. The water supported a rich fauna consisting of larvae of insects such as mayflies, dragonflies, etc., Ostracods and micro-organisms, young of *Gyraulus* and other Molluscs, etc., while ants and other insects moved about among the marginal vegetation. The eggs were found attached (text-fig. 1*b*) singly by the long filamentous threads to the semi-submerged root clumps of *Mikania scandens*, among the meshes of which dark green filaments of *Tribonema* grew. Though solitary, several eggs were generally attached to the same root clump, but these were found to be in different stages of development indicating that they had been laid at different times. Subsequently eggs have been found attached to algal filaments and the fine leaves of aquatic vegetation. During the early stages of development the eggs are transparent, but later become pigmented and appear to be of a dirty brown colour, effectively harmonising with the dark coloured substrata, so that only a very careful examination reveals their presence. Obviously this serves as a protective colouration for the developing eggs. Contrary to the statement of Mellen and Lanier (*loc. cit.*) the eggs are fairly heavy and demersal, and when disengaged from the attachment, sink to the bottom. Subsequently collections were made regularly twice a week throughout the months of May, June and July and afterwards at irregular intervals in the months of August, September and October. The period covered some of the hottest days of the year with the temperature rising to 105°F. on some days in May, with some very stormy and cool days from June to October. Mr. K. K. Nair, who regularly accompanies the Zoological Survey party in connection with the Pulta Survey informs me that he has seen young stages of the fish in the waters round about Pulta in other months as well. It may thus be assumed with Chatterjee (*loc. cit.*) that the fish breeds throughout the year. This does not agree with what has been reported by Norlund (*op. cit.*, p. 60) in regard to the habits of this fish in aquaria in North America. In dealing with *A. panchax* he remarks that the spawning of most of the egg-laying Cyprinodonts is confined to winter. Further, as noted above, Innes puts down the temperature range for spawning as 70 to 84 degrees. But at Pulta, as remarked above, egg-laying is continued even on the hottest day in the year. It is to be noted, however, that the eggs and fry occur in larger numbers during the months of June, July and August when the south-west monsoon rains inundate the low-lying lands and interconnect numerous puddles and pools. The new-born fry at this time wander about the shallow stretches of water over submerged areas, thus effecting their wide dispersal. Hardy as the fish is, it naturally becomes more prolific under favourable conditions. Chatterjee (*loc. cit.*) states that the fish breeds in confined waters in tanks. Observations made at Pulta both in still waters as well as in gently moving waters show that while the fish can live in sweet waters of most kinds, (its occurrence in brackish water has already been recorded), it perennially

[1] The plant was kindly identified for me by Dr. K. P. Biswas, Superintendent of the Royal Botanical Gardens, Sibpur, to whom my thanks are due.

multiplies and flourishes more in shallow waters maintaining a gentle flow and affording suitable substrata for egg-laying.

Some of the early stages of the eggs were examined in the field under a microscope and figures were drawn immediately from fresh material. Others along with the attached root clumps were removed to the improvised laboratory in the Zoological Survey of India camp at Pulta, and the individuals carefully removed along with pieces of attached rootlets to separate aquarium jars containing clear water from the same

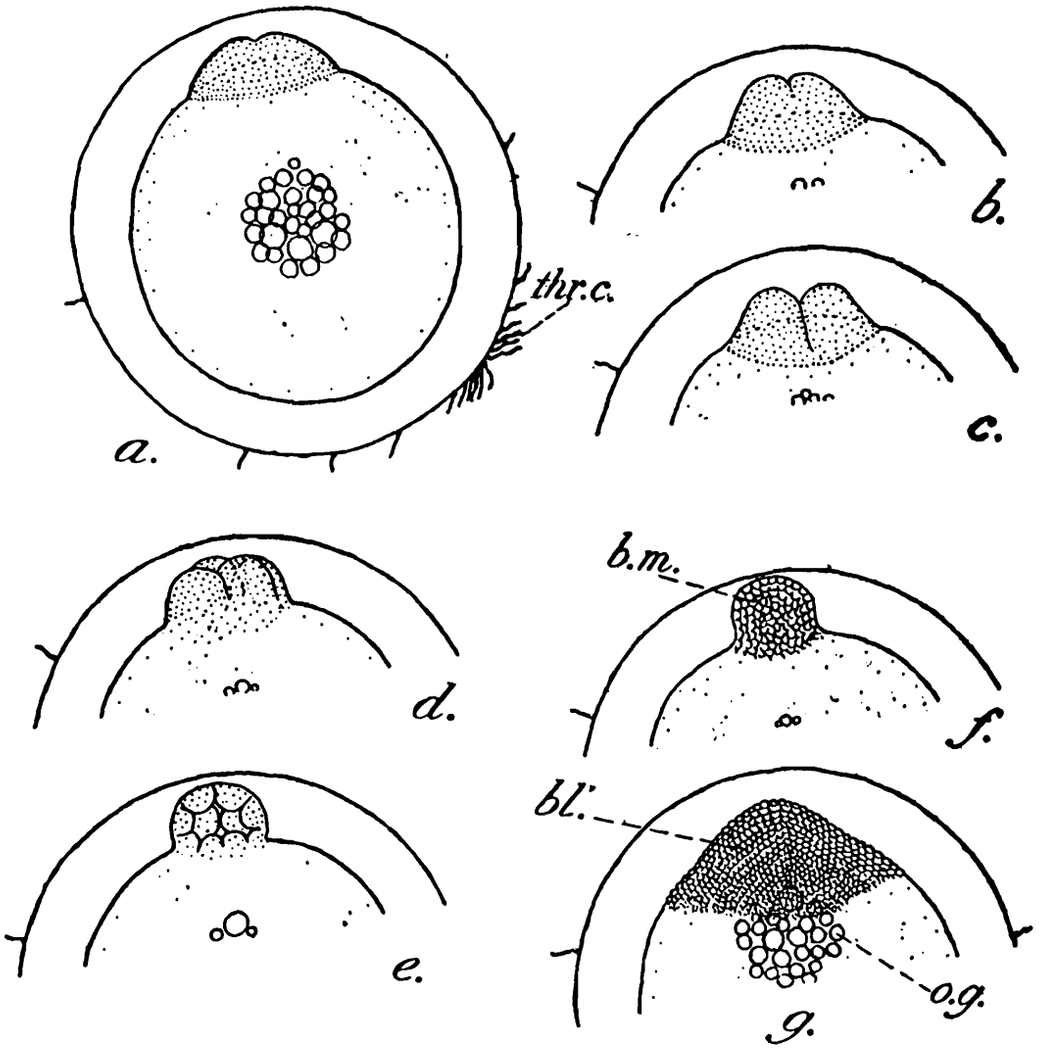


TEXT-FIG. 1.—Eggs of *Aplocheilus panchax* (Hamilton) : × *ca.* 30.
a. Various stages of ovarian ova ; *b*. A fertilised egg anchored to rootlet of *Mikania*. *al*. algal filament ; *bl*. blastodisc ; *o.g*. oil globule ; *rt*. rootlet ; *thr*. adhesive threads ; *y*. yolk.

drain and small quantities of algae so as to aid the natural oxygenation of the water, which was renewed every day. The jars themselves, to keep the contents sufficiently cool, were kept partly immersed in water. The development of the eggs was closely followed, initially at short intervals and later on daily. Care was taken to collect various developmental stages of eggs and larvae from the 'field' and to compare these stages and identical stages in the batches of eggs and larvae allowed to develop in the aquarium jars.

Early Embryonic Development.—The earliest developmental stage collected is figured in text-fig. 1*b*. The egg is fairly large, being highly

laden with yolk, and is more or less spherical, measuring on an average, about 1·4 mm. in diameter. It is transparent and bears adhesive filamentous threads standing out from the surface. At one pole the threads are long and crowded to form a tuft radiating out from around a tiny central spot. The tuft is usually reinforced by a few shorter filaments scattered sparsely over the rest of the egg surface, though most of these " short hairs " stand out free. The long elastic threads can stretch to a length of 20 mm. and readily coil up against any foreign object and effect a safe anchorage for the egg as soon as it is laid. The eggs closely resemble those of *A. lineatus* obtained by Jones and the writer from Travancore (*vide infra*, p. 68).



TEXT-FIG. 2.—Early segmentation and blastoderm formation in the eggs of *Aplocheilus panchax* (Hamilton): × *ca.* 30.

a. Egg, two minutes after first stage (text-fig. 1*b*); *b.* Egg, three minutes after first stage; *c.* Egg, five minutes after first stage; *d.* Egg, half an hour later; *e.* Egg, about two hours after first stage; *f.* Egg, about four hours after first stage; *g.* Egg, about six hours after first stage.

bl. blastoderm; *b.m.* Blastoderm mass; *o.g.* oil globule; *thr. c.* cut ends of adhesive threads.

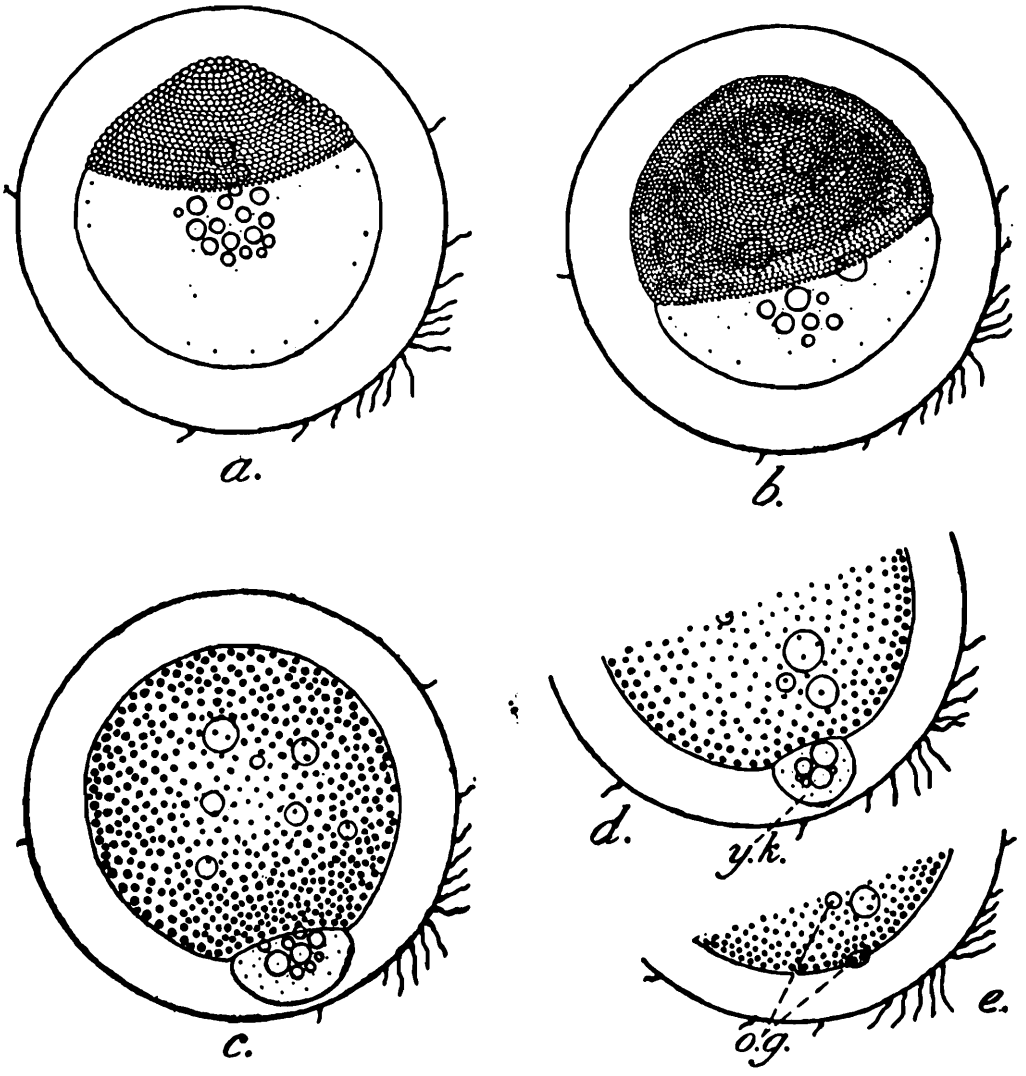
(In *b.* to *g.* only portions of the eggs are shown.)

In a newly fertilised egg the transparent zona radiata is separated from the inner egg mass by a space containing a clear fluid, and the cytoplasm collects together at one pole of the egg and stands out from the yolk surface as a convex dome-like blastodisc which is highly granular and devoid of yolk, while the yolk which forms the major part of the egg is clear and transparent. A group of oil globules, about

thirty-six in number, occurs in the yolk. Their number, however, is highly variable, and even in the same egg it changes in the course of development. They seem to burst and reassemble, but a number of them persist until the larva hatches out. The egg mass being freed from the zona, the blastodisc bears no fixed relation to the pole bearing the adhesive tuft.

Cleavage.

In an egg collected at 9-23 a.m. on the 5th of May 1939, a faint sign of dipping in the middle of the blastodisc was noticed (text-fig. 2*a*) after two minutes, and gradually the dipping advanced (text-fig. 2*b*) and in another three minutes the division was completed (text-fig. 2*c*). Nearly half an hour elapsed before the second meridional



Text-fig. 3.—Invasion of the yolk by the blastoderm and the dispersal of the oil globules in the eggs of *Aplocheilus panchax* (Hamilton): × *ca.* 30.

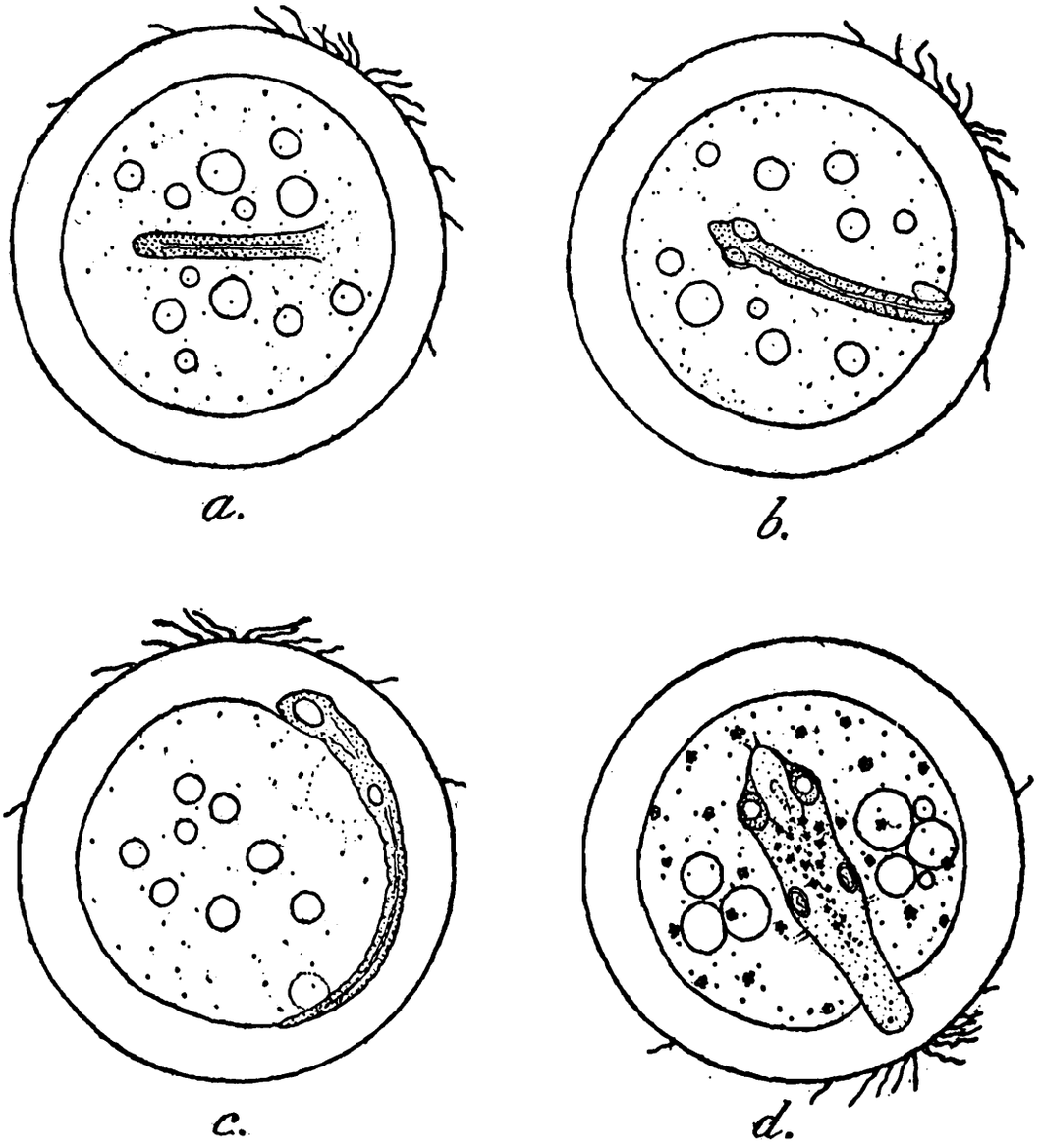
a. Egg, about eight hours after first stage ; *b*. Egg, about ten hours after first stage ; *c*. Egg, about twelve hours after first stage ; *d*. Egg, about 14½ hours after first stage ; *e*. Egg, about sixteen hours after first stage.
o.g. oil globule ; *y.k*. yolk knob.

(In *b*., *d*. and *e*. only portions of the eggs are shown.)

division at right angles to the first was accomplished resulting in four blastomeres (text-fig. 2*d*). In another half an hour the cells doubled their number by dividing horizontally. Subsequent divisions followed in quicker succession in the usual manner and by quarter past eleven the cells formed a projecting button (text-fig. 2*e*).

Yolk Invasion.

In another two hours the button became a mulberry-like mass of minute cells (text-fig. 2*f*) which began to spread at the base over the yolk, and thus the mulberry-like appearance was lost, and the protuberance was reduced as the cells spread out in a thin layer over the yolk with a very faint and indistinct margin (text-fig. 2*g*). In another two hours the cells formed a regular blastoderm layer extending over about one-third of the circumference, with a distinct margin (text-fig. 3*a*). Two hours later, the blastoderm covered more than half of the yolk, and by



Text-fig. 4.—Early embryo differentiation up to the commencement of circulation in the egg of *Aplocheilus panchax* (Hamilton): × *ca.* 30.

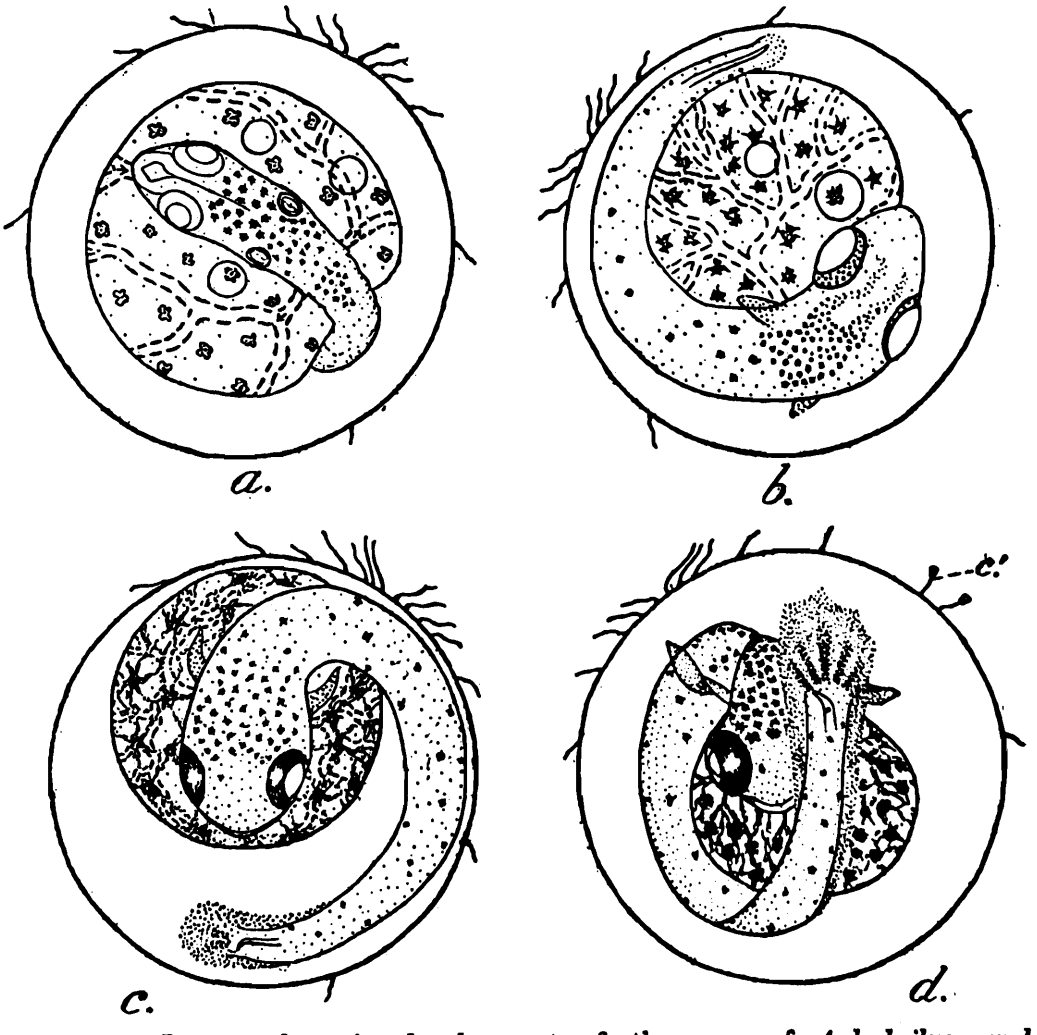
a. Egg, about twenty hours after first stage; *b*. One day old egg; *c*. Egg, thirty hours after first stage; *d*. Egg, about forty-two hours after first stage.

this time the oil globules separated out from the original single group (text-fig. 3*b*). In another two hours the blastoderm extended over more than seven-eighths of the yolk, and the remaining yolk stood out as a large button pinched off as it were by the constricting margin of the blastoderm (text-fig. 3*c*). By midnight this button was reduced to a spherical knob (text-fig. 3*d*) and by 1-30 a.m., *i.e.*, about thirteen hours after the first cleavage, the invasion of the yolk by the blastoderm was

nearly completed (text-fig. 3*e*) and the latter appeared as a thin more or less uniform layer surrounding practically the whole of the yolk.

Formation of the Embryo.

Twenty hours after the first stage the embryonic ridge is formed (text-fig. 4*a*) as a multilayered thickenning in the antero-posterior axis, and in a day old egg (text-fig. 4*b*) the embryo is fairly differentiated, the optic vesicles and about five of the early somites being clear. The embryo now encircles more than one-third of the yolk. In another two hours the auditory vesicles appear and four hours after that they are well marked with about ten somites in the body (text-fig. 4*c*). The whole embryo is embedded as it were in the yolk, and no portion of



TEXT-FIG. 5.—Late embryonic development of the eggs of *Aplocheilus panchax* (Hamilton): × *ca.* 30.

a. Two days old egg; *b*. Three days old egg; *c*. Five days old egg; *d*. Eight days old egg.

c'. Epizoic Ciliate on the egg membrane.

its length is as yet freed from the same. A fair-sized Kupfer's vesicle is visible just ventral to the caudal region. By about the thirty-fourth hour the otoliths are formed in the auditory vesicles, and by the forty-second hour (text-fig. 4*d*) pigmentation is developed. Small rounded black dots at first appearing on the nape and on the yolk-sac develop into star-like blotches, those on the yolk-sac assuming a more diffused form of a brownish colour. The oil globules coalesce and increase in size

while their number decreases. Embryonic circulation just commences with the appearance of vitelline vessels of which there are three main ones, one anterior and two lateral. The embryo shows activity by jerking movements of its tail which is by this time freed from the yolk. The lens appears in the eye, which begins to growfaintly dark.

Late Embryonic Development.—Two days old egg : In a two days old egg (text-fig. 5*a*) the primordia of the pectoral fins begin to appear as tiny conical buds. The heart pulsates rhythmically about 140 times in a minute. The yolk-sac circulation is well established, and a network of vitelline vessels brings blood over the yolk-sac from the posterior region of the body. The side to side movements of the tail are more pronounced. Pigmentation is deeper, the darkest asters being in two paired ovoid groups on the head between the optic and the auditory regions.

Three days old egg : In a three days old egg (text-fig. 5*b*) about 28 somites are recognizable. Oil globules are about 14 in number. The yolk is appreciably reduced. The pectoral buds are well established, but as yet are not mobile. Pigmentation is well defined on the head and nape and sparsely on the body. The yolk-sac bears stellate pigment spots. The heart beats about 150 times a minute. The median fin-fold just makes its appearance as a narrow membranous edging around the caudal end of the embryo.

Four days old egg : In a four days old egg the pectorals are still better developed and begin to make faint flapping movements. The yolk is being reduced markedly by assimilation, and the globules are only about twelve in number. The pigmentation is deeper. The asters on the yolk-sac send out irregular processes, some of which begin to anastomose. Just behind the constriction, a circular area of the yolk-sac is devoid of pigment. The rudiment of the air bladder is faintly visible. The median fin-fold begins to extend as a narrow fringe dorsally and a comparatively broader fringe ventrally. When the egg is four and a half days old the well developed pectoral fins begin to flap actively. The air bladder appears as a clear vesicle. The yolk is further absorbed, and it is now seen to occupy only about half the diameter of the egg. The chromatophores on the yolk-sac begin to form a patchy reticulum. The darkly pigmented eyes on reflection appear pale green.

Five days old egg : In a five days old egg (text-fig. 5*c*) the median fin-fold is fairly well established, and traces of rays already begin to appear in the caudal part. The pigmentation extends to the body as sparsely scattered spots here and there, which, however, appear to form five discontinuous irregular rows, one dorsal, two laterals and two ventrals. The pectoral fins exhibit active flapping movements. The embryo also twists and turns frequently, changing its position inside the egg membrane. The mouth opens and closes at irregular intervals, roughly about thirty-two times a minute. It usually opens slowly, closes incompletely and then snaps tight. Sometimes the whole act of closing is quick and snappy. The embryo has a light greenish yellow hue. Over the yolk, which is now reduced to less than half the diameter of the egg, the vitelline vessels form an irregular network. The air bladder has become elongate. The pigmented areas of the

yolk-sac are connected together into a coffee-coloured patch. Oil globules are reduced to five or six. The hind gut is just discernible. A pale golden sheen is seen all around the cornea in the eye. The pigmentation on the head is denser.

Six days old egg : In a six days' egg the gill arches are clear with the gill rakers. The heart beats about 130 times a minute. Teeth make their appearance as rudiments in the jaws, which latter are now blunt in front. The oil globules are about six in number. Pigment dashes appear on the pectoral fins and three asters are developed on each of the opercles.

Seven days old egg : The next day finds the yolk still further reduced and the embryo larger in size. The pigmentation is deeper, and the Kupfer's vesicle is no longer visible.

Eight days old egg : In an eight days old egg (text-fig. 5*d*) the pigment patches on the yolk-sac anastomose to form a complex web, whose 'stem' is gathered over the yolk constriction. The caudal is rounded and continued as a short narrow dorsal fringe and a longer wider ventral fringe which latter runs up to the anus. About six rays are present in the caudal portion of the fin-fold. The pectoral fins are actively flapped about thirty-two times a minute. The pigment patch on the head is well marked. The eye is blackish with a pale golden green outer ring whose lustre is bright in reflected light. The mouth opens and closes at irregular intervals, about seventy times a minute. The pigmentation of the body is irregular and sparse, but roughly arranged in five discontinuous rows along with some irregularly scattered spots. Epizoic Ciliates such as Vorticellids sometimes become attached to the egg membrane ; for, the accumulation of dirt and traces of decaying matter on the egg surface often promotes the growth of such organisms. But these have not been found to affect the embryo in any way. The egg, however, ceases to be clear and transparent owing to these extraneous organisms, and still more owing to the well developed pigmentation of the yolk-sac.

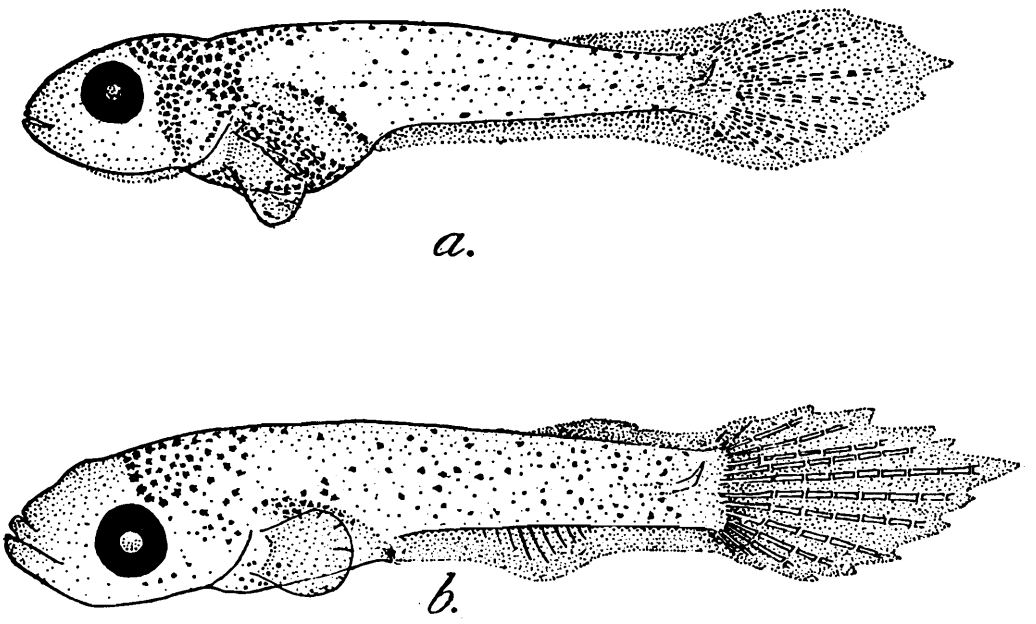
Nine days old egg : In a nine days old egg the yolk is materially reduced, and the embryo, which begins to be remarkably active wriggles furiously inside the egg, while the flapping of the well developed pectorals is strong and regular. Sooner or later hatching takes place, sometimes the head emerging first, sometimes the tail.

Eggs usually take about nine to twelve days to hatch in warm weather and in properly aerated media. But the period may be prolonged in colder weather, and in wates which was not regularly renewed they took eleven to fourteen days to hatch. Norlund (*op. cit.*, p. 60) mentions that in the American winter the eggs of the species sometimes take twenty-five days to hatch.

Newly Hatched Larva.—The exact stage of development of the newly hatched larva varies to some extent according to the period of incubation, those hatching out late being slightly more advanced than early hatchlings.

A larva hatching after ten days' incubation (text-fig. 6*a*) is about 4·4 mm. long and is nearly transparent except for the conspicuous black eyes and dark pigmentation on the nape, and the projecting abdomen

appears more solid and opaque owing to some yolk still present in it. Further, the body is tinged with a light greenish yellow hue. On coming



TEXT-FIG. 6.—Early hatchlings of *Aplocheilus panchax* (Hamilton): *a*. Newly hatched larva: × *ca*. 20; *b*. Five days old larva: × *ca*. 15.

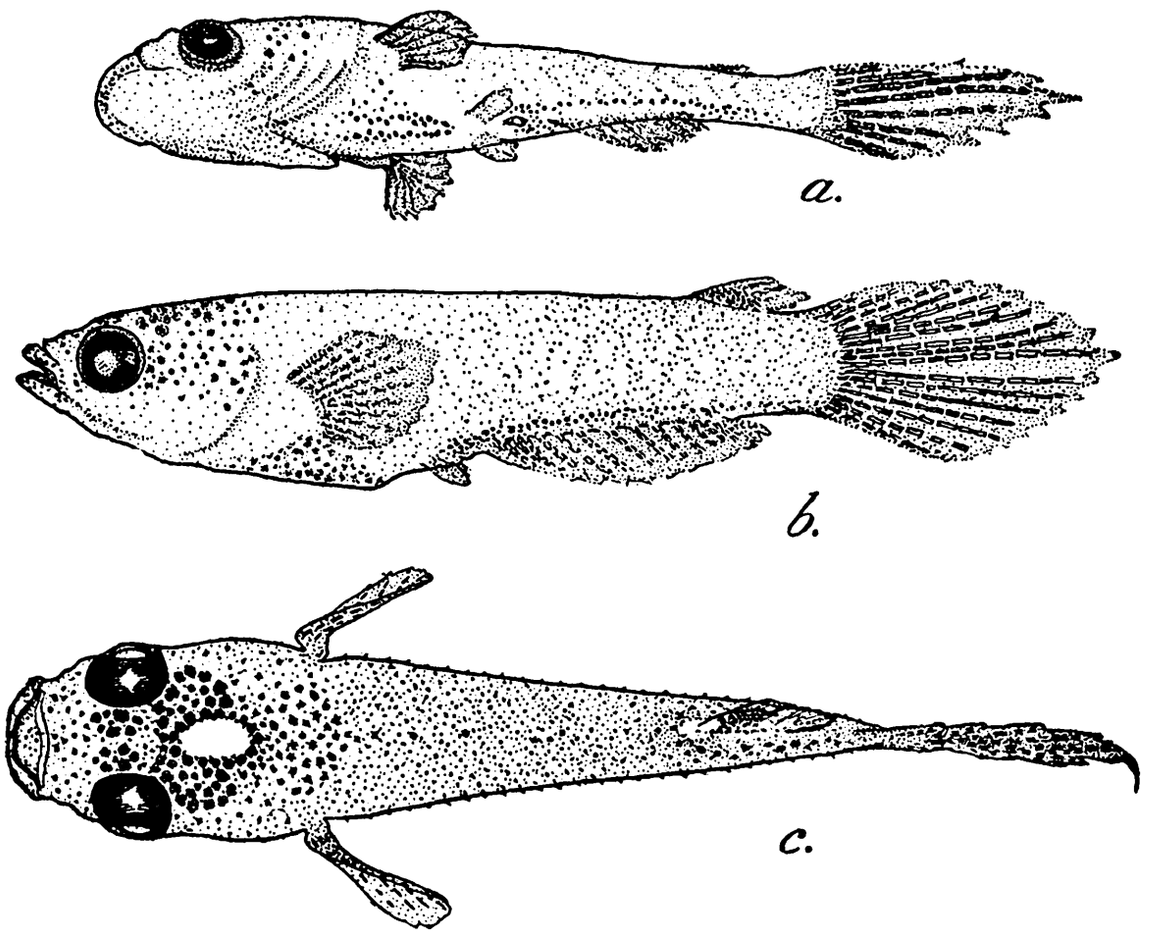
out of the egg the larva usually remains for a minute or two resting on the substratum, with the tiny pectoral fins quivering actively all the while. Having thus acclimatised itself to the new environment it smartly darts up to the surface and swims about hither and thither for some time. When apparently exhausted by these activities it again rests for a while, after which active swimming is resumed. Sometimes, especially in the case of late hatching, the larva swims immediately after liberation from the egg membrane. Often it assumes a nearly vertical pose resting, head downwards, at some spot on the substratum. The head is large, slightly flattened below, but strongly convex above, quite unlike the adult. The eyes are large and blackish with bright green and yellow iridiscent patches. The jaws are sub-equal, the lower being slightly longer than the upper, and the tiny premaxillae are marked off by a shallow groove from the rest of the jaw. The gill region is reddish, and the opercular clefts are well formed. No separate yolk-sac is visible at this stage as the yolk is nearly all absorbed, but it is indicated by a slight swelling of the abdomen. In early hatchers, however, more of the yolk is evident. The vent is apparent just behind the margin of the yolk-sac; from this region the body becomes compressed and gradually tapers towards the posterior end. The pigmentation is characteristic. In most larvae it is blackish, but it may vary from reddish brown to dark brown. In the earliest stage, pigment appears as tiny rounded black spots, these later assume aster-like form and subsequently some of the asters turn into blotchy circles and polygons with irregular margins. A conspicuous patch of asters closely adjoining one another covers the occiput and the nape with a backward prolongation tapering towards the mid-dorsal region and two lateral prolongations on either side over the operculum, the anterior one being directed towards the gular region and the posterior stopping short of the opercular margin, though appearing to merge into the patch on the abdomen behind. In

front the occipital patch of chromatophores is nearly truncate behind the inter-orbital line. On the body at this stage pigment spots are sparse and irregular. They appear to be disposed in five irregular and discontinuous rows, one mid-dorsal, two laterals and two ventrals. Besides, other spots are irregularly scattered. These are few and far between. Chromatophores developing inside the abdominal wall can be seen through the thin wall of the abdomen. The fins excepting the caudal and to a slight extent the pectorals are entirely free from pigment. Each ray in the caudal fin has a double row of tiny pigment dashes. The caudal fin alone is well developed with about nine rays. The urostyle is turned upward. The caudal is fairly large with a few graceful indentations at the terminal region. Dorsally the median fin-fold is continued forward as a thin membranous fold tapering over the middle of the tail. Ventrally it is continued as a similar membrane of more or less uniform width right up to the vent. The pectorals are placed rather low, and though very active, are still hyaline with but slight indications of rays. Since very little of the yolk is left, further growth of the larva depends to a great extent on the quality and quantity of the food available, those obtaining a richer diet and enjoying a free environment growing more rapidly than those kept in small receptacles and supplied with scanty food. The larvae usually feed on diatoms, ciliates and other micro-organisms.

Metamorphosis.—Five days old larva: By about the fifth day after hatching the yolk is completely absorbed, and the length of the larva increases to about 6·5 mm. (text-fig. 6*b*). The dorsal aspect of the head is less convex, and the premaxillae are more pronounced. The pigmentation is deeper and less scanty, but the lateral prolongations of the occipital patch are less marked. The caudal is better developed, having about fourteen well developed rays which appear jointed. The indentations on the margin are more marked. The dorsal fin is beginning to be marked off by a notch in the dorsal fin fold and by the appearance of the rudiments of one or two rays in it. The anal also becomes conspicuous by a slight widening in the middle of the ventral fin-fold, where the rudiments of about nine rays are indicated. The pectorals are still without well formed rays. Though the pectoral fins begin to be functional even before hatching, the fin rays appear only at a later stage. The comparatively dense, though hyaline, appearance of these fins even when inside the egg, shows that even in the absence of rays, they are, with the help of the strong pectoral muscles, capable of active flapping movement.

Ten days larva: By about the tenth day the larva (text-fig. 7*a*) reaches to about 9·5 mm. in length. The premaxillae are now definitely protractile. About twenty rays have appeared in the caudal and eleven in the anal, which is now quite distinctly marked off from the caudal. The dorsal also is similarly demarcated and shows four to five rays. About ten rays have appeared in the pectorals. The pelvic fins are definitely established though no fin rays can be distinguished. A pair of oval patches of pigment spots appear in the inter-orbital region. Pigment has appeared on the jaws, and ventrally on the abdomen the chromatophores are arranged in a pair of irregular longitudinal rows

forking out as it were from the middle of the abdomen and running forward towards the throat. A pair of irregular rows on the ventral aspect



TEXT-FIG. 7.—Late fry of *Aplocheilus panchax* (Hamilton).

a. Ten days old larva, ventro-lateral view : × *ca.* 10 ; *b.* Two weeks old larva, side view : × *ca.* 10 ; *c.* Two and a half weeks old young, dorsal view : × *ca.* 9.

of the tail end in front in a lunar group of pigment round the vent. The pigment patch of the occiput is heart-shaped with a backwardly directed apex ; its posterior continuation appears rather darker.

Two weeks old larva : In a fortnight the larva (text-fig. 7*b*) assumes a length of about 10·8 mm. The ' third eye ' is faintly visible as a slight whitish speck in the middle of the occipital pigment patch. Pigment dashes are formed also on the pectoral fins, the rays of which become jointed by this time. About four rays are seen in the pelvics ; but they are not pigmented. The anal and the dorsal fins are very well demarcated and the membranous fin-fold has completely disappeared except for a narrow adipose remnant on the dorsal side near the base of the caudal. The anal has about twelve rays. About five rays are seen in the dorsal, in which pigment begins to appear towards the base of the three anterior rays as the fore-runner of the ocellus of the dorsal fin of the adult. The caudal has twenty-three rays.

Post larva ; two and a half weeks old : By the middle of the third week, *i.e.*, when nineteen days old (text-fig. 7*c*) the length increases to about 12 mm. The ' third eye ' is established and shines as an oval silvery bright spot. The spot becomes dark being over-run by the chromatophores during fixation. The ocellus on the base of the dorsal fin also is fairly well marked. The mouth appears to be sub-terminal as

the upper jaw looks apparently longer since the premaxillae are now quite protrusible. Larvae of mosquitoes and other insects, if thrown into the aquarium, are consumed by the fish even at this early stage. For all practical purposes the fish is a "young adult", and the assumption of full adult features is now only a matter of further growth.

Aplocheilus lineatus (Cuv. and Val.).[1]

General.—The '*piku*' or '*poochaatie*' is the largest of the Asiatic members of the genus; it has been recorded (Day, 1878, p. 523) as growing to four inches in length; but the average length is not more than three inches. It occurs in Peninsular India, is common in paddy-fields, tanks, canals and even in tidal waters in Bombay, Malabar District, Coorg, Wynaad and the States of Cochin and Travancore, and has been reported also from Ceylon, where it is called '*Irri Nalla Handhaya*' in Sinhalese. Owing to its brilliant hues it is one of the very popular exotic fishes in American aquaria. The habits of this fish are very much like those of its North Indian congener, *A. panchax*, and it is hardy, active and a prolific breeder. In its natural habitat its insectivorous propensities have been fully recognized, as pointed out above, and Prashad and Hora (*op cit.*, p. 640) mention that the fish is reported to be as efficient for mosquito control as *A. panchax*.

Breeding.—No record of the eggs of this fish from natural habitat has appeared so far, and there are but few observations regarding its breeding.

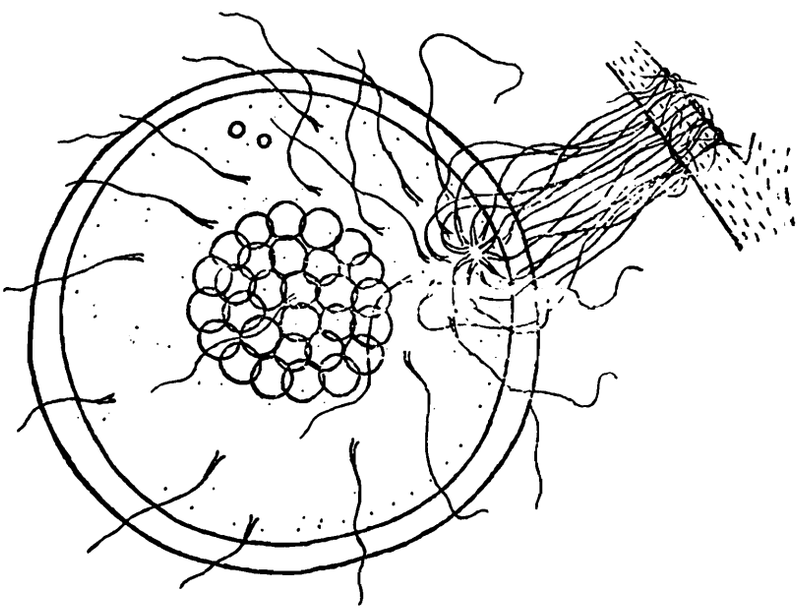
There is a marked sexual dimorphism, and it is noted that the males and females have by some authors been described and designated as two distinct species, *viz.*, *rubrostigma* and *lineatus* respectively. The males far outnumber the females, sometimes comprising, according to Stoye (*op. cit.*, p. 84) ninety per cent. of the offspring. As recorded by various observers the colouration of the species is to some extent variable according to the colour of the surroundings and lighting conditions. The basic colour of the male (*rubrostigma-type*), however, is olive brown, lighter on the ventral region, the chest being bluish white. Rows of metallic golden green and beautiful red dots are scattered on the body. The fins are of a greenish orange hue with reddish fringe. The ventral fins are elongate and with age develop a filose point. About half a dozen faint transverse bars are often present passing across the sides in the hind region of the body.

The female (*lineatus-type*) is darker than the male and has seven to eleven clear black transverse bars, but is devoid of the beautiful red spots of the male. The median fins are paler than those of the male though edged with red. A dark basal spot on the dorsal fin and a shield-shaped silver spot on the occiput are invariably present in both the sexes. The colour differentiation of the male begins with maturity, while the female retains the juvenile colouration throughout life.

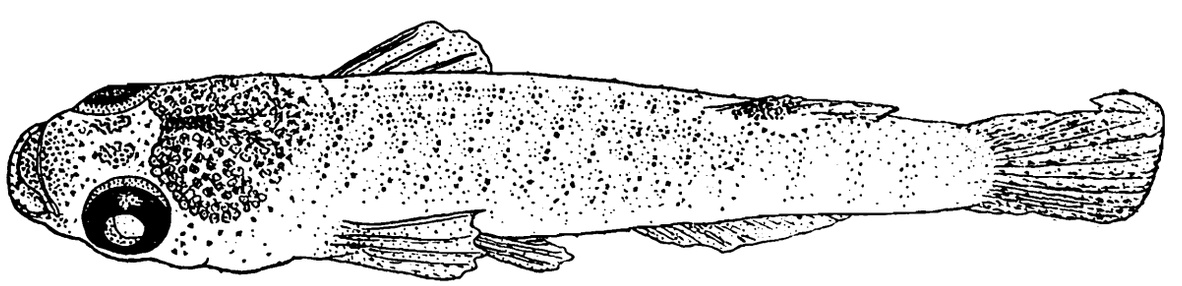
Stoye (*op. cit.*, p. 84) mentions that the fish "seems eager and ready to spawn at all times", and puts down the spawning temperature at 70 degrees with reference to the American aquaria. Mellen and Lanier

[1] *Panchax lineatus* of Day (1878, p. 522) and other authors.

(*op. cit.*, p. 135) state that the spawning habits are similar to those of *A. panchax*. Moody (1933, p. 186) has observed its breeding habits in the aquarium, and writes, " Each morning for a week or more I found them excitedly chasing through the surface plants and pausing every few seconds to deposit an egg. The female was always ahead. She, apparently, picked out the sites. The male's part was limited to coming forward at the proper moment and assisting in the brief ceremony attending oviposition. Both male and female wore their most brilliant colours immediately before and during the egg laying period, and a



a.



b.

TEXT-FIG. 8.—Egg and young of *Aplocheilus lineatus* (Cuv. & Val.).

a. Egg attached by adhesive tuft: × *ca.* 30; *b*. Dorso-lateral view of " young adult ": × *ca.* 7½.

limited amount of courting was observed. The spawning, however, was in no way spectacular, and there was little driving or quarreling " Willey (*op. cit.*, p. 122) refers to the adhesive eggs of *A. lineatus* becoming attached by glutinous threads to water plants. In May, 1938, Mr. S. Jones and the writer collected a few large sized adult fish from the big tank in front of the Entomological Station at Karamana and kept them in an aquarium with a few water plants. The next day eggs (text-fig. 8*a*) were found attached by adhesive threads to the filiform leaf segments and also to algal filaments. The eggs are laid singly as in the case of *A. panchax*.

The eggs are nearly spherical, being about 1·4 to 1·7 mm. in diameter, heavily laden with yolk and demersal, though containing several oil globules. They bear numerous filamentous threads all over the surface, some of which are longer, and these radiate from a tiny central spot as in the eggs of *A. panchax*. There are, however, a larger number of short filaments in the case of *A. lineatus*. The long adhesive threads form an anchoring tuft attaching the egg to the aquatic vegetation. In all essential details the egg resembles that of *A. panchax*.

Fry and Assumption of Adult Characters.—Innes (1939, p. 151) has already observed that the eggs of the species hatch in about a fortnight producing "fry of good size", which "grow fast if supplied with food" Therefore, as Moody (*loc. cit.*) has mentioned, even when no special diet is supplied, "youngsters of respectable size can be netted out at the end of three months" Unlike *Gambusia affinis* the proportion of males among the hatchlings of *A. lineatus* is much greater than that of females. The young of *A. lineatus* closely resembles that of *A. panchax*. An immature fish, about 14·7 mm. long (text-fig. 8*b*) has the adult specific structures more or less established. The body is considerably stout. The pigmentation is very similar to that of *A. panchax*, but the transverse bands are just beginning to be represented, especially in the posterior region. The occipital spot is not shown in the specimen, as during fixation the chromatophores usually "spread" and cover the spot rendering it dark. The fins have developed all the rays, and the protractile premaxillae are well marked as in *A. panchax*. For about three months the colouration of the young continues to be of the "*lineatus-type*" But when about four months old, by which time the fish attains maturity and begins to breed, the male develops his nuptial characters. The brilliant red spots appear on his body, the dark vertical bars grow faint, and the anal fin elongates to form the filose point. The female retains her original appearance except for a somewhat broader abdomen due to the number of eggs.

Aplocheilus blockii (Arnold).[1]

General.—The *dwarf panchax* or *pachai munda kanni* of Madras is the smallest known species of the genus, and attains a maximum size of only two inches. The average length, however, does not exceed one and a half inches. It is said to be a freshwater species inhabiting "stationary and sheltered waters of tanks and rivers overgrown with vegetation" The fish is recorded to be of limited distribution occurring in the East Coast of India near Madras, but Innes (1935, p. 265) lists Ceylon also as its home. It is freely reared in American aquaria as an ornamental fish. *A. blockii* closely resembles *A. panchax*, so much so that Stoye (*op. cit.*, p. 83) treats it as a "variety" of the latter, and refers to it as "*panchax* var *blockii*" It is, however, easily distinguished by its projecting lower jaw, characteristic colouration and the lesser number of scales both in the longitudinal and transverse series. Sundara Raj (*loc. cit.*) has given a good description of the species under the name *Panchax parvus*. The fish is a fairly good larvivore, and its

[1] *Panchax parvus* of Sundara Raj (1916, pp. 268, 269.)

insectivorous propensities have been discussed by writers such as Macdonald (1914), Sundara Raj (1916), Hora (1927) and Gravely (1937). It has, however, been found to be less hardy than *A. panchax* and *A. lineatus*. Further, it is smaller in size and more limited in distribution, and Russell and Jacob (1939, p. 275) who have conducted experiments on the species in the " sandy and scantily vegetated casuarina pits of the Ennore-Nellore coastal area " near Madras, found it to be not as efficient as *Gambusia affinis* for mosquito-control in those pits.

Breeding.—Sexual dimorphism is marked as in the other congeners. The large males looking like " living sparkling jewels ", are more brightly coloured than the females, and have the posterior rays of the dorsal and anal fins drawn out into filaments which reach the caudal fin, while in the female these fins are rounded and do not reach the caudal. The basic colour of the body in both sexes is dark olive with a metallic sheen above, passing to a translucent enamel blue on the ventral side. The fins are light orange. Alternating green and pink dots occur in longitudinal rows over the back and sides, and in the male they extend over the proximal portions of the median fins. A pearly white occipital spot occurs in both sexes. An ocellus at the anterior region of the base of the dorsal fin is less distinct in mature males. The female's colours are merely " a pale suggestion of those in the male " excepting the occipital spot and the ocellus on the dorsal fin.

The first reference to the spawning habit of the species is by Thomas (*op. cit.*, p. 112). He writes, " *H. panchax* (he means *A. blockii*) extrudes one egg at a time and that is 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 " About the breeding habits of the fish, Mellen and Lanier (*op. cit.*, p. 134) state that its spawning habits are similar to those of *A. panchax*, and Innes (1935, p. 265) notes that it is a good breeder, and puts down the temperature range as 70 to 84 degrees. Russell and Jacob (*loc. cit.*) observe that the fish " does not multiply effectively when confined in casuarina pits or nurseries " According to Sundara Raj (*loc. cit.*) the egg closely resembles that of *Oryzias melastigma* (=*H. melanostigma*), but is slightly larger, the chief difference being the absence of the tuft of long processes.[1]

Oryzias melastigma (McClelland).[2]

General.—This is a delicate little Killifish growing to but an inch and a half, and is widely distributed in the Indian Empire. Though usually regarded as an estuarine and brackish water form, *Oryzias melastigma* is found in large numbers in pieces of fresh water as well, and is common in ponds, lakes, rivers, canals and creeks in Lower Bengal, Orissa and Madras Presidency, and has been recorded from Wynaad, Burma, the Kiangsu Province of China ?, Formosa ?, Korea ?, and Japan ?. Sewell and Chaudhuri (*op. cit.*, p. 4), Fry (1912), Macdonald (1914), Sundara

[1] Mr. S. Jones has informed me that his description of the egg and development of *Panchax parvus* (Jones, 1937, pp. 284, 285) is really that of *Hemirhamphus* sp. and that this correction is in the course of publication.

[2] *Aplocheilus melastigma* of McClelland (1839) and other authors.

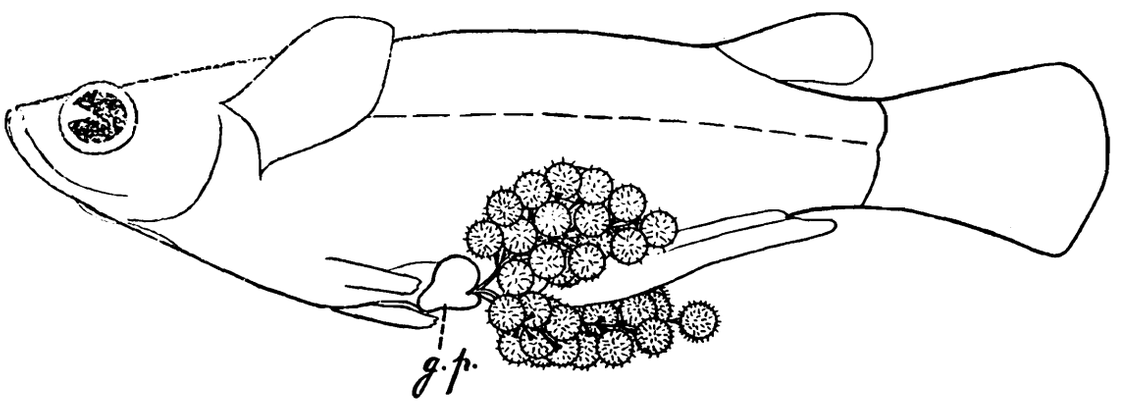
Raj (1916, p. 268) and Southwell (*op. cit.*, p. 182) have commented on the utility of this fish as a larvivore. It is, however, less hardy than the *Aplocheilus* species, and Russell and Jacob (*op. cit.*) found it inferior to *Gambusia affinis* in the matter of mosquito-control in their casuarina pit experiments. Allied in appearance and habits to the *Aplocheilus* species, the fish is easily distinguished by the strongly compressed diaphanous body, small fixed upper jaw, and a thin dark line along the side from the upper angle of the opercle to the middle of the base of the caudal fin, which is truncate or rounded, and the elongated anal fin.

Breeding and Parental Care.—The sexes in the species have the same colouration, the usual ground colour of the diaphanous body being a light olive grey above, passing on to sides of a lemon shade with silvery white abdomen below. The fins are usually faintly yellowish, and in a mature fish the median fins often develop a dash of brilliant yellow along the margin. Minute black spots are scattered over the body apart from the characteristic narrow dark line of the side. A shining silvery spot is usually present in the middle of the head; but it is less conspicuous than in species of *Aplocheilus*. The eyes are bright and greenish in both sexes. As noted by Sundara Raj, the colouration of the fish may vary according to surroundings, "those among green weeds" being "greenish" and "those in clear water translucent white", and in road-side puddles sometimes they show a dirty reddish hue. Mellen and Lanier (*op. cit.*, p. 136) refer to the "Golden Medaka" as an orange gold variation of *Oryzias latipes* (Temminck and Schlegel), a fish which is widely used in genetic studies and which Chaudhuri (1916, p. 455) considers as being synonymous with *O. melastigma*. Although the colours of the sexes are the same, the male can easily be distinguished by its larger and more pointed pectorals, a longer dorsal with the last ray rather separated from the others and a wider anal fin. The female has a deeper abdomen often distended with eggs in the breeding time.

The peculiar method of spawning and parental care exhibited by the fish has attracted the attention of workers such as Jenkins (1910, p. 137), Sundara Raj (1916, p. 267) and Jones (1937, p. 282). Sundara Raj's observations have been supplemented by a detailed description with more accurate figures by Jones of the egg and the development up to hatching.

O. melastigma has been observed to be a perennial breeder in the brackish water area at Adyar (Jones, *op. cit.*, 286). Russell and Jacob (*loc. cit.*) note that "in a special nursery it failed to show much increase in numbers" The writer has observed eggs and gravid females from the fresh waters in the suburbs of Calcutta in all the months from April to October, 1939, but found that intensified breeding occurs from June to August. Thus with the advent of the monsoon rains fry of the fish in crowded associations could be seen wandering over shallow collections of water and even in dirty puddles in the middle of roads and lanes into which drains overflow. Chatterjee (1934, p. 13) has observed that the fish breeds throughout the year in confined waters of tanks. *O. melastigma* may, therefore, be regarded as a perennial breeder both in fresh as well as brackish waters.

Mature males are seen to chase the females during breeding time. As observed by Jenkins, Sundara Raj and Jones, the eggs are carried about by the mother in conspicuous clusters. The eggs, as figured by Jones, are spherical and transparent, each about a millimeter in diameter and containing a single oil globule. The outer egg-membrane bears all over it short filaments, while from one region a cluster of long anchoring threads are given off. As the female extrudes the eggs they remain suspended usually in a pair of clusters ; for, the long anchoring threads of the eggs of each cluster are twisted together to form a common chord which protrudes from the genital opening of the female behind a notch



Text-fig. 9.—Semidiagrammatic ventro-lateral view of a female *Oryzias melastigma* (McClelland) bearing egg cluster : × *ca.* 3½.

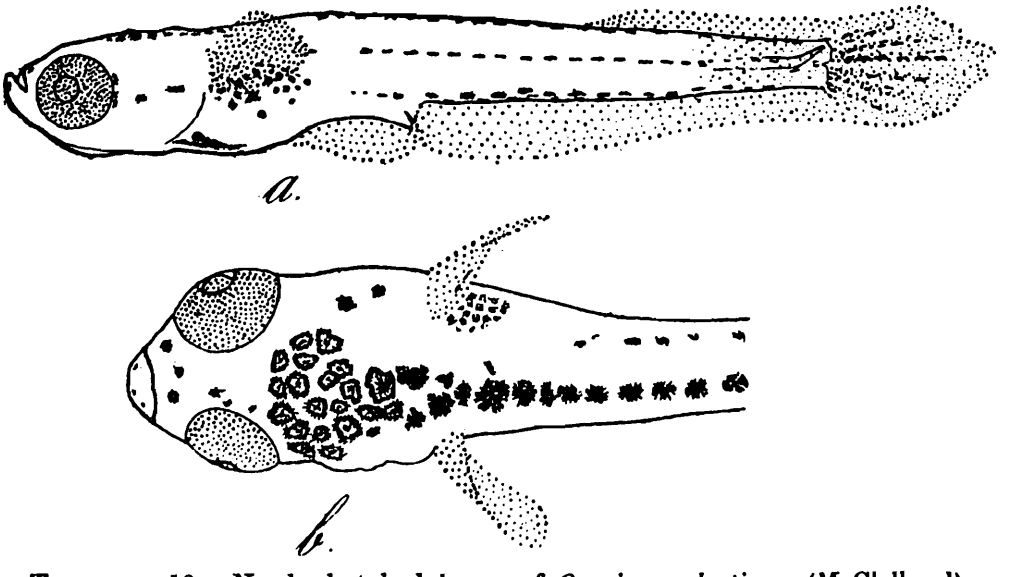
g.p. Genital pad.

in the middle of the flattened genital pad. The two clusters impinging on each other appear as a single bunch of transparent eggs (text-fig. 9). On an average twenty to forty eggs are usually carried by a female. Mellen and Lanier (*op. cit.*, p. 136) record 50 to 225 in the case of *O. latipes* found in Japan. In the position described above the eggs are fertilised by the male, and they may be thus carried by the mother until they are hatched, " a condition highly favourable for their protection and aeration " Often, however, the eggs get detached either singly or in groups and get re-attached to algal filaments or other suitable objects and finally hatch out. The female's " attempts to free herself of her burden of eggs " in the case of *O. latipes* is picturesquely described by Ulmer (1933, pp. 271, 272). According to him " she seeks out some convenient stem and swims slowly across it in such a way that the eggs will catch in a notch formed by the junction of leaf and stalk. Tugging and pulling against this anchor, she struggles valiantly for perhaps a minute or two at a time to free herself of the roe and often becomes quite entangled in the floating plant. If her first effort is unsuccessful, she will rest for a few minutes before returning to her task. Two or three trials are often necessary before she succeeds in attaching the eggs, singly or in clusters, to the plant ; but her persistence invariably arouses the beholder's admiration" In the case of *O. melastigma* observed here, although the parental care, as Jones opines, may not be intentional, the fish exhibits no anxious struggle to throw off the eggs, which on the other hand often continue to be carried about by the mother by means of specialised anchoring " ropes " until they are hatched. As, however, the attachment is not very firm, they easily get detached by accident one after another or in small numbers, and

being adhesive, stick to aquatic plants or other objects as the fish moves about amidst the vegetation. Amemiya and Saburo (1931, pp. 176-178) report rare instances of internal fertilisation and occurrence of developing embryos within the body of the female *O. latipes*. So far the writer has not observed similar instances in the case of *O. melastigma*.

Development.—As Jones has observed, the eggs take from eight days to a fortnight to hatch, though in exceptional cases the hatching period of some eggs may be unduly prolonged. At Calcutta they hatched out in eleven days in water at 88 degrees and in fourteen days at 85 degrees. A few eggs kept in a vessel without change of water hatched out in nineteen days. The average temperature was 85 degrees. Mellen and Lanier assign but ten days for *latipes* at 78 degrees and two weeks at 74 degrees. This shows that temperature is not the sole factor determining the period of incubation. The embryonic development of *O. melastigma*, which has been well described by Jones, is very similar to that of the other Killifishes treated above. Yolk pigmentation to some extent resembles that of the species of *Aplocheilus*.

NewlyHatched Larva.—The newly hatched larva is 4 to 4·5 mm. long according to the period of incubation. It can be easily distinguished from *Aplocheilus* larvae, which it somewhat resembles, by (1) a more slender build, (2) five clear well developed rows of chromatophores



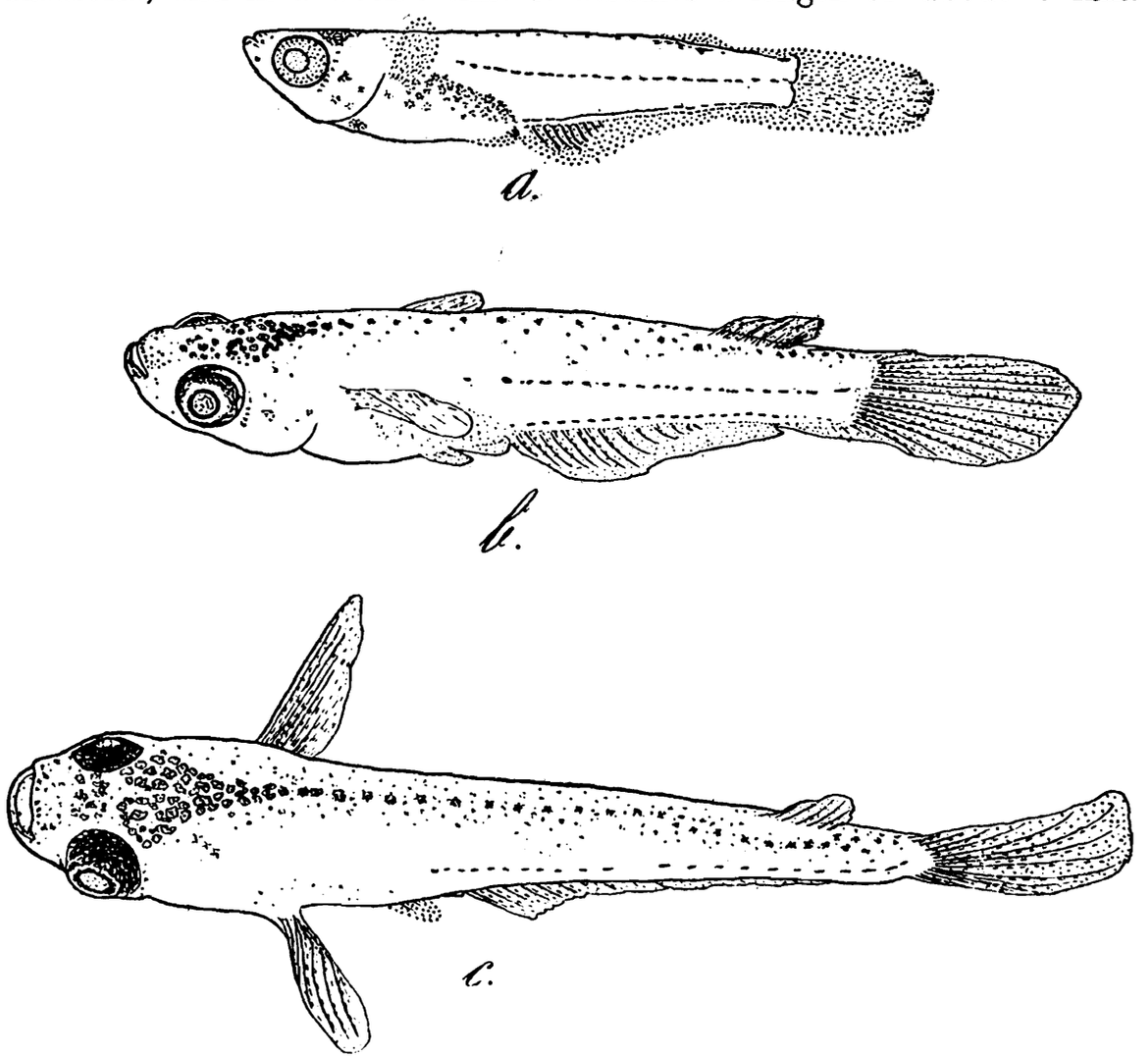
TEXT-FIG. 10.—Newly hatched larva of *Oryzias melastigma* (McClelland).

a. Side view: × *ca*. 24; *b*. Slightly latero-dorsal view of the anterior region: × *ca*. 36.

on the trunk, "one mid-dorsal, two lateral and two ventral, one on either side of the mid-ventral line of the body", (3) highly placed pectorals, (4) large ventral fin-fold with a small pre-anal lobe, the anus being fairly posterior in position and (5) upturned mouth. Sundara Raj has figured the newly hatched larva. Certain points of inaccuracy in the same may be observed. Hatchlings from both Madras as well as Calcutta present in the writer's collection show that the position of the mouth is really more superior than figured by Sundara Raj. Again the dorsal fin-fold is neither so wide nor so anterior as shown by him. It is actually "small and starts far behind" The pigmentation shown also is inaccurate. Actually there is a conspi-

cuous, more or less rounded patch of a variable, but limited number of large chromatophores behind the eyes tapering posteriorly to be continued backward as the mid-dorsal row. Text-figures 10*a* and 10*b* show camera lucida drawings of the side view and dorso-lateral view of the anterior region respectively of a newly hatched larva. " On the head and snout there are a few scattered spots ", and immediately behind the root of the pectoral fin dorsally there is a semicircular patch of close set small asters. On the ventral aspect of the abdomen, which is now practically devoid of yolk, there is an irregular patch of pigment often consisting of two or more anastomosing blotches. Only the heterocercal caudal fin has about seven rays. The other fins are still hyaline. The larva " moves about actively as soon as it comes out and constantly swims along the surface of the water ".

Metamorphosis.—The hatchling begins to grow slowly, feeding on Infusoria, and in a week's time it assumes a length of about 6 mm.



TEXT-FIG. 11.—Metamorphosis of *Oryzias melastigma* (McClelland).

a. Two weeks old larva, side view : × *ca.* 9 ; *b.* Three and a half weeks old larva, slightly latero-dorsal view : × *ca.* 9 ; *c.* One and a half months old " young adult ", latero-dorsal view : × *ca.* 9.

Now the dorsal fin rudiment begins to be separated off by a slight dipping in the dorsal aspect of the median fin fold. The fin-fold also widens slightly behind the anus on the ventral side. When examined under a binocular microscope the eye-balls can be seen to be tilted in opposite directions, *i.e.*, when the right one is turned upward the left one

is turned downward, and when the right one is tilted forward the left one is tilted backward and *vice versâ*. The pupil is black, but the cornea acquires an azure blue and golden green colour and shines with bright iridiscence.

Two weeks old larva (text-fig. 11*a*): Length, 7·5 mm. The snout is triangular, and the lower jaw is more prominent than the upper. The rudiment of the dorsal fin is constricted off from the caudal part of the fin-fold, and the anal becomes pronounced owing to the widening of its anterior region and the appearance of about eight rays in it. The pre-anal fold remains as a small adipose lobe. The pigmentation on the head takes the form of a paired patch united posteriorly. The pelvic buds begin to appear when the larva is about 9 mm. long.

Three and a half weeks old larva (text-fig. 11*b*): Length, 10 mm. The pelvics are clearly formed, and the commencement of two rays can be seen in each of them. About nine rays can be made out in the pectoral, about sixteen in the caudal, six in the dorsal and about fifteen in the anal. The snout is conical. The pigment patch on the head assumes the appearance of a pear-shaped patch distinctly bifid in front. Further, in the inter-orbital space a pair of oval patches appear as in the case of *Aplocheilus* larvae.

One and a half months old post larva (text-fig. 11*c*): Length, 12 mm. Most of the rays are developed in the median fins, and the fish approaches the adult in general appearance. The pectorals, however, has still about ten rays only, and the pelvics only three. The pigmentation of the head consists of a pair of rounded patches adjoining the two sides of a triangular patch behind, the base of the triangle tapering backwards to be continued as the dorsal row. The inter-orbital oval patches are more distinct. Besides, several other irregular rows of small pigment spots appear on either side of the mid-dorsal row, thus making the latter less distinct. The ventral rows also are less pronounced, while the lateral rows continue to persist. Pigment dashes have appeared on the fins also along the course of the rays. From now onward the post-larva is capable of taking in early instars of mosquito-larvae if supplied, besides other tiny insect larvae, Ostracods, etc. With further growth it gradually assumes the typical adult characters and begins to breed when about six months old.

GENERAL OBSERVATIONS.

The Killifishes treated above are widely distributed in the Indian waters, and are seen to be active, hardy and prolific. Most of them are perennial breeders both in fresh as well as brackish waters. The spawning habits of the various species of *Aplocheilus* are found to be very much alike, and even in the case of *Oryzias*, where a sort of parental care is apparent, the presence of the parent is not essential for incubation; for, the adhesive eggs usually get attached to external objects and hatch out in the same way as in *Aplocheilus*. The eggs of these Killifishes can withstand stagnation of water, poor aeration and temperature variation to a remarkable extent, and the hatching period may vary from one week to as much as three weeks or even more. The

yolk is nearly all absorbed by the time of hatching, and active feeding and growth commence very soon. The larvae of *Aplocheilus* species resemble one another very closely with but slight differences, while those of *Oryzias* are more slender and provided with characteristic pigmentation. Whereas *Aplocheilus* larvae are stouter to start with, and feed and grow fairly quickly, taking but three to four months for attaining maturity, the growth of *Oryzias*, which is more delicate to start with, is more slow, and it takes about six months to become mature. Not only in the larval condition, but also in the adult stage, *Oryzias* is found to be a more delicate fish than *Aplocheilus*. Its small size and diaphanous body, however, render it an agile inconspicuous fish which actively wanders about in shallow water. With the advent of the rains, not only tanks and pools, but all drains and shallows into which they overflow also teem with the fry of these surface-feeding Killifishes of Indian waters.

Summary.

The breeding and development under natural conditions of the indigenous Killifishes of the genera *Aplocheilus* and *Oryzias* have been investigated. As a type of the former genus the widely distributed *tri-choki*, *A. panchax* was taken up, and of the latter genus, *O. melastigma*, the only representative of the genus in Indian waters was studied.

The North Indian species, *A. panchax*, unlike what has been observed in aquaria, is, under natural conditions, a perennial breeder, with a spawning maxima in the monsoon months of June, July and August. The rounded, highly yolk-laden, demersal eggs contain several oil globules and bear numerous adhesive anchoring filaments. They are laid singly, and following the typical teleostean type of embryonic development, hatch out in about ten days. The period of embryonic development may, however, vary from nine to fourteen days according to the state of the egg, temperature, aeration and other physical and chemical conditions of the water. The yolk is usually absorbed inside the egg, and on hatching, the larva is fairly large, being about half a centimeter in length and capable of active swimming ; it is provided with efficient pectorals and a well developed caudal fin. At this stage the rest of the median fins are represented by a continuous membranous fold starting from the middle of the tail above and running up to the anteriorly placed vent below. Other characters of the larva are described. Metamorphosis takes about three weeks, in the course of which the median fins are differentiated and develop fin-rays, the " third eye " and the dorsal ocellus appear, the pre-maxillae become protractile, and from this stage the post-larva is capable of consuming larger prey including larvae of mosquitoes and other insects, Ostracods, etc.

The Peninsular species, *A. lineatus*, common in the West Coast districts, is similar to *A. panchax* in its habits. The eggs closely resemble those of *A. panchax*, but usually the transverse bands characteristic of the adult *A. lineatus* begin to appear when the fish is about half an inch long.

The breeding period of the Madras species, *A. blockii*, thriving in fresh water, is said to be January and February.

In the widely distributed diaphanous species, *Oryzias melastigma*, parental care practically ceases as the eggs get detached from the cluster borne by the mother and adhere to external objects where they develop. After an incubation period varying from one to two weeks or more, slim, delicate hatchlings come out. Of a size below half a centimeter, they are distinguished from the *Aplocheilus* larvae by their (1) slender build, (2) five regular longitudinal rows of pigment spots, (3) more highly placed pectorals, (4) a small pre-anal fold and (5) upturned mouth. Metamorphosis is more prolonged than in *Aplocheilus*, since the growth of the dainty hatchlings is more protracted.

The fry of *Aplocheilus* species are very similar to one another, being comparatively stout and marked by dark eyes and pigmented nape and belly. *Oryzias*, both fry and adult are more delicate. All these Killifishes, however, are hardy and enterprising, the adults and fry invading fresh "grounds" during the rains over submerged land.

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ACANTHOCEPHALA FROM INDIA.

II. On a new genus of Acanthocephala of the family Rhadinorhynchidae, from a local fish, *Pangasius pangasius* (Ham.)

By M. N. Datta, *M.Sc., Zoological Survey of India, Indian Museum, Calcutta.*

While examining the intestines of *Pangasius pangasius* (Hamilton) from one of the local markets at Calcutta in August 1938, I found 5 acanthocephalan worms. Out of twelve fishes only two harboured the parasites, 3 in one (all males) and 2 in the other (one male and one female). They were all fixed, stained and mounted on a slide. The worms belong to the family Rhadinorhynchidae but do not tally completely with the descriptions of any of the known genera. A new genus *Mehrarhynchus* is, therefore, proposed for these worms, with the new species, *Mehrarhynchus prashadi* as its genotype.

Mehrarhynchus, gen. nov.

Generic diagnosis.—With the characters of the family Rhadinorhynchidae; body of small size with long, cylindrical proboscis, armed with fine recurved hooks; with a short neck devoid of spines; anterior region of the body armed with regular rows of small, triangular spines in both sexes; proboscis-sheath double layered muscular sac; central nerve ganglion situated in the wall of the proboscis-sheath a little away from its posterior end; lemnisci long, filamentous and bifurcated near the end; prostatic glands four, club-shaped masses. Adult in the digestive tracts of fishes.

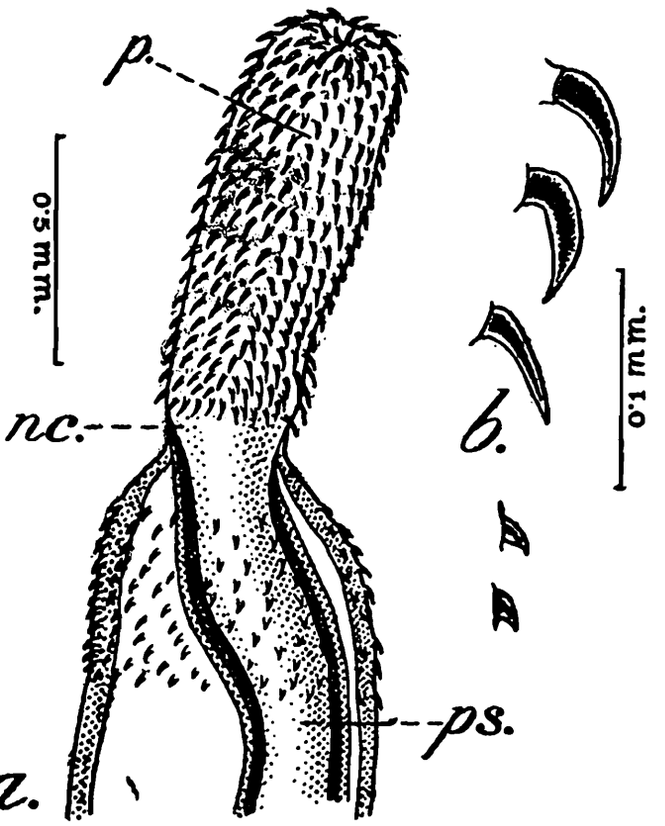
Mehrarhynchus prashadi, gen, *et* sp. nov.

The worms are small and club-shaped. They are whitish in colour. In two specimens the proboscis was protruding and in the other three it was pushed out by slight pressure of the cover-slip. In one case the lemnisci and the proboscis-sheath were pushed out of the body through a narrow crack near the neck and the female genitalia was also pushed out by pressure near the posterior end of the only female specimen in the collection; these injuries instead of being detrimental were helpful in the study of these organs.

The body shows slight marks of external furrows. Sexual dimorphism is not well marked, as is evident from the measurements, but as only one female was obtained much stress cannot be laid on this point. The males measure 4·62-6·71 mm. in length and 0·68-0·79 mm. in breadth the female 7·96 mm. in length and 1·53 mm. in breadth.

The proboscis is narrow and cylindrical and studded with 20-22 regular rows of 12-14 fine recurved spines in each row. The posterior portion, the neck, is slightly narrow and is devoid of spines. There are

slight variations in the size of the proboscis spines, those of the anterior region are slightly longer than those of the posterior.



TEXT-FIG. 1.—*Mehrarhynchus prashadi*, gen. *et* sp. nov. *a*. Anterior region; *b*. Hooks of the proboscis and body magnified; *nc*., neck; *p*., proboscis; *ps*., proboscis-sheath.

The anterior region of the body (text-fig. 1) has 12-13 rows of 15-17 small and thick hooks in each row. These hooks are covered near the basal portion by cuticular folds, which in some cases completely engulf the hooks. The body-wall is traversed by a regular lacunar system, transverse and longitudinal canals are very prominent and the branching canaliculi traverse the whole of the body-wall. In some places near the middle of the body the circular canals are more marked. Granular nuclei are found all over the body-wall.

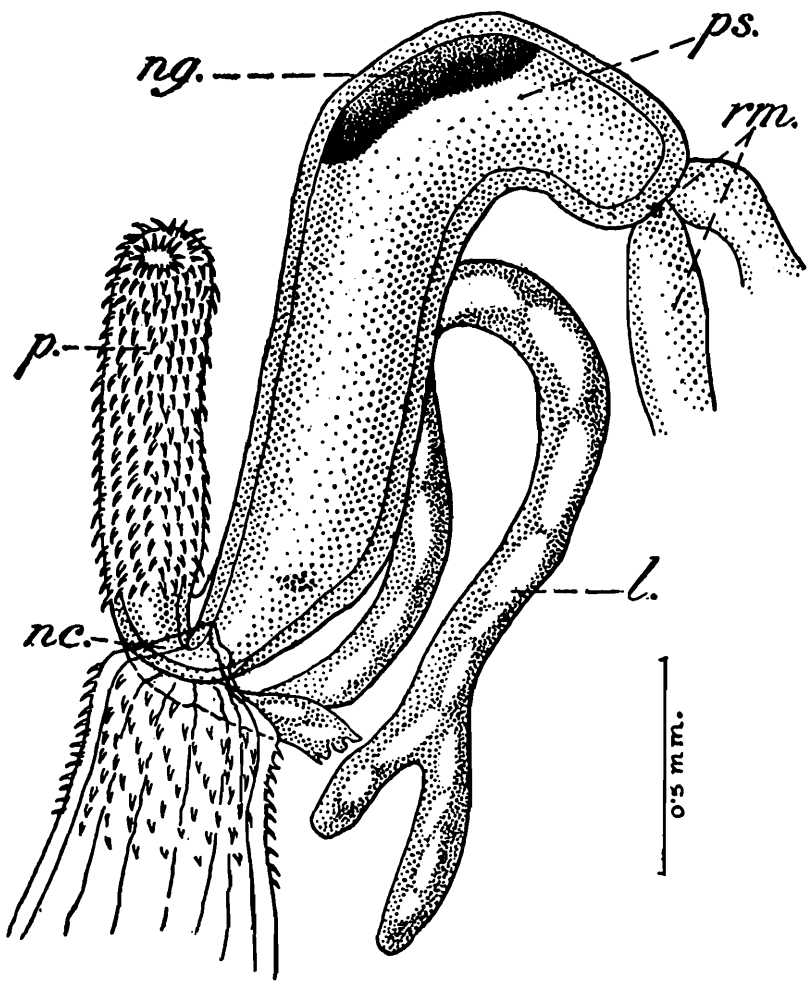
The proboscis-sheath is a narrow, double-layered muscular sac, and is nearly twice as long as the proboscis. It originates at the base of the proboscis and hangs freely in the body cavity. At its posterior end there are a couple of strong muscular bands, the retractors, and there are a few inside the sheath, the protractors. These regulate the retraction and protrusion of the proboscis (text-fig. 2).

The central nervous system consists of a single spindle-shaped ganglion, with a few radiating nerve retinaculi, embedded in the wall of the proboscis-sheath a little away from its posterior end.

The two lemnisci are thin, cylindrical structures, longer than the proboscis-sheath and sometimes even reach up to the anterior testes. The free ends of these are bifurcated as finger-like diverticula.

The male genitalia (text-fig. 3*a*) consist of two oval testes arranged tandem-wise close to each other. The two vasa efferentia coming out of the testes join together to form the vas deferens just behind the prostatic glands. The prostatic glands are four, club-shaped bodies of unequal

size, at the narrow end, in each of these glands, there are a few small nuclei, the ducts from each gland join together to form a thick prostatic



TEXT-FIG. 2.—Anterior region of *Mehrarhynchus prashadi*, gen. *et* sp. nov., showing the internal organs everted out through a crack near the neck.

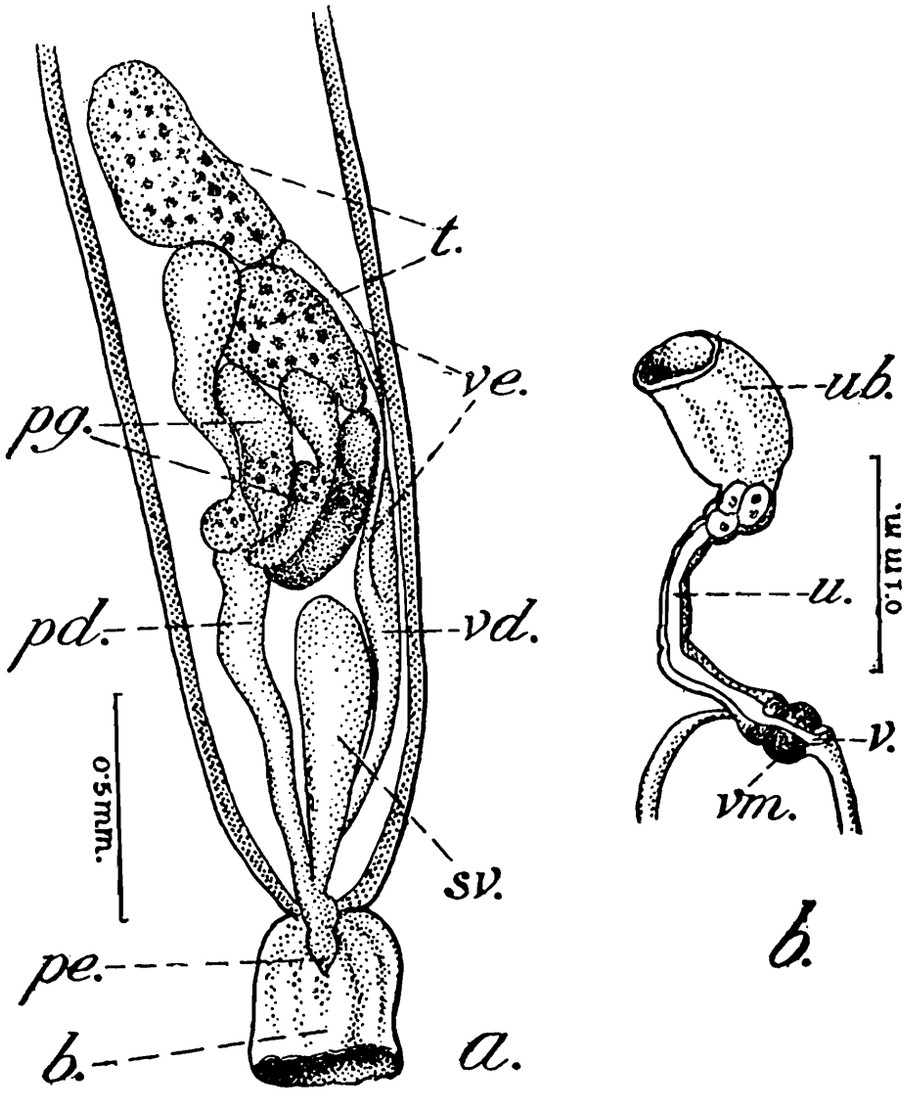
l., leminisci; *nc.*, neck; *ng.*, central nerve ganglion; *p.*, proboscis; *ps.*, proboscis-sheath; *rm.*, retractor muscles.

duct which ends in a muscular penis. The seminal vesicle is a thin-walled sac. The vas deferens joins with the base of the seminal vesicle and jointly opens with the prostatic duct at the base of the penis. The cone-shaped muscular penis hangs on top of the eversible bell-shaped bursa.

The study of the anatomy of the female genitalia (text-fig. 3*b*) has been rendered easier by their being everted out of the body by accidental pressure. These consist of a funnel-shaped uterine bell with a few guard cells near the base of the funnel thus regulating the exit of ripe ova only to the uterus. The narrow, tubular and thin-walled uterus leads on to the vagina which is long and is guarded at its posterior end by two sets of strong muscular bands. These allow of the exit of mature ova in a single file. The vulva or the external genital opening is situated postero-ventrally.

Measurements.—Males 4·62-6·71×0·68-0·79, mm.; female 7·96×1·53 mm.; proboscis 0·95×0·33 mm.; proboscis-sheath 1·83×0·29 mm.; lemnisci 2·71×0·15 mm.; testis anterior 0·22×0·37 mm.; posterior 0·33×0·37 mm.; prostatic glands 0·33×0·15 mm.; seminal vesicle

0·81 mm. long; bursa 0·46×0·53 mm.; uterine bell 0·46×0·20 mm.; uterus 0·31 mm. long; vagina 0·29 mm. long; ova 0·065 mm. long;



Text-fig. 3.—*Mehrarhynchus prashadi*, gen. *et* sp. nov. *a*. Male genitalia; *b*. Female genitalia.

b., bursa; *pd*., prostatic duct; *pe*., penis; *pg*., prostatic glands; *sv*., seminal vesicle; *t*., testes; *u*., uterus; *ub*., uterine bell; *v*., vagina; *vd*., vas deferens; *ve*., vasa efferentia; *vm*., vaginal muscles.

proboscis hooks anterior 0·080 mm., posterior 0·055 mm.; body hooks 0·025 mm.

Discussion.—It is evident from the table (on page 86 and 87) that while the new genus agrees in some points with the existing genera, it differs considerably in the shape and size of the proboscis and the proboscis-sheath, the number of rows of hooks and the number in each row on the proboscis and the anterior part of the body, the lemnisci and its shape, the prostatic glands and the genitalia. From Van Cleave's descriptions of *Serrasentis*[1] and *Telosentis*[2] it is clear that the rows of hooks and their number in each row on the proboscis and the anterior part of the body are very different; the lemnisci in *Serrasentis* are very long while in *Telosentis* they are approximately of the same size as the proboscis. In Van Cleave's other two genera

[1] Van Cleave, H. J., *Roosevelt Wild Life Bull.* II, pp. 73-84 (1933).
[2] Van Cleave, H. J., *Journ. Parasit.* IX, pp. 174-177 (1923).

Aspersentis[1] and *Tegorhynchus*[2] the lemnisci in the first case are short and flattened and in the other long and twice the length of the proboscis, while the rows of hooks and the number in each row on the proboscis and the body and the dimensions of the body in both genera differ from the genus under discussion. In the case of *Leptorhynchoides* Kostylew[3]; the body spines are totally absent, the prostatic glands are eight and the central nerve gland is situated in the middle of the proboscis-sheath, in these points it differs from the present genus. In *Polyacanthorhynchus* Travassos[4], the body is abnormally large, the prostatic glands are eight, the rows of proboscis hooks are nearly double than that of the new genus. In *Rhadinorhynchus* Lühe[5] the dimensions of the body vary considerably, the central nerve ganglion is situated near the middle of the sheath, the only point in which it agrees with the present case is that the lemnisci are finger-like. The description of *Cleaveius* Subrahmanian[6] agrees to some extent with the new genus in the dimensions of the body, but it differs considerably in number of proboscis hooks, the prostatic glands and the lemnisci. Subrahmanian has noted that there are no scattered spines on the anterior part of the body of males but there are 23 regular rows of spines stretching as far as the commencement of the anterior testis; he also observed that in the female only the anterior portion up to 262μ is armed with scattered spines and about two-third of the body is armed with 41 circular rows of spines, the lemnisci in his case are much coiled, the prostatic glands are four compact bodies and the proboscis is short and cylindrical. These points separate *Cleaveius* from the new genus described in this paper.

Host.—*Pangasius pangasius* (Hamilton).

Location.—Intestine.

Locality.—Calcutta (Local market).

Type Series deposited in the collections of the Zoological Survey of India, Indian Museum, Calcutta.

I have great pleasure in naming the species after Dr. Baini Prashad, Director, Zoological Survey of India, as a mark of respectful gratitude for his unceasing help and guidance in my work. The generic name is associated with the name of Dr. Haru Ram Mehra, Reader, Department of Zoology, University of Allahabad, to whom I am indebted for initiating me in the study of this group of Helminths. My thanks are due to Babu A. Mondul for finishing the figures for this paper.

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[1] Van Cleave, H. J., *Ann. Mag. Nat. Hist.*, (10) IV, pp. 229-232 (1929).
[2] Van Cleave, H. J., *Nat. Hist. Juan Fernandez and Easter Is.* III, (1921).
[3] Kostylew, N. N., *Ann. Parasit. Humane et Comp.*, II, pp. 214-223 (1924).
[4] Travassos, L., *C. R. Soc. Biol.* Paris XC, pp. 935-937 (1926).
[5] Lühe, M., *Susswasserfauna Deut.* XVI, p. 60 (1911).
[6] Subrahmanian, K., *Ann. Mag. Nat. Hist.*, (9) XIX, pp. 275-279 (1927).

TABLE I.

Names of genera.	Dimensions of body.	Measurement of proboscis.	Proboscis hooks.		Proboscis sheath.	Body spines.	Central nerve ganglion.	Prostatic glands.	Lemnisci.	Host.
			Long. rows.	No. in each row.						
Serrasentis Van Cleave 1923.	..	clavate	24	15-18, about 80 μ	..	18-23 rows of 6-24 spines, a collar of spines just behind the neck.	..	..	very long	fish, marine.
Telosentis Van Cleave 1923.	6·8-8·6 mm.	cylindrical to club-shaped, 1·14 1·3 mm. × 0·15-0·19.	12	20, 48-60 μ long.	2·2 mm.	posterior extremity near genital opening armed in both sexes with few scattered cuticular spines.	about one-third the distance from posterior extremity.	..	approximately the same length as proboscis receptacle.	fishes.
Aspersentis Van Cleave 1929.	short, cylindrical. ♂ 3·25 × 0·65 mm. ♀ 4·0-6·0 mm.	0·53 × 0·23 mm.	14-16	9 or 10	..	anterior region decked with minute spines. Ventral 100μ few less than 89μ, dorsal 30μ.	located in the proboscis sheath some distance from posterior extremity.	pyriform, closely compacted.	short, flattened in male reaching up to the anterior testis.	..

Rhadinorhynchus Lühe 1911.	♂ 6·0-20·0 × 0·46-0·9 mm. ♀ 14·0-75·0 × 0·6-1·4 mm.	2·5 × 0·18 mm.	14-16	26	5·0 mm. long.	..	near the middle of the sheath.	..	long and finger-like.	fresh water fishes.
Leptorhynchoides Kostylew 1924.	12-24 mm. × 1·0-1·3 mm.	very slightly club-shaped.	14	20	..	absent	near the middle of the sheath.	eight	very long	fishes.
Polyacanthorhynchus Travassos 1926.	♂ 105-110·0 × 1·4 mm. ♀ 335·0 × 3·0 mm.	3·0-3·5 mm. long.	40-46	16-18	..	..	at the posterior extremity of the proboscis sheath.	eight 6·5 × 8·5 mm.	6·0 mm.	fish & alligator.
Tegorhynchus Van Cleave 1920.	♂ 3·0-6·0 × 0·8 mm. ♀ 4·0-8·5 × 1·4 mm.	1·0 × 0·2 mm.	14	17-19	..	..	..	..	long and twice the length of the proboscis.	..
Cleaveius Subrahmanian 1927.	♂ 5·1 × 0·21 mm. ♀ 8·1 × 0·38 mm.	157 μ long, anterior 175 μ middle 105 μ posterior 140 μ in diameter.	18	4, 55-30 μ	630 μ long.	circular rows of hooks are present in both sexes, but scattered hooks are seen at the anterior end of females only.	placed laterally, 157μ from posterior end of proboscis sheath.	four compact bodies.	coiled	fishes.
Mehrarhynchus, gen. nov.	♂ 4·62-6·71 × 0·68-0·75 mm. ♀ 7·96 × 1·53 mm.	cylindrical 0·95 × 0·33 mm.	20-22	12-14	1·83 × 0·29 mm.	12-13 rows of stout, conical spines, 15-17 in each row.	in the posterior third of the sheath.	four club-shaped bodies.	2·71 × 0·15 mm., long with finger-like bifurcation at the end.	Siluroid fish (*Pangasius pangasius*).

ON A NEW PISIONID FROM THE SANDY BEACH, MADRAS.

By R. Gopala Aiyar and K. H. Alikunhi.

(From the University Zoological Research Laboratory, Madras.)

(Plates I & II.)

Contents.

Historical.

While engaged in a study of the fauna of the sandy beach of Madras we came across a very interesting polychaete, allied to *Pisione*, but markedly different from it in several respects.

Pisione was first discovered by Kroyer on the Chillian Coast and in 1857 Grube described it and created a new genus and species *Pisione oerstedi*. He placed it in the Phyllodocidae and regarded it as a transitional form between the Phyllodocidae and Glyceridae. Later Levinsen (1886) created a new family Pisionidae for its reception. Then Ehlers (1901) gave a full description of the species *P. oersteli* and also added a second species *P. contracta*. In 1914 Southern described another genus and species *Praegeria remota* which he collected from Clew Bay during the Clare Island Survey. In 1924 Augener described a third species of *Pisione* viz., *P. germanica* from the Black Sea.

Material and Methods.

The worms live in the upper layers of the intertidal sandy zone. Though small, they are easily detected by their active movements. Numbers of them can be collected by shaking the sand with water in a glass trough, allowing the sand to settle when the worms could be seen swimming in the water and then quickly pipetting them out into a tube before they burrow again into the sand. When removed from the sand and placed in a dish of water they swim with peculiar jerking

movements and then curl themselves and settle down at the bottom of the dish.

The sexes are separate, and the mature males and females can be distinguished from each other under the microscope by their reproductive organs seen through the body wall. But an experienced eye can distinguish the sexes by mere sight. The males are usually smaller than the females. The worms breed freely in their natural habitat and we were able to obtain some of the developmental stages. Fully mature male and female specimens could be obtained throughout the year.

The description given below is based on living worms, whole mounts and serial sections. The worms were fixed in Bouin's Fluid. Iron haematoxylin, Mann's Methyl-blue Eosin, Carmine and Picro-nigrosin were used for staining the sections.

EXTERNAL CHARACTERS.

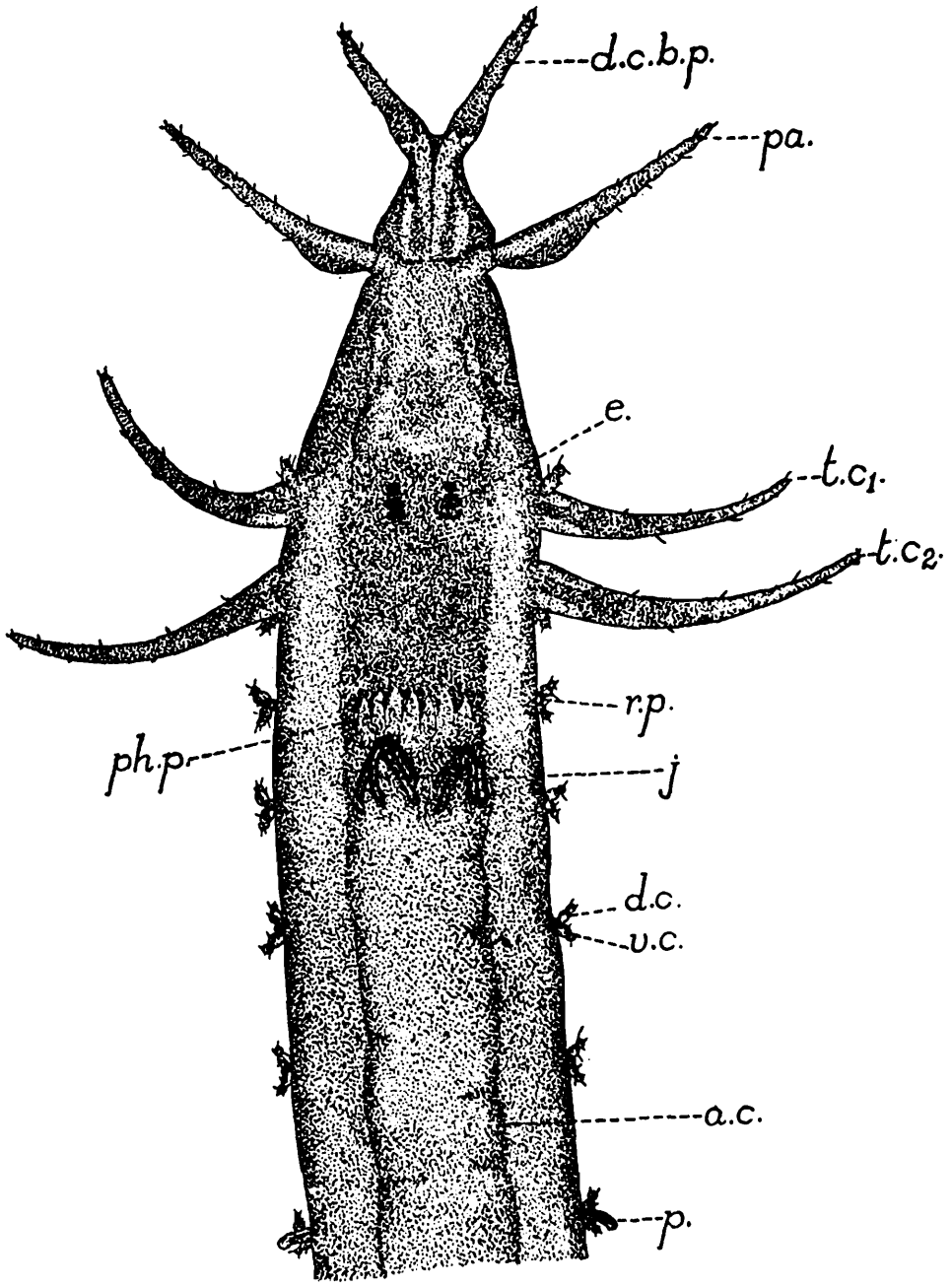
A fully grown male worm measures about 14 to 18 mm. in the living condition. The body is cylindrical, the tail tapering and there are as many as 50 to 60 distinct body segments.

Head.—The prostomium is highly reduced. The appendages of the head are all well developed (Pl. I, fig. 1 and text-fig. 1) and following Southern's description of *P. remota*, an allied form, the bases of the buccal parapodia are fused in front of the head. In addition, the bases of the dorsal cirri of the buccal parapodia have also fused to a great extent, the fusion being marked by well defined dorsal and ventral grooves. The ventral cirri of the buccal parapodia, mentioned as occurring as small flask shaped structures at the bases of the dorsal cirri of the same parapodium in *Praegeria*, are conspicuous by their absence. The buccal parapodia are devoid of any setae. Immediately behind these dorsal cirri is a pair of well defined palps. Their bases are enclosed by conspicuous sheaths of tissue from which they appear to arise. These palps as well as the modified dorsal cirri have a jointed appearance and are provided with stiff processes, the palpocils. The basal core of each of the dorsal cirrus of the buccal parapodia is supported by rigid tissue which at first gives the appearance of setae, but application of caustic potash and subsequent examination under the microscope do not reveal any. In this respect the present form differs markedly from *Praegeria*.

Below the palps there follows an elongated region wherein the fused brain is situated. About half way down the brain are placed the two pairs of eyes. They are irregularly placed. The anterior pair is smaller and diverge slightly while the posterior pair, of almost twice the size of the anterior pair of eyes converge slightly. Behind the posterior pair are two spots of dark brown pigment.

The ventral cirri of the first segment are elongate and function as tentacular cirri but unlike the case in *Pisione* and *Praegeria*, the segment is non-setigerous. As in *Pisione* the dorsal cirri of the second segment are modified into tentacular cirri, but here again this segment is non-setigerous whereas the corresponding segment in *Pisione* and *Praegeria* is setigerous. This second pair of tentacular cirri is the largest of the cephalic appendages. The dorsal cirri of the first segment and the ventral cirri of the second segment are present as slightly inconspicuous globular structures.

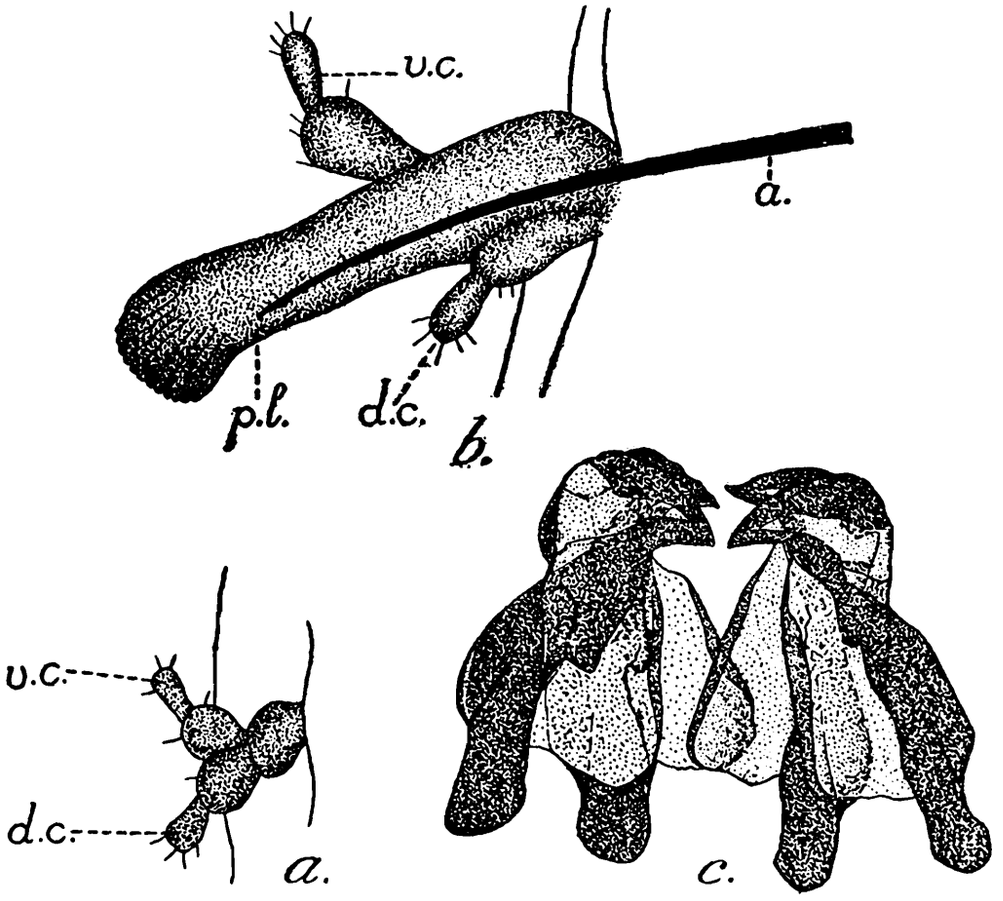
The parapodia of the third to the sixth segments are peculiar and are represented only by very minute globular structures provided



TEXT-FIG. 1.—Anterior end of *Pisionella indica*, gen. *et* sp. nov.: ×80.

with palpocils at their tips (text-fig. 2*a*). Curiously enough these parapodia, are not provided with any kind of setigerous support. What has happened in these segments—judging from the development of the larvae —is that the main setigerous lobe of the parapodia has mysteriously disappeared and the minute globular structures, in the place of the parapodia are really the dorsal and ventral cirri of the corresponding segment. The condition in the first two segments carrying the tentacular cirri is also the same except that the dorsal or ventral cirri, as the case may be, are modified. The parapodia from the 7th segment backwards are setigerous and they begin to increase in dimension until they attain fair proportions in the middle segments.

A parapodium from one of the middle segments may be considered as typical (text-fig. 2*b*). Such a parapodium is uni-ramous like the rest



TEXT-FIG. 2.—*Pisionella indica*, gen. et sp. nov.
a. A reduced parapodium of the 6th segment: ×375;
b. Parapodium of the 10th segment: ×375;
c. The jaws of the worm: ×375.

and is provided with a distinct dorsal and ventral cirrus. Each cirrus is two jointed and has a definite globose cirrophore with a terminal papilla provided with a few palpocils at the end. The ventral cirrus springs from the middle of the main parapodial lobe while the dorsal cirrus takes its origin almost from the body wall just at the base of the parapodium. Each parapodium is supported by only a single bristle. There are no setae of any other kind. In the male, in the segments in which the sperm-sacs are developed, the parapodia are greatly modified. The proximal half of the parapodium together with the ventral cirri gets hypertrophied and carried along the eversible portion of the sperm-sacs (text-fig. 5). The dorsal cirrus remains unmodified. In the female the parapodia, at the bases of which the receptacula seminis open, have not undergone any modification.

There is a pair of long anal cirri of about the same length as the tentacular cirri (Pl. I, fig. 2).

Adult females are slightly bigger and stouter than adult males with a corresponding number of segments. Some exceptionally large females measuring about 25 mm. in length are also not uncommon. In the anterior region there is practically nothing to distinguish the sexes externally. The palps and cirri of the head are similar in both the sexes. So also are the four pairs of tiny anterior parapodia. The anal cirri also are alike in the male and the female.

Genital Papillae (Suckers).—When the worms are fully mature they become provided with a series of median genital papillae or suckers on the ventral side (Pl. I, fig. 3). Their arrangement is different in the two sexes. In the male they are arranged in two series, an anterior and a posterior. The first series consists usually of 5 to 7 papillae occurring from the 10th to 16th segment. The second series is developed in the posterior half of the body. In a specimen having 50 body segments the anterior series occupied segments 10 to 16, while the posterior series occurred on segments 24 to 39. In a number of specimens this posterior series of papillae was found to occur on segments 26 to 38.

In the female the anterior series of papillae is absent. The posterior series consisting usually of 10 to 12 in number is found in the second half of the body. These papillae in the female are usually developed only on alternating segments, whereas in the male the papillae follow each other without any break in the series (text-figs. 5, 6). Also they are smaller and less strongly built than in the male.

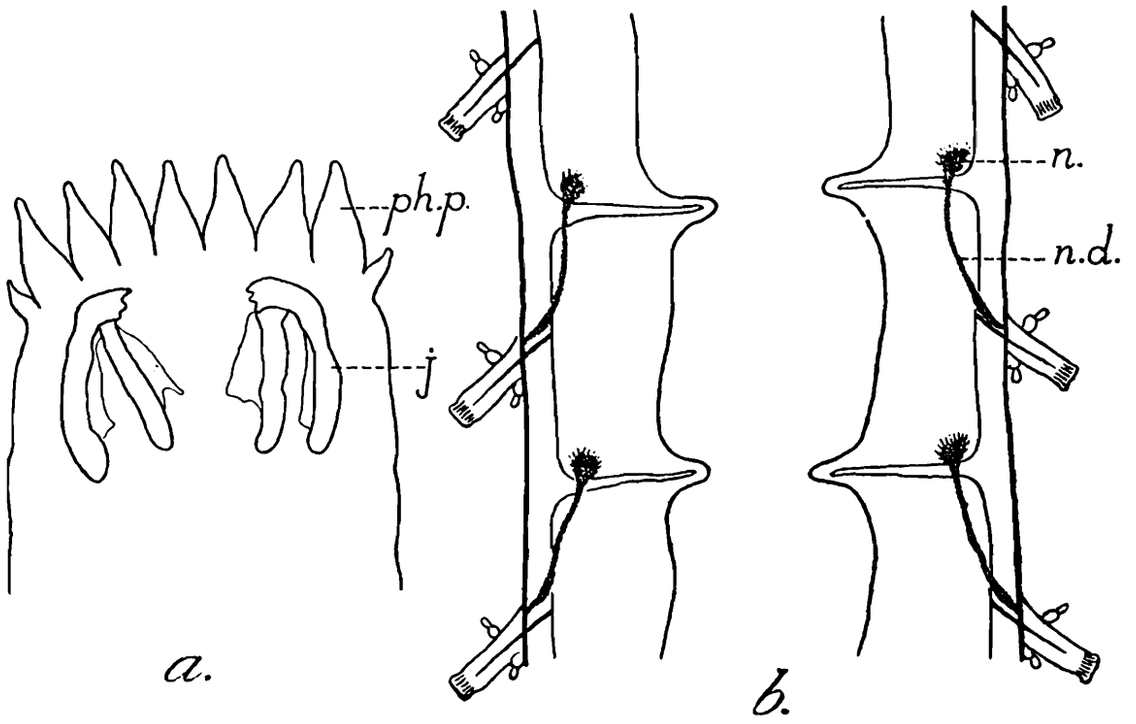
When protruded they remind one of the false feet of lepidopterous larvae. As has been mentioned they are developed only when the worms become mature. Their structure can be made out by a reference to text-figures 5 and 6 and Plate I, fig. 4. From the centre of each sucker there arises a stout muscular papilla the tip of which is divided into 3 or 4 smaller processes. The circular rim of the sucker or cup is chitinised and shows minute teeth-like serrations and this portion has got a bright amber colour. To the bottom of the cup internally is attached a group of muscles spreading fan-wise and getting attached to parts of the dorsal body wall. By the help of this stout band of muscles the papilla is capable of being retracted. Eversion is probably effected by the contraction of the body wall resulting in the body fluid exerting a pressure on the papilla and forcing it out. In this condition the latter takes the form of a finger like process.

BODY-WALL.

Externally there is a thin cuticle. The epidermis consists of a single layer of flattened cells with darkly staining nuclei. There is a rich development of glands. The glands are of two kinds. The first kind consists of minute unicellular structures with their outer ends drawn out into short narrow tubes opening to the outside. The second consists of larger and more specialised glands. They are developed in the thickness of the body wall and are metamerically arranged on either side in between two successive parapodia. In the living worm they appear as definite groups of coiled refractile tubes. In sections they are poorly stained and nuclear elements could not be made out. In some of the very anterior segments they are not so conspicuously developed. These glands are probably of a mucous secreting function. Below the epidermal layer is placed an extremely thin layer of circular muscles and below this is the highly developed layer of longitudinal muscles arranged in five definite bands; two dorso-lateral, two ventro-lateral and one ventro-median. The oblique muscles are also well developed. Below the longitudinal layer is the coelomic epithelium.

ALIMENTARY CANAL.

The mouth is median, ventral in position, elongated in shape and is situated between the palps and the first pair of tentacular cirri. It leads into a highly muscular protrusible pharynx (Pl. I, fig. 5). In the retracted condition the pharynx extends to the 8th segment. The pharyngeal armature consists of two pairs of highly chitinised amber coloured jaws (text-fig. 2*c*) with blunt teeth. The pharynx is provided with a crown of 14 conical papillae of almost uniform size (text-fig. 3*a*). The two lateral papillae on each side carry in addition a small papilla on their outer margins. The bases of all these papillae are extremely rich in glandular tubules. The pharyngeal wall consists of an external covering of visceral epithelium below which is situated the highly developed longitudinally arranged muscles. The internal lining is formed of an epithelial layer made up of flattened cells.



TEXT-FIG. 3.—*Pisionella indica*, gen. *et* sp. nov.
a. Pharyngeal papillae and the jaws : ×166⅔ ;
b. Diagram to show the arrangement of nephridia in the non-genital segments : ×166⅔.

The pharynx is followed by a thin walled chamber—the stomach—occupying the next four segments. This is followed by the intestine which gets wider in the middle segments but undergoes deep constriction at the level of the septa. Behind, the gut gets narrower and finally ends in the anus situated ventrally in the last segment. In the segments in which the gonads are developed the alimentary canal is in the form of a narrow tubular structure on account of internal pressure from the gonads. The wall of the intestine is thin and is formed of only a single layer of digestive epithelium consisting of large cells with big, deeply staining basal nuclei.

NERVOUS SYSTEM.

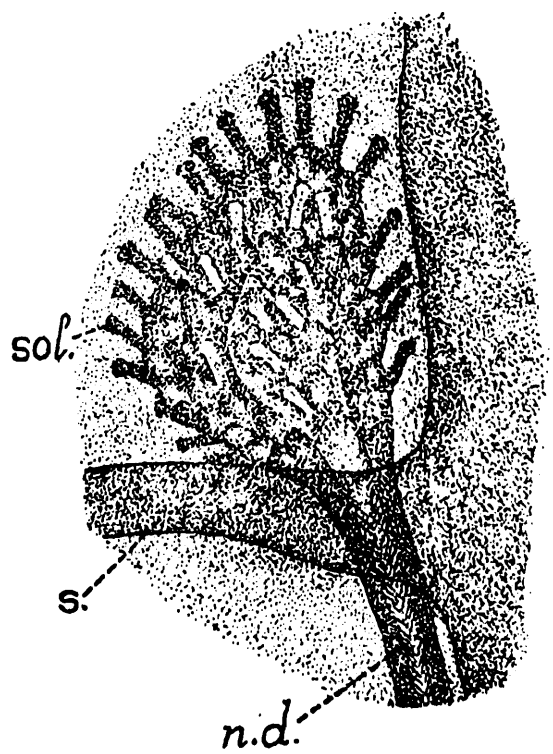
As has been previously mentioned the brain is situated dorsally in the region between the palps and the first pair of tentacular cirri. It is in

the form of two more or less elongated lobes which are fused together in the middle. The eyes, situated at the level of the first pair of tentacular cirri, are placed on two elongated conical posterior extensions of the brain.

The brain is covered over by a strong membrane which consists of cells having very deeply staining nuclei. These nuclei are very large with very little cytoplasmic covering. From the anterior portion of the brain are given off two stout nerves to the palps. The circum-oesophageal commissures run down to the ventral side, fuse together in the mid-ventral line and then proceed as the nerve cord. Well defined ganglionic swellings are not present. The nerve cord is of almost uniform thickness throughout but in the level of the septa there is slight reduction in the thickness. Hence, segmentally, there is a gentle enlargement which may be taken as the ganglionic swelling for each segment. Sections reveal that in certain regions there is a space between the two halves, in other places the covering membrane runs between the two halves and in still other places the two halves are completely fused.

NEPHRIDIA AND GENITAL FUNNELS.

Nephridia.—On examining with a microscope a living specimen of the worm gently compressed under a coverglass, paired nephridia can be seen in every segment after the first three or four, as bunches of cells projecting into the body cavity from the corner between the body wall and the septum. (Pl. I, fig. 6 and text-fig. 3*b*.) Each nephridium consists of a globular cluster of cells. There is a cavity inside. From the outer side of each one of these cells springs a slender process which ends in a minute swelling. These swellings together with the connected processes

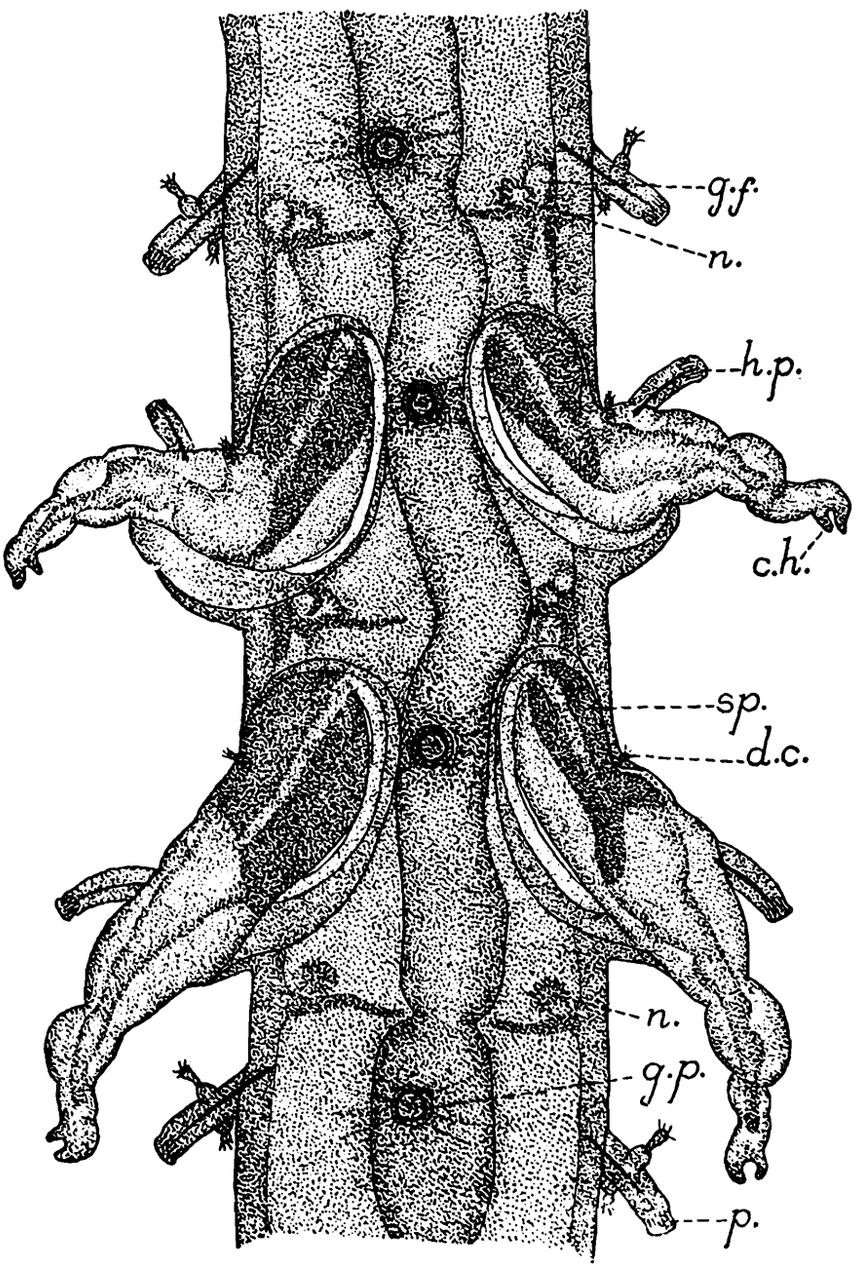


TEXT-FIG. 4.—Nephridium of *Pisionella indica*, gen. *et* sp. nov.; ×1125.

constitute the solenocytes of the nephridium. Each nephridium is provided with a number of these solenocytes (text-fig. 4) projecting into

the coelomic cavity and thus making the nephridial swelling conspicuous. Each solenocyte is a short narrow tube of even diameter throughout. The minute swelling at the tip constitutes the cell body of the solenocyte. A long flagellum works rapidly down each tube of solenocyte and passes into the lumen of the nephridial swelling and may even pass into the commencement of the nephridial canal.

Certain irregular vacuoles and globules—probably of excretory nature—are found in the cells of the walls of the nephridial swelling. Each nephridium opens ventrally to the exterior just in front of the base of the parapodium. This external opening leads into a slightly dilated chamber which is continued into the narrow, straight, ciliated nephridial duct extending forwards and finally emerging beyond the septum in front as the dilated closed swelling. The nephridial duct



Text-fig. 5.—The middle segments of a mature male of *Pisionella indica*, showing the sperm-sacs and copulatory hooks (Slightly diagrammatic) : ×80.

is inter-cellular (text-fig. 4) and in the ordinary segments it is not coiled anywhere.

Genital Funnels.—Besides the nephridia, well developed genital funnels are developed in the adult worms—male and female—in the segments in which the gondas are formed (text-figs. 5, 6). To take a specific example in a female with 55 segments, 4 pairs of ovaries and 4 pairs of receptacula seminis, only 4 pairs of genital funnels were developed. They were situated in segments 27, 31, 35 and 40 *i.e.*, in those segments which just precede the segments in which each pair of receptacula seminis is situated. In the case of the males also the occurrence of these funnels is restricted to the reproductive region. In a male worm, for instance, with 50 segments there are 14 pairs of testes and two pairs of sperm-sacs. The latter occurred in segments 29 and 30. There were two pairs of genital funnels and they occurred in segments 28 and 29.

This highly localised distribution of the genital funnels, receptacula seminis and sperm-sacs is necessitated by the fact that the reproductive elements have to pass through the receptacula seminis or sperm-sacs as the case may be. As will be explained presently the nephridial canal in these segments after the union with the genital funnel invariably opens into the receptaculum seminis or sperm-sacs according as the worm is female or male. Hence the reproductive products are gathered by the genital funnel and are taken to the receptaculam seminis in the female and to the sperm-sacs in the male and from there sent to the outside.

Genital funnels are fully developed only when the worms become sexually mature and they are associated with the nephridia. In a specimen which was sexually immature *i.e.*, without any trace of the genital papillae as well as the reproductive elements, genital funnels were not developed. In another specimen—a developing female—in which the first rudiments of the reproductive elements were visible, the nephridia in the segment following each developing group of ovaries were found to be enlarged. On careful examination it was found that the coelomic epithelium at the very corner between the body wall and the septum had undergone active cell proliferation, with the result, a thick mass of cells towards the body wall side of the nephridium had formed. This is the first rudiment of the genital funnel. As the genital elements mature, the cells of the funnel subdivide and the genital funnel rudiment enlarges. In another specimen which was slightly more developed these rudiments of the genital funnels had become cup like with a few cilia but still with no communication with the nephridia. In a fully mature female specimen the cup has become enlarged and thin walled. The rim of the funnel is specially differentiated and becomes thickened and strongly ciliated. It is about three times the size of the nephridium associated with it (Pl. II, fig. 1). The funnel has now acquired an opening into the nephridial canal just above the septum and below the nephridial swelling. The nephridial canal after piercing the septum slightly enlarges and, as has been already mentioned, opens into the anterior half of the receptaculum seminis. The development of the genital funnel in the male is similar but it does not get so highly enlarged as in the females probably because of the much smaller size of the sperms.

In the fully differentiated condition the wall of the genital funnel is found to be formed of columnar epithelial cells with larger but less

deeply staining nuclei than those of the nephridial canal. In transverse sections passing just above the point of union of the genital funnel with the nephridium the difference between the genital funnel and the nephridium could be made out clearly owing to the differential staining property of the nuclei of the two organs.

REPRODUCTIVE ORGANS.

Male.—The sexes are separate. In the male the reproductive organs are in the form of paired testes which could be seen shining through the body wall. They are usually developed in the second half of the body, the anterior half as well as some of the posterior segments being probably sterile. In a specimen with 50 segments 14 pairs of testes were found extending from the 24th to the 39th segment *i.e.*, in the segments in which the posterior series of genital papillae were developed.

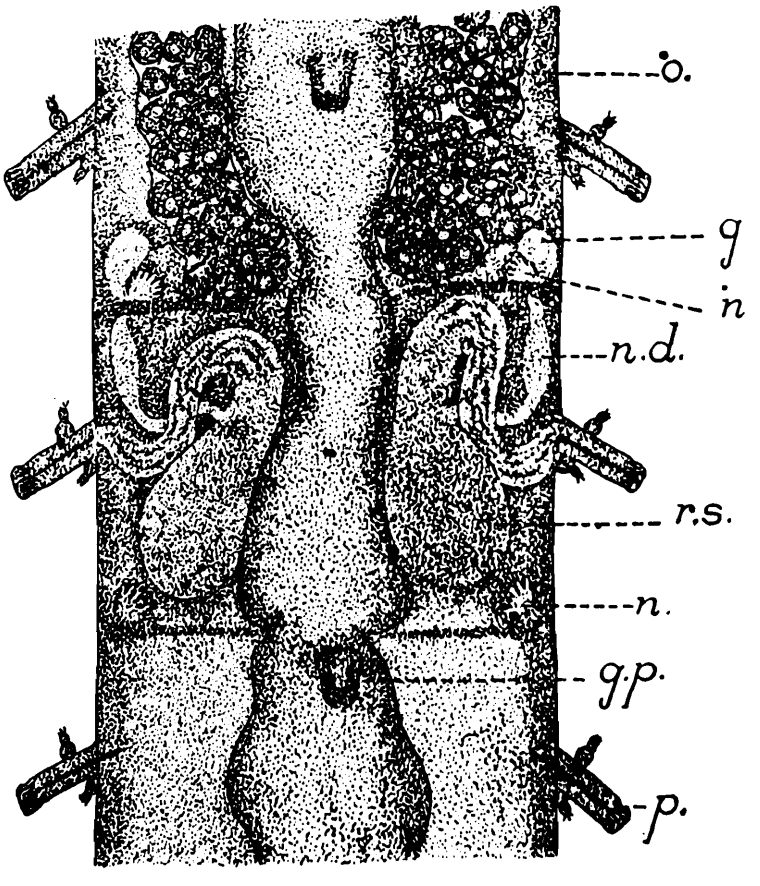
It is curious to note that the sperms are non-motile. Mature sperms are liberated into the coelomic cavity and can easily pass to the adjoining segments through the interspaces in the septa at the point of their attachment with the alimentary canal. In segments 29 and 30 there are two pairs of highly conspicuous sacs which are the sperm-sacs (text-fig. 5). The testes themselves are absent in these two segments. Often 3 or rarely 4 pairs of sperm-sacs are developed but instead of being found in two consecutive segments, are situated in such a manner that there are one or more intervening ordinary segments in between succeeding pairs. For instance in a specimen with 54 segments and three pairs of sperm-sacs the first pair was found in segment 30, the second pair in segment 36 and the third pair in segment 41. Exceptionally, however, only one pair of these spermatophoral sacs is developed, but these, then, may extend into two or three neighbouring segments.

The sperm-sacs are club-shaped sacs, the posterior portion being drawn out and eversible (Pl. II, fig. 2). Its outer end is slightly chitinised and definitely modified for sperm transference into a grooved spatula-like structure. The terminal part also acts as a copulatory hook. The tip of the copulatory hook is peculiar and has three definite processes two of which are conical and pointed while the third is a curved hook like one which in its turn is retractile partially. Transverse sections through the anterior half of the sperm-sacs show these sacs to be formed of a layer of elongated cells with rounded basal nuclei (Pl. II, fig. 3). The cells are all packed with highly refringent granules which are uniformly distributed. So numerous are these granules that the sperm-sacs become very conspicuous in the living worm. These special cells are confined to the anterior two-third of the sac while the distal portion merely functions as a passage or conducting part in which these cells have disappeared. This distal portion of the sperm-sac, devoid of the cells with refringent granules, develops a strong outer sheath of muscles. The cells lining the interior are minute and flattened. The external muscle layer which probably brings about the extrusion of the sperms has a very peculiar deceptive appearance in the living worm, and is seen as a clear and transparent space around the sperm-sac but the muscle striations can be made out by careful focussing. When

fixed and cut, transverse sections through this region reveal no such space around the sperm-sacs but a well defined sheath of muscles.

The internal lumen of the sac is narrow and is powerfully ciliated throughout. Mature sperms could be seen tossed about in the lumen by the action of the cilia. They are brought into it by means of the nephridial duct. The actual course of the nephridial duct in the segment carrying the sperm-sacs and the opening of the sac to the outside can be clearly made out on examining a male worm which is not fully mature. After the union of the genital funnel with the nephridial canal, the nephridial tube pierces the septum and enlarges into a thin walled chamber which again narrows and running inwards below the distal portion of the sperm-sac, takes an upward bend and runs forwards between the sperm-sacs and the alimentary canal and finally opens into the sperm-sac which in its turn is continued to the exterior by the narrow ciliated duct which opens just behind the tip of the copulatory hook.

The structure of the sperm is peculiar (Pl. II, fig. 4). As has been mentioned the sperms are non-motile; and in comparison with the size of the worm, they are large. Each sperm has got a central thick and deeply staining portion the extreme ends of which on either side are drawn out into a long flagellum. The sperms are thus a typical (bi-flagellate) and this kind of sperm is of rare occurrence amongst polychaetes.



TEXT-FIG. 6.—Genital segments of a mature female of *Pisionella indica*, gen. et sp. nov. showing a pair of ovarian groups and a pair of receptacula seminis: ×90.

Female.—In the female the reproductive organs are in the form of a few paired ovarian bags confined to the middle segments of the body (Pl. II, fig. 5 and text-fig. 6). As in the male the sexual elements are

absent in the anterior one-third part of the body and in several segments at the posterior end. This localisation of the sexual elements is known to occur in other polychaetes also like the Eunicids but the distribution of these elements in paired groups is peculiar. The eggs are greenish in colour and by this character the mature female can be easily distinguished from the mature male with the naked eye.

Usually two to five pairs of ovarian groups are developed. Exceptionally worms with six pairs have also been seen. In a specimen with 55 segments four pairs of ovarian groups were found developed. The first pair occupied segments 24 to 27. In the 28th segment there was a pair of receptacula seminis. In segments 29 to 31 was situated the second pair of ovarian groups. Segment 32 was occupied by another pair of receptacula seminis. The next three segments were occupied by the third group of ovaries which also was immediately followed in the next segment by a pair of receptacula seminis. Segments 38 to 40 were occupied by the 4th pair of ovaries while the 41st segment contained the 4th pair of receptacula seminales. In some worms it has been noticed that there is an interval of two or three segments between the last and the penultimate pair of ovarian groups.

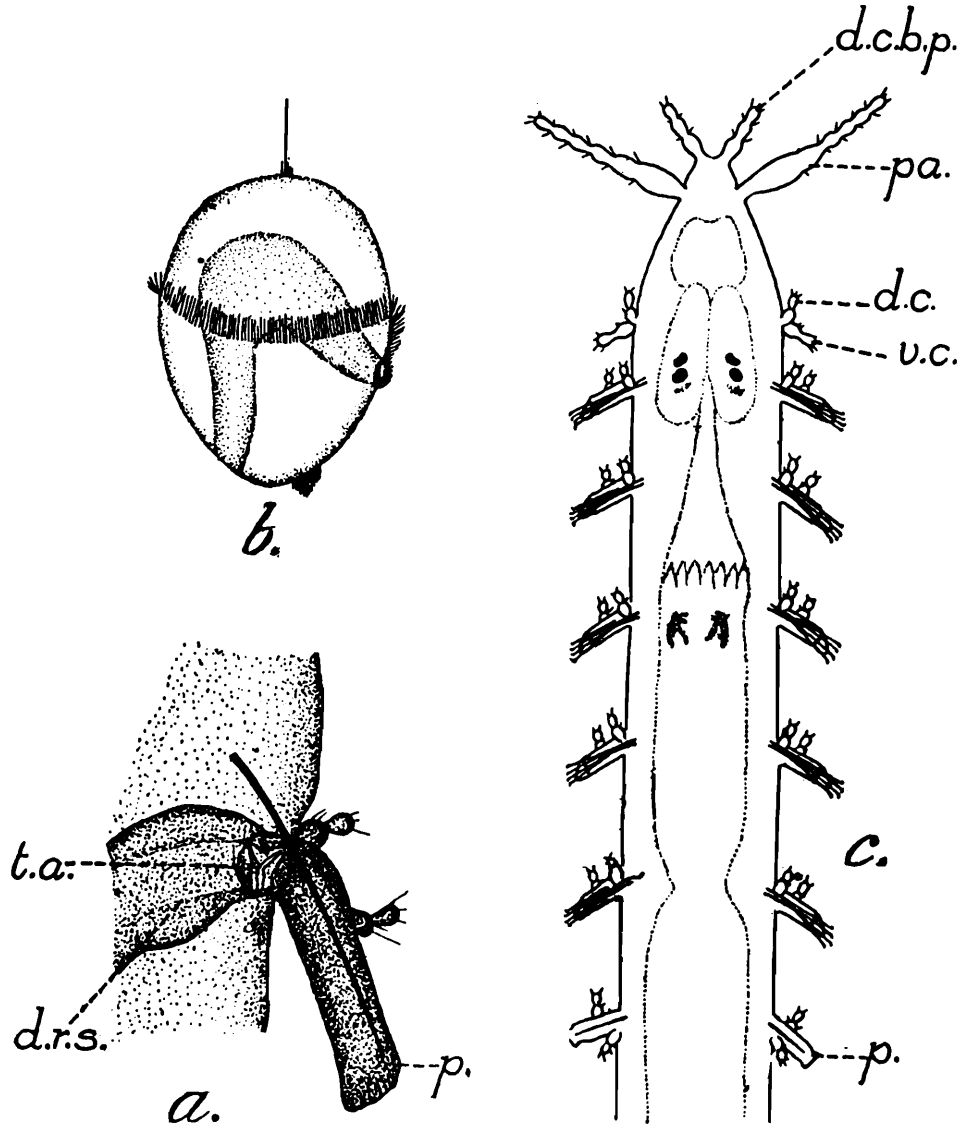
There are as many pairs of receptacula seminis as there are pairs of ovarian groups and the state of development of the receptacula seminis corresponds to the state of maturity of the ovaries. The receptacula seminis are globose or club-shaped sacs containing spermatozoa. Unlike the sperm-sacs already described, these are very thin walled and are lined externally by a layer of highly flattened epithelial cells and a thin layer of muscle fibres lined internally by a layer of cubical cells. At the proximal end of the sac the cells are very small while their size increases gradually until in the terminal portion they become large and highly protoplasmic. This terminal portion is drawn out into a muscular duct which opens to the exterior by means of a triradiate aperture (Pl. II, fig. 6 and text-fig. 7*a*) surrounded by a fleshy area at the base of the parapodium. The interior of the receptaculum seminis, unlike the lumen of the sperm-sac is not ciliated.

The mature eggs are heavily yolked and as they grow the ovarian bags rupture liberating them into the coelom. From here they are attracted towards the genital funnel due to the ciliary action of the latter and then are carried down the genital funnel into the nephridial duct which in its turn takes them to the receptaculum seminis. Here they are fertilised by the sperms received during copulation.

Breeding Habits.—As has been mentioned the worms breed throughout the year and numbers of fully mature specimens of either sex could be easily obtained.

The presence of well developed sperm-sacs and copulatory organs in the males and the presence of seminal receptacles containing spermatozoa inside, in the females, naturally suggest the occurrence of some sort of copulation between the two. Fortunately we were able to notice the actual process by keeping a number of male and female worms together in finger bowls containing clear sea water. Union usually takes place between fully mature worms only. During the process, unlike the case in the earthworms, the head of each worm is directed to

the same side. The suckers are everted in both the copulating individuals. The sperm-sacs of the male project out and the copulatory



TEXT-FIG. 7.—*Pisionella indica*, gen. *et* sp. nov.

a. External opening of the receptaculum seminis : ×187½ ;

b. Trochophore : ×600 ;

c. Anterior end of the worm with 13 segments (1st stage) : ×90. (Note the nature of the anterior parapodia).

hooks of a pair are firmly applied to the openings of a pair of receptacula seminis of the female. Sperm transference is thus effected. The sperms thus received from the male are stored up in the receptacula seminis and used for fertilising the eggs as already described.

It is clear that during an act of copulation only one pair of receptacula seminis is furnished with sperms and only a single pair of sperm-sacs is used in transferring the sperms as the second pair of sperm-sacs situated in the next segment cannot reach the openings of the next pair of receptacula seminales situated five or six segments below or above as the case may be. Female worms with only one or two pairs of receptacula seminis with sperms and the others empty are often met with. It is therefore probable that the eggs arriving at the receptacula seminis devoid of sperms remain there till a supply of sperms is received Now the presence of three or even four pairs of sperm-sacs in some

male worms with an intervening space of 4 or 5 segments between successive pairs, as has been already described, suggests the possibility of simultaneous sperm transference from three or four pairs of sperm-sacs to a corresponding number of receptacula seminis.

DEVELOPMENTAL STAGES.

Trochophore.—The fertilised eggs are perfectly spherical in outline and measure ·03 mm. in diameter. Segmentation is very rapid and the gastrula stage is reached in 5 to 6 hours after fertilization. Now they come to the surface and begin to swim actively. In about 14 to 18 hours the trochophores are formed (text-fig. 7*b*). They are very minute, a 46 hours old trochophore measuring only ·04 mm. along the long axis and ·03 mm. across the prototroch. The pre-trochal region is greenish in colour. The apical tuft consists of usually one or two very long cilia of about thrice the length of the cilia of the prototochal circlet. At the base of these long cilia there are two or three small cilia also. The mouth is comparatively large and is placed just behind the prototroch. Short vibratile cilia surround the mouth opening. In the interval between the mouth and the prototroch there is a row of cilia. There is a short band of cilia near the posterior end on the ventral side which probably represents the remnant of the neural band.

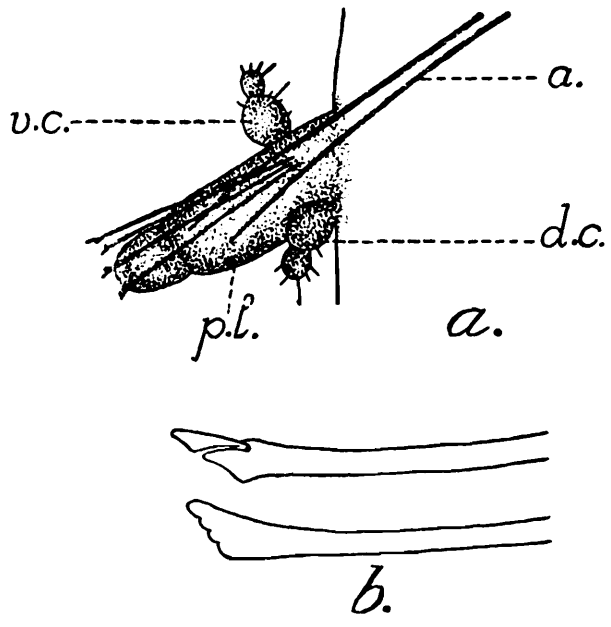
During the second day the posterior end gets suddenly elongated into a narrow conical projection beset with a few cilia. These cilia are continued into a row to a certain distance and ends behind the anal opening. The trochophores are often noticed to attach themselves to the bottom of the glass by this elongated projection and then execute quick rotatory movements. Situated at some distance above the anal opening, on what will become the dorsal side, is a group of four or five cilia which are slightly longer than the cilia of the prototroch.

The trochophores were kept in the laboratory up to the fourth day after which they failed to develop. The description that follows is that of the larvae picked out from sand and found occurring side by side with the adult worms.

Larval Stages.—Stage I. (Text-fig. 7*c*). This is the earliest stage obtained. The larva measures about 2 mm. in length and including the prostomial there are 13 segments. Two pairs of eyes have developed. The anterior pair is somewhat crescent like while the posterior is larger and rounded. Partly surrounding the posterior pair there are two dark brown pigment spots. The dorsal cirri of the buccal parapodia are fused in the middle as in the adult. The palps are well developed and have attained the adult condition except in size. These appendages are faintly constricted giving a jointed appearance and are provided with palpocils. The ventral cirri of the buccal parapodia are absent as in the adult. The ventral cirri of the parapodia of the first segment are slightly elongated while the dorsal cirri remain globose and two jointed as in the adult. The main lobe of this parapodium is absent and as such there are no setae present.

The parapodia from the 2nd to the 6th segments are well developed and conspicuous (text-fig. 8*a*). Each parapodium has a definite two jointed globose dorsal and ventral cirrus. The main parapodial lobe

is uniramous and is provided with a terminal bluntly conical fillet. Two acicula are present in the main lobe of the parapodium. The setigerous



TEXT-FIG. 8.—*Pisionella indica*, gen. *et* sp. nov.
a. Parapodium of the 4th segment of young worm with 13 segments: ×375;
b. Setae from the 4th segment: ×1500.

support of this lobe consists of 4 setae of which three are compound and one simple. This simple seta has a slightly bivelled tip (text-fig. 8*b*) and is often protruded along with the compound setae. Each compound seta has got a terminal joint provided with a small blade devoid of any teeth.

The parapodia from the 7th segment backwards differ from the preceding ones. These are also provided with dorsal and ventral cirri with palpocils as in the anterior ones. The main lobe is uniramous but is devoid of the terminal fillet. The setigerous support consists of only one simple capillary seta representing the aciculum. The rest of the simple setae as well as the compound setae of the anterior parapodia are absent.

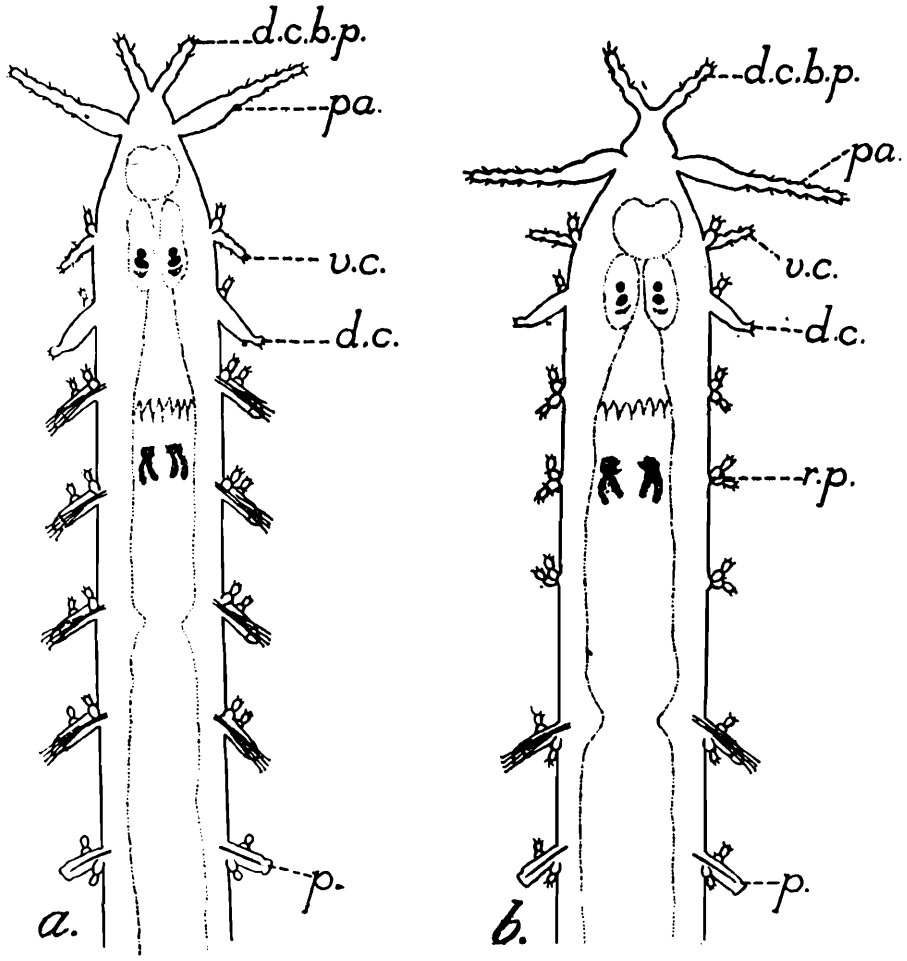
On the anal segment just above the posterior extremity there is a layer of brown pigment. A pair of long anal cirri is present.

The mouth is median and ventral. There is a protrusible pharynx. Two pairs of jaws are developed and have all the adult characters except size. Pharynx is provided with a crown of papillae as in the adult. The alimentary canal is slightly constricted. Specialised groups of glandular tubules are developed on either side of the body wall in between the successive parapodia. The minute tubular glands that are found on the general body surface in the adult worms are not yet developed.

Stage II. (Text-fig. 9*a*)—Obtained from sand along with the adult worms, measures about 3 to 4 mm. in length and including the prostomial there are 19 distinct segments. Besides the general growth in length this stage differs from the previous one in the following respects.

The palps have lengthened. The ventral cirri of the first segment are more elongated. The main setigerous lobe of the

parapodia of the second segment has disappeared and hence the segment, like the first, is non-setigerous. The dorsal cirri of this parapodium are slightly elongate. The parapodia from the 3rd to the 6th segments remain the same as in the previous stage.



TEXT-FIG. 9.—*Pisionella indica*, gen. *et* sp. nov.

a. Anterior end of young worm with 19 segments (2nd stage): ×80;

b. Anterior end of worm with 23 segments (3rd stage) ×80. (Note the changes in the anterior parapodia.)

The eyes are situated slightly more apart. The pigmentation of the anal segment is more diffuse. The constrictions of the alimentary canal are more pronounced and the jaws have become more chitinised. Paired nephridial swellings with a few solenocytes could be seen as flattened saucers pressed against the anterior face of the posterior septum of each segment.

Stage III. (Text-fig. 9*b*)—Also obtained from the sand along with the adult worms. Measures about 4·5 to 5 mm. and there are as many as 23 segments. The main points of difference from the previous stage are the following :—

The parapodia from the third to the fifth segments have become highly reduced and inconspicuous. The main setigerous lobes of these parapodia have disappeared and hence the segments are non-setigerous. The dorsal and ventral cirri of these parapodia persist as minute globular structures as in the normal parapodia. In the sixth segment the parapodia correspond with those of the previous stage and are provided with setae.

The pigmentation of the anal segment is hardly visible now. The alimentary canal has all the adult characters. The jaws have developed the amber colour characteristic of the adult. The nephridial clusters have grown larger.

In the next stage the setigerous parapodia of the sixth segment also disappear and then the worm has become an adult with the tentacular cirri well developed, the first four pairs of parapodia inconspicuous and non-setigerous and the rest of the parapodia having only simple setae.

Thus in the earlier stages there is an apparent uniformity in the presence of well developed parapodia even though the first 5 pairs differ from the rest. This uniformity is completely lost by the disappearance of the setigerous lobes of these 5 pairs of parapodia. The worms are not yet sexually mature and the sexes are now quite indistinguishable. Genital papillae are completely absent at this stage.

SUMMARY AND CONCLUSION.

From the account given above it will be seen that there are a number of characters peculiar to this form. There is no doubt, however, that it is a Pisionid and that it is more closely related to the genus *Pisione* than to *Praegeria*. It differs from *Pisione* and *Praegeria* in the non-setigerous nature of the first two segments carrying the tentacular cirri, in the non-setigerous inconspicuous parapodia of the next four segments, in the entire absence of compound setae from the parapodia, and in the absence of curved hook-like genital papillae on any of the parapodia. It differs again from *Praegeria* in the presence of two pairs of tentacular cirri carried on non-setigerous segments and in the absence of the buccal spines, besides in some minor points in the reproductive organs. The accompanying table will make the position clear.

Tabular Statement of the Generic Characters.

Praegeria.	*Pisione.*	*Pisionella.*
1. Segments 50 to 60.	Segments numerous.	Segments 50 to 70.
2. First segment setigerous.	First segment setigerous.	First segment non-setigerous.
3. Ventral cirrus of the first parapodium elongate.	Ventral cirrus of the first parapodium elongate.	Ventral cirrus of the first parapodium elongate.
4. Second segment setigerous.	Second segment setigerous.	Second segment non-setigerous.
5. Dorsal cirrus of the second parapodium globular.	Dorsal cirrus of the second parapodium elongate.	Dorsal cirrus of the second parapodium elongate.

Tabular Statement of the Generic Characters—contd.

Praegeria.	*Pisione.*	*Pisionella.*
6. Other parapodia similar and setigerous with simple as well as compound setae.	Other parapodia similar and setigerous with simple as well as compound setae.	Parapodia of 3rd to the 6th segments inconspicuous and non-setigerous. Rest of the parapodia similar with a single slender aciculum only and with no other setae of any kind.
7. Genital papillae absent.	Genital papillae present on the posterior parapodia as hook like structures.	Genital papillae present in the anterior as well as posterior segments in the form of suckers arranged along the mid-ventral line.
8. A pair of buccal spines present.	....	Buccal spines absent.
9. Sperms typical but non-motile.	....	Sperms a typical and non-motile.

The differences mentioned above seem to us so vital that we believe there is clear justification in creating a new genus for the reception of this form. We propose the name *Pisionella* for the new genus and in doing so we wish to indicate the relationship between *Pisione* and this new genus.

Pisionella, gen. nov.

Pisionidae with, much reduced head, the buccal and the six succeeding segments non-setigerous, ventral cirrus of the first segment and the dorsal cirrus of the second segment elongate and functioning as tentacular cirri, the parapodia of the next four segments minute and inconspicuous, only one seta in the form of an aciculum in each parapodium, genital papillae in the form of suckers in the mid-ventral line of the body in the anterior and posterior segments and compound setae in the anterior parapodia in the young condition which are lost in the adult.

Pisionella indica, gen. *et* sp. nov.

Characters of the species are the same as those of the genus.

Locality.—Madras Beach India.[1]

Holotype.—(No. W3436-1) in Zoological Survey of India, (*Ind. Mus.*) Calcutta.

Affinities.—The affinities of the family Pisionidae have been considered by early authors in the light of the external features only. Grube describing *Pisione oerstedi* has placed it in the Phyllodocidae and regarded it as a transitional form between the Phyllodocidae and the Glyceridae. Later Ehlers and Southern have discussed the affinities of the family

[1] Since writing this paper Mr. K. Chidambaram of the West Hill Biological Station has sent us a few specimens of the same species from the sandy beach, Calicut.

and have pointed out its relationship with Aphroditidae, Sigalionidae, Nephthydae, Hesionidae and Syllidae. The structure of the nephridia which has been studied for the first time in the family, lends support to the view held by Grube that it is related to Phyllodocidae and Glyceridae. In the genus *Pisionella* each nephridium in the non-genital segments consists, as already shown, of tufts of solenocytes with a conducting tube to the exterior. Ciliated organs are developed in the genital segments and later become associated with the nephridia. A similar condition of the nephridia and the genital funnels has been observed by one of us in *Praegeria remota* and in a new species of *Praegeria* both occurring in the Madras beach, a detailed account of which will form the subject matter of another paper. The condition of the nephridia and the genital funnels is very similar to that met with in the Phyllodocidae and the Glyceridae as described by Goodrich (1898, 1900) and thus confirms the view held by Grube in regard to the relationship of the Pisionidae.

ACKNOWLEDGMENT.

Our thanks are due to Mr. R. Velappan Nair for making several of the illustrations.

EXPLANATION OF LETTERING IN TEXT-FIGURES.

a., aciculum ; *a. c.*, alimentary canal ; *c. h.*, copulatory hook ; *d. c.*, dorsal cirrus ; *d. c. b. p.*, dorsal cirrus of the buccal parapodium ; *d. r. s.*, duct of the receptaculum seminis ; *e.*, eye ; *g. f.*, genital funnel ; *g. p.*, genital papilla ; *h. p.*, hypertrophied parapodium ; *j.*, jaw ; *n.*, nephridium ; *n. d.*, nephridial duct ; *o.*, ova ; *p.*, parapodium ; *pa.*, palp ; *p. l.*, parapodial lobe ; *ph. p.*, pharyngeal papillae ; *r. p.*, reduced parapodium ; *r. s.*, receptaculum seminis ; *s.*, septum ; *sol.*, solenocyte ; *sp.*, spermasac ; *t. a.*, triradiate aperture ; *t.* c_1., first tentacular cirrus (ventral cirrus) ; *t.* c_2., second tentacular cirrus (dorsal cirrus) ; *v. c.*, ventral cirrus.

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EXPLANATION OF PLATE I.

Photomicrographs of *Pisionella indica*, gen. *et* sp. nov.

FIG. 1.—The anterior end of worm.

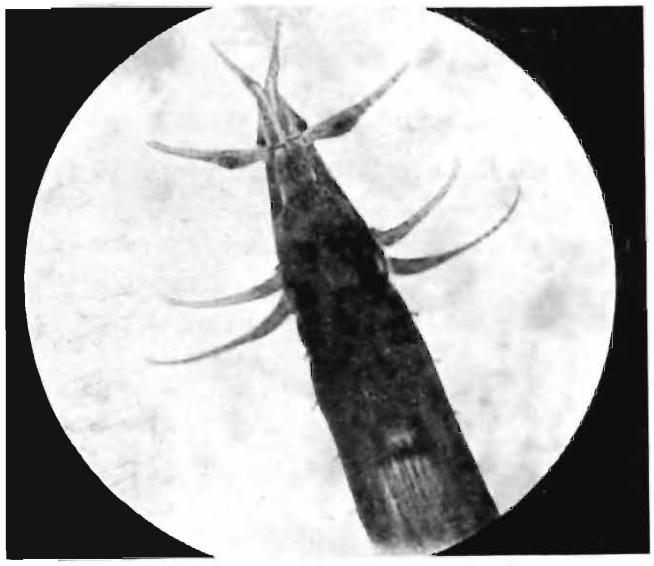
FIG. 2.—Posterior end of worm showing the anal cirri.

FIG. 3.—Anterior segments of a mature male showing the first series of genital papillae.

FIG. 4.—A vertical median section of a genital papilla.

FIG. 5.—The anterior end of the worm showing the protruded pharynx.

FIG. 6.—Longitudinal section of the nephridium.



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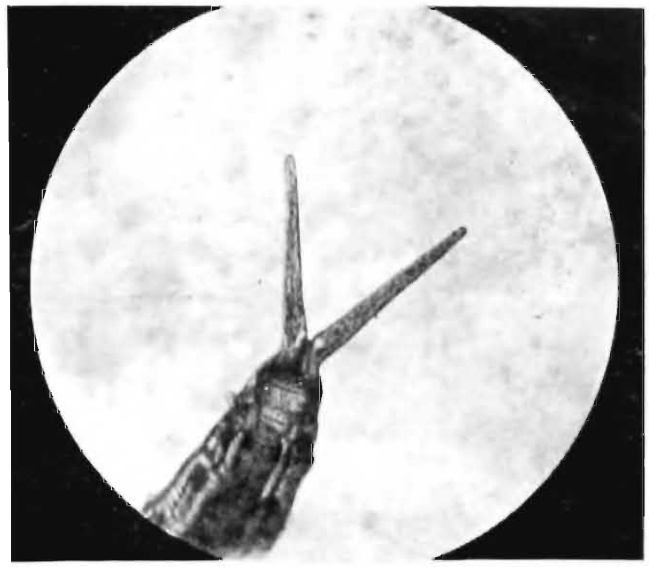

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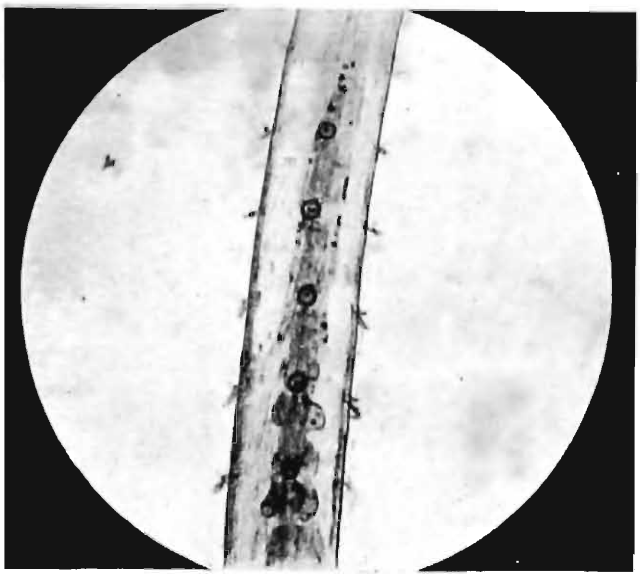

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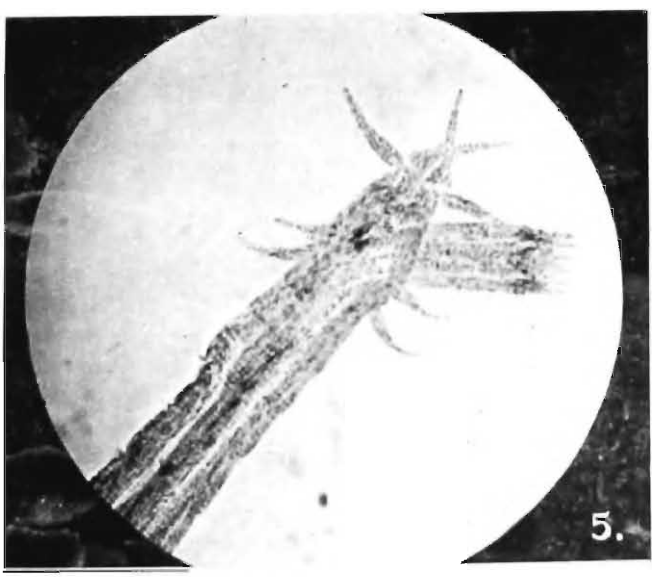

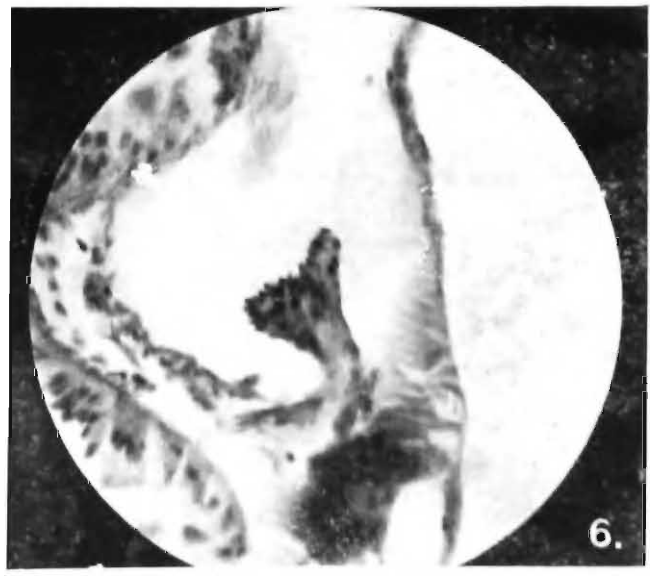

Pisionella indica sp. nov.

EXPLANATION OF PLATE II.

Photomicrographs of *Pisionella indica*, gen. *et* sp. nov.

FIG. 1.—A longitudinal section passing through the genital segments of a female showing the nephridium and the associated genital funnel.

FIG. 2.—Genital segments of a mature male showing the sperm-sacs everted.

FIG. 3.—Transverse section passing through the anterior half of a pair of sperm-sacs.

FIG. 4.—The sperms.

FIG. 5.—Transverse section passing through the ovaries.

FIG. 6.—Transverse section passing through the external opening of the receptaculum seminis.

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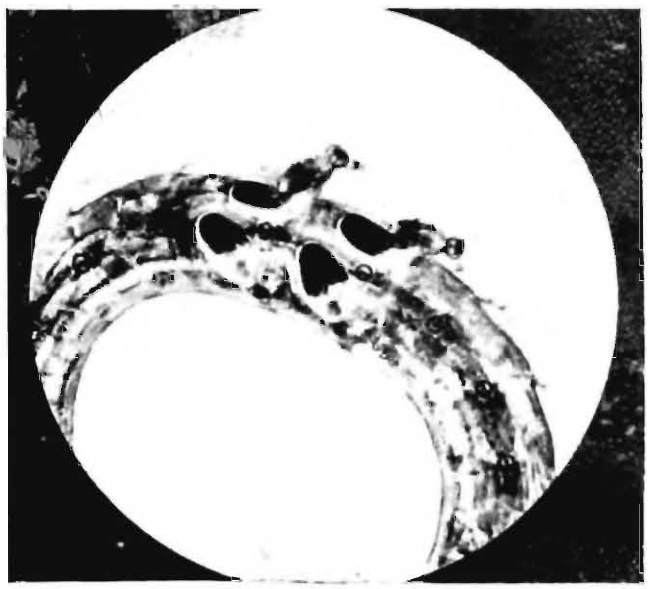

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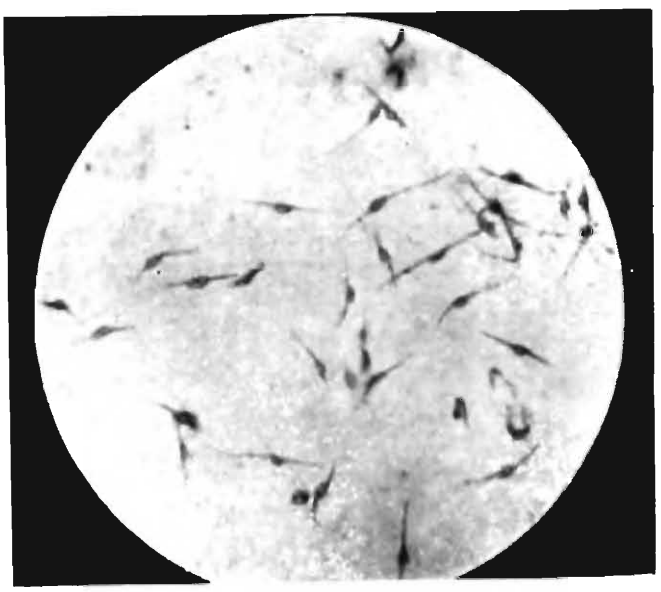

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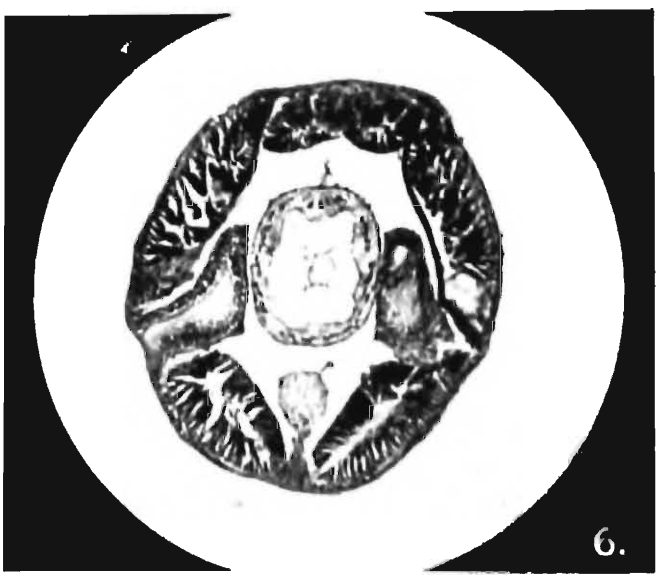

Pisionella indica sp.nov

ON THE OCCURRENCE OF SWINHOE'S SNIPE, *CAPELLA MEGALA* (SWINHOE), IN BENGAL, WITH REMARKS ON ITS DISTRIBUTION IN THE INDIAN REGION.

By M. L. ROONWAL, *M.Sc., Ph.D. (Cantab.), Zoological Survey of India, Calcutta.*

(Plate III.)

CONTENTS.

I. INTRODUCTION.

Swinhoe's Snipe, *Capella megala* (Swinhoe)[1], breeds in summer in Eastern Siberia and North China. In winter it migrates south and is found in South China, Eastern and Southern India, the Philippines, Borneo, Palawan, Bali, Celebes and Solar Islands, the Moluccas, Admirality Islands, New Britannia Island, New Guinea, Palau Islands, Northern and North-Western Australia and finally, the Guam Islands in the Marianne or Ladrone Group.[2] It also occurs in the Malay Peninsula and Siam.[3] In India it was first obtained in 1903 by Stuart Baker[4] at Dibrugarh in North-Eastern Assam. Subsequently, a number of specimens were collected in Burma and the Madras Presidency, but none from the intervening regions, namely, Bengal, Bihar, Orissa and the Central Provinces. The Indian distribution of this snipe is not fully known. Stuart Baker[5] remarks: "Probably it occurs early in some numbers in Madras and more often in Eastern India and Assam but is overlooked owing to its resemblance to the Pintail Snipe."

I am greatly indebted to Dr. Baini Prashad, Director, Zoological Survey of India, for kindly going through the manuscript and discussing with me several points raised therein, especially with regard to the distribution of Swinhoe's Snipe in India and adjacent countries.

II. DISTINCTION BETWEEN SWINHOE'S SNIPE AND THE PINTAIL SNIPE.

Swinhoe's Snipe, *Capella megala* (Swinhoe), closely resembles the Pintail Snipe, *Capella stenura* (Bonaparte), and is often mistaken for

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[1] 1861. *Gallinago megala*, Swinhoe, *Ibis* III, p. 343. (Peking, North China.)
[2] Hartert, E., *Vögel paläarkt. Fauna* II, p. 1665 (1921).
[3] Robinson, M. C. and Chasen, F. N., *Birds Malay Penin.* III, p. 171 (1936).
[4] Stuart Baker, E. C., *Journ. Bombay Nat. Hist. Soc.* XX, p. 596 (1911).
[5] Stuart Baker, E. C., *Fauna Br. India, Birds* (2nd ed.) VI, p. 265 (1929).

the latter. The usual distinction between the two is in the number of tail-feathers which are about 26 (never less than 22) in the Pintail Snipe and 20 in Swinhoe's Snipe. In moulting birds this number cannot often be ascertained with accuracy, and La Personne[1] has recently given the following alternative key which has been confirmed by Stuart Baker in the same note :—

A. Bastard wing always over 19 mm.—C. *megala.*
B. Bastard wing always under 19 mm.—*C. stenura.*

From an examination of four specimens of Swinhoe's Snipe and some twenty-one of the Pintail Snipe in the Indian Museum collection I am able to confirm the above diagnosis.

III. Occurrence of Swinhoe's Snipe in Bengal.

Recently, the Director, Zoological Survey of India, received from Mr. G. H. Johans, Assistant Superintendent (Goods), East Indian Railway House, Calcutta, a snipe skin which on examination proved to be *Capella megala* (Swinhoe). In his letter Mr. Johans remarks that the snipe was " shot at 7 hrs. on 6. 9. 39 near village Sankargachi in the Sub-division of Barasat[2] amongst young paddy. The bird constituted one of a bag of 30 snipes of which the balance, *i.e.*, 29 were Pintail." He adds that " at least one more snipe of similar build was seen on the morning of 6. 9. 39 in the same area "; and further that in 1938 he shot a bird of similar build.

Mr. Johans's specimen constitutes the first record of the occurrence of Swinhoe's Snipe in Bengal. The specimen sent by Mr. Johans is now preserved in the collections of the Indian Museum (Zoological Survey of India), Calcutta, and bears the Registered Number 26481.

IV Specimens of Swinhoe's Snipe and the Pintail Snipe in the Indian Museum, Calcutta.

Of Swinhoe's Snipe there are only four specimens in the Indian Museum. Three of these (I. M. Registered Nos. 20902 ; 20903 and 20904) were collected by Mr. C. B. Rickett in September 1890 from Foochow in East China, while the fourth (I. M. Registered No. 26481) is the Bengal specimen recorded in the present paper.

Of the Pintail Snipe there are some twenty-one specimens in the Indian Museum from the following areas, all, with one exception, in India :—East of Temktze (Central Asia ?) ; Tenasserim and Arakan Districts in Burma ; Kamrup and Darrang Districts in Assam ; Hooghly and 24-Parganas Districts in Bengal ; the Nepal Valley ; Raipur District in the Central Provinces ; and finally, Travancore in South India.

V Records of Swinhoe's Snipe from the Indian Region.

In view of the comparative rarity of Indian records of Swinhoe's Snipe and the desirability of recording its occurrence wherever found

[1] La Personne, V. S., *Journ. Bombay Nat. Hist. Soc.* XXXVII, p. 734 (1934).
[2] 24-Parganas District, Lower Bengal.

in India, a compilation of its hitherto known occurrences is given below (Table 1 and Plate III).

TABLE 1.

Known records of the occurrence of Swinhoe's Snipe, Capella megala *(Swinhoe), in the Indian Region.*

LOCALITY.	DATE.	COLLECTOR.	PUBLISHED RECORD.	REMARKS.
Burma.				
1. Shan States	Dec. 1908.	..	E. C. Stuart Baker, *Journ. Bombay Nat. Hist. Soc.* XX, p. 596 (1911).	First record from Burma, and second record from the Indian Region. One specimen.
2. Myitkyina (Myitkyina District).	Jan. 1910.	Capt. Venning.	Harrington, *Rangoon Gaz.* 1910.[1]	
3. Katha District	Mar. 7, 1910.	H. Blanford.	Harrington, *Rangoon Gaz.* 1910.[2]	
4. Maing Kaing (Upper Chindwin District).	Sept. 29, 1911.	C. S. Barton.	E. C. Stuart Baker, *Game Birds India, Burma and Ceylon* II, p. 105 (1921).	One specimen, in company with 12 Pintail and 8 Fantail Snipes. In young paddy.
5. Thayetmyo (Thayetmyo District).	Oct. 3, 1911.	J. P. Cook.	Ditto.	
6. Pyawii (District ?).	1911.	Capt. Venning.	Ditto.	
7. Around Rangoon	1911 (?).	Mr. Bloech.	Ditto.	
8. Tharrawady District.	Nov. 5, 1913.	C. Gwyer.	Ditto.	
Assam.				
9. Dibrugarh (Lakhimpur District).	Jan. 1903.	E. C. Stuart Baker.	E. C. Stuart Baker, *Journ. Bombay Nat. Hist. Soc.* XX, p. 596 (1911).	First record from the Indian Region. One specimen.
Bengal.				
10. Village Sankargachi (Barasat Sub-division, 24-Parganas District).	Sept. 6, 1939.	G. H. Johans.	M. L. Roonwal. (Present paper.)	First record from Bengal. Shot in young paddy in company with 29 Pintail Snipes. One specimen shot, and one seen. One specimen also seen in 1938, but not collected.
Madras Presidency.				
11. Tindivanam (South Arcot District).	Mar. 3, 1912.	R. F. Stoney.	R. F. Stoney, *Journ. Bombay Nat. Hist. Soc.* XXI, p. 1083 (1912).	First record from the Madras Presidency. One specimen.
12. Chingleput District.	1911-12 shooting season.	I. S. Fraser; R. F. Stoney; G. Ross.	I. S. Fraser, *Journ. Bombay Nat. Hist. Soc.* XXI, p. 1083 (1912).	Six specimens.
13. Chingleput District.	Sept. 30, 1914.	R. F. Stoney.	H. Whistler and N. B. Kinnear, *Journ. Bombay Nat. Hist. Soc.* XXXIX, p. 262 (1936).	One specimen.
14. Madura (Madura District).	Nov. 29, 1914; Nov. 3, 1915.	R. F. Stoney.	Ditto.	Two specimens.

[1, 2] Quoted from E. C. Stuart Baker, *Game Birds India, Burma and Ceylon* II, p. 105 (1921).

TABLE 1—*continued.*

LOCALITY.	DATE.	COLLECTOR.	PUBLISHED RECORD.	REMARKS.
Madras Presidency—*contd.*				
15. Cannanore (Malabar District).	Sept. 21; Nov.; Dec.; Jan.; Feb. 22. (Shooting seasons 1925-26 to 1934-35.)	E. G. Phythian Adams.	E. G. Phythian Adams, *Journ. Bombay Nat. Hist. Soc.* XXXII, p. 606 (1928); and H. Whistler and N. B. Kinnear, *Journ. Bombay Nat. Hist. Soc.* XXXIX, p. 262 (1936).	Fifteen specimens shot in ten shooting seasons.
Mysore State.				
16. Within 40-mile radius of Mysore.	1938-39 shooting season.	E. G. Phythian Adams.	E. G. Phythian Adams, *Journ. Bombay Nat. Hist. Soc.* XLI, p. 178 (1939).	First record from the Mysore State. Three specimens.
Ceylon.				
17. Maduramadu, a small tank on the road from Madawachchiya to Mannar (North Ceylon).	April 8, 1934.	R. H. S. Schrader.	W. E. Wait, *Spol. Zylenica* XIX, p. 337 (1936).	First record from Ceylon. Latest date of occurrence in the Indian Region.

The following tentative conclusions may be drawn from Table 1 and Plate III :—

1. Swinhoe's Snipe is a regular winter visitor to India, usually from the beginning of September to about the middle of March, and sometimes the middle of April. During this period (Tables 1 and 2), the earliest known date of its occurrence in the Indian Region is September 6 (Bengal), and the latest April 8 (Ceylon). The earliest date for South India is September 21, and the latest March 3.

On April 8, 1934, Mr. R. H. S. Schrader shot the first specimen of this snipe from Ceylon, as was recorded by Wait[1]. This is the latest date for the whole of the Indian Region, and probably represents a straggler left behind in the northward migration with the advent of warmer weather.

TABLE 2.

Earliest and latest recorded dates of the occurrence of Swinhoe's Snipe in the Indian Region during the snipe season (winter).

Province.	Earliest date.	Latest date.
Burma	Sept. 29.	Mar. 7.
Assam	January.	
Bengal	Sept. 6.	
Madras ..	Sept. 21.	Mar. 3.
Ceylon		April 8.

[1] Wait, W. E., *Spol. Zylenica* XIX, p. 337 (1936).

2. Swinhoe's Snipe has been recorded from practically the whole of Burma (several specimens); both the south-eastern and the western areas of the Madras Presidency (several specimens); Mysore (a few specimens); Ceylon (one specimen); Assam (one specimen); and Bengal (a few specimens). However, it seems likely that this snipe will be found to occur throughout the remaining portions of Eastern and Southern India, *viz.*, Bihar, Orissa, probably Nepal, Hyderabad State, the northern portion of the Madras Presidency and the southern portion of the Bombay Presidency.[1] It is, therefore, desirable that all bags of snipe shot in these areas should be carefully examined and finds of Swinhoe's Snipe published. The western limit of Swinhoe's Snipe in North India must remain a matter of conjecture until actual records are forthcoming.

VI. SUMMARY.

1. Swinhoe's Snipe, *Capella megala* (Swinhoe), has been recorded for the first time from Bengal.

2. A list of the known occurrences of Swinhoe's Snipe in India, Burma and Ceylon is given.

3. Swinhoe's Snipe is a regular winter visitor to the Indian Region usually from the beginning of September to the middle of March and sometimes the middle of April. The earliest recorded date is September 6 (Bengal) and the latest April 8 (Ceylon).

4. Swinhoe's Snipe is expected to occur in the whole of Eastern, Southern and South-Western India. Its western limit in India is not precisely known.

5. All future records of the occurrence of Swinhoe's Snipe in the Indian Region deserve publicity.

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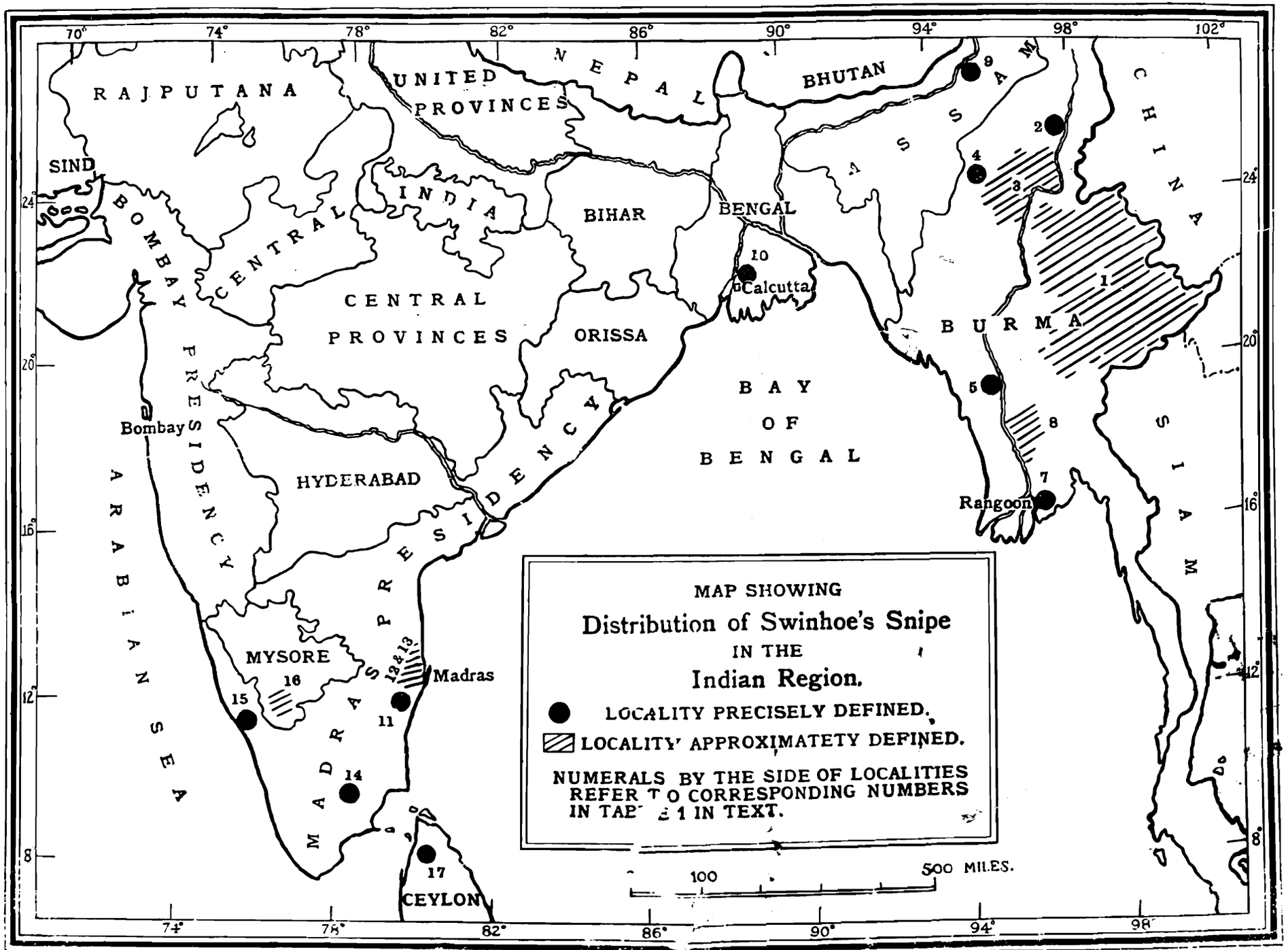
[1] This expectation is based on the assumption of a more or less continuous distribution of the bird from Burma to Peninsular India *viâ* the existing coast-line.

In the course of a discussion on the subject, Dr. B. Prashad suggested another possible explanation which needs to be considered. He has noted, in the course of studies on the geographical distribution of animals in India, that several species common in Burma reappear in Peninsular India, while they are absent from the intervening land area, *viz.*, Bengal, Orissa and the northern portion of the Madras Presidency. Dr. Prashad surmises that this anomaly is explicable by the probable existence, in geological times, of a direct and straight land connection between South-Eastern Asia (Burma, Malay, Indo-China and Southern China) and Peninsular India. The existence of such a land connection is supported by some geological evidence, as also by evidence from fresh-water fish distribution (Hora, S. L., *Curr. Sci.* V, pp. 351-356, 1937). To the objection that such an explanation could not be applied to those animals which progress through the air, and less so to a bird like Swinhoe's Snipe which is highly migratory, it can be said that the bird originally immigrated by the *direct* land route which then existed between South Eastern Asia and Peninsular India, and continues to do so to-day as a matter of instinct even after the submergence of the direct land connection. If that is so, one would not expect to find, except as stragglers, Swinhoe's Snipe in Eastern India (Bengal, Orissa and the northern part of the Madras Presidency), and the scanty records so far obtained in this zone would seem to support this contention. Further, one would expect to find the birds migrating *viâ* the Bay of Bengal; so far no such records have been obtained and only future finds of Swinhoe's Snipe in the Bay can settle the question, at least partially.

EXPLANATION OF PLATE III.

Map showing the known records of the distribution of Swinhoe's Snipe, *Capella megala* (Swinhoe) in the Indian Region.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Bombay
HYDERABAD
ARABIAN SEA
MADRAS PRESIDENCY
MYSORE
Madras
Rangoon
SIAM
CEYLON
MAP SHOWING
Distribution of Swinhoe's Snipe
IN THE
Indian Region.
LOCALITY PRECISELY DEFINED.
LOCALITY APPROXIMATETY DEFINED.
NUMERALS BY THE SIDE OF LOCALITIES REFER TO CORRESPONDING NUMBERS IN TABLE 1 IN TEXT.
100
500 MILES.
70°
74°
78°
82°
86°
90°
94°
98°
102°
24°
20°
16°
12°
8°

INDIAN EARTHWORMS. VIII—XI.

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CONTENTS.

VIII. *PRIODOCHAETA*, GEN. NOV.

INTRODUCTORY NOTE.

Perichaeta pellucida Bourne 1894 has been included in the Australian genus *Diporochaeta* since 1900 in spite of morphological and geographical evidence indicating that the Indian worm probably "is not phyletically related to the Australian species" (Stephenson 1923, p. 317). Bourne's form is a ghost species, unembodied in a material type, and even the locality from which the worms were secured is unknown. It is possible that the types of *pellucida* were found at or near Coonoor. Dr. F. H. Gravely of the Madras Museum very kindly arranged for the collection of earthworms from Coonoor.

Among the worms thus secured are several individuals which are possibly, if not probably, conspecific with the types of *pellucida*. Study of these worms shows that the excretory system comprises micro- as well as meganephridia. Accordingly *pellucida* cannot be retained in a purely meganephridial genus (*Diporochaeta*) and in the absence of an appropriate genus to which the species can be transferred erection of a new genus becomes necessary.

The author's thanks are extended to Dr. F. H. Gravely for arranging for the collection of specimens at Coonoor and to Colonel Iyengar for the care taken in the preservation of material as well as for his efforts to obtain representative collections from the various habitats in his locality.

Priodochaeta, gen. nov.

Diagnosis.—Quadrithecal, spermathecal pores on viii and ix. Male pores on xviii. Female pores paired on xiv. Setae perichaetine. Clitellum mainly annular ; on development of clitellar glandularity intersegmental furrows disappear and dorsal pores are occluded but setae are retained. Unpigmented. All septa from 4/5 present. Gizzard in v. Calciferous glands three pairs, in xiv-xvi ; markedly protuberant, constricted off from the gut dorsally and ventrally but opening widely into gut lumen by high, vertically placed, slit-like apertures. Intestine begins in xix, typhlosole rudimentary. Hearts three pairs (latero-oesophageal ?), in x-xii. Excretory organs : one pair of closed (?) exonephric (?) nephridia (or clusters ? of reduced micronephridia ?) vertically placed on the anterior faces of septa 5/6-13/14 : one pair of clusters of four to six (?) large, closed, transversely placed, parietal, exonephric micronephridia per segment from xiv to (?) ; one pair (?) of small exonephric (?) meganephridia with preseptal funnels per segment from ? to posterior end. Holandric ; seminal vesicles in xi and xii. Prostates tubular.

Genotype and only species.—*Perichaeta pellucida* Bourne 1894, as described and defined below.

Distribution.—Known only from two localities in the Nilgiri Hills, South India.

Remarks.—The generic definition above is only tentative, as the excretory and circulatory systems, and in particular the former, cannot be adequately characterized. Furthermore it is impossible at present in any monospecific Megascolecid genus to determine which characteristics are of generic or merely specific rank.

Priodochaeta pellucida (Bourne).

1894. *Perichaeta pellucida,* Bourne, *Quart. J. Mic. Sci.* XXXVI, pp. 13, 20, 27. (No types. Type locality unknown.)
1900. *Diporochaeta pellucida,* Michaelsen, *Das Tierreich,* X, p. 207.
1903. *Diporochaeta pellucida,* Michaelsen, *Geogr. Verbr. Olig.,* p. 88.
1909. *Diporochaeta pellucida,* Michaelsen, *Mem. Ind. Mus.* I., p. 107.
1910. *Diporochaeta pellucida,* Michaelsen, *Abh. Nat. Ver. Hamburg,* XIX, (5), p. 9.
1923. *Diporochaeta pellucida,* Stephenson, *Oligochaeta,* in *F. B. I. Series,* p. 317.
1925. *Diporochaeta pellucida,* Stephenson, *Rec. Ind. Mus.* XXVII, p. 63.

Material examined.—From the Madras Museum : 7 aclitellate and 6 clitellate specimens labelled, " Earthworms collected from water channel. Coonoor. 1936. Major Iyengar.", and 6 juvenile, 3 aclitellate and 1 clitellate specimens in another tube but with same label.

External characteristics.—Length 180-205 mm. ; of the clitellate specimen in second batch, 330 mm. Diameter four mm. (in clitellar region, elsewhere $3\frac{1}{2}$-$3\frac{3}{4}$ mm.) ; of the clitellate specimen in second batch, $4\frac{1}{2}$ mm. The clitellate specimen of the second batch is contracted in such a manner that an anterior portion containing the gizzard has a bulbous

shape. Unpigmented. Prostomium prolobous or almost so, usually retracted. The anterior portion of each clitellate specimen is " hooked " as the result of a ventral bend in the clitellar region. Aclitellate specimens are not hooked.

Setae begin on ii and are more closely crowded ventrally, occasionally so much so that the setal arcs have a slightly zigzagged appearance. A wide midventral gap is present from ii posteriorly; *aa* =4-6 *ab* or about one mm. wide. The mid-dorsal gap is about twice the width of the midventral gap anteriorly and may about =¼ C but gradually decreases in size posteriorly until it is of about the same width as *yz* or even smaller. No regular pairing of setae is recognizable and in the posterior portion the setae are quite irregularly distributed (not in straight longitudinal ranks). Some of the ventral setae of xviii are lacking. Setal numbers are shown below.

Setal Formulae.

ii	iii	viii	xi	xii	xx	xxi	
33	36	35	37	..	..	35	Clitellate specimens from first batch.
27	31	35	36	..	..	30	
35	39	32	39	..	..	33	
35	33	34	33	..	..	34	
29	33	34	38	..	..	31	
..	34	38	..	36	35	..	
..	34	39	..	39	29	..	Second batch.
..	36	39	..	40	34	..	
..	40	38	..	38	36	..	

The first dorsal pore is on 8/9 (1, from second batch) or 9/10 (11), usually with a pore-like though unperforate marking near the anterior margin of ix on the mid-dorsal line.

The clitellum is dark red or purple, protuberant and extends from the presetal or postsetal furrow of xii onto xix, to 19/20, occasionally with a slight reddening of an anterior portion of xx, annular on xiii-xvii; intersegmental furrows and dorsal pores (except on 12/13 and 18/19) lacking, setae present.

Quadrithecal, spermathecal pores small, transversely placed slits on the anterior margins of viii and ix just behind 7/8 and 8/9 and anterior to a tertiary furrow on the presetal secondary annulus, one to two intersetal intervals wide, in *bd* or *be*. Each pore has a fairly sharply demarcated circumferential lip that is slightly tumescent.

Female pores are paired (9), on *a* or in *ab*, just in front of the setal circle.

Male pores are minute, transversely placed slits, in *be*, usually on *c* or in *cd*, each pore at or near the centre of a small, transversely placed

area of shortly elliptical outline. On the youngest aclitellate specimen there is on xviii a transversely placed area of epidermal thickening and rather spindle-shaped outline, reaching laterally into *ef* and antero-posteriorly to 17/18 and 18/19 except towards the lateral ends. Each male pore is at the centre of an opaque area with regularly convex surface that is surrounded except laterally by a depressed marginal band of greyish translucence. On larger aclitellate specimens all of the male porophore is greyish translucent except for an extreme lateral portion which is opaque and depressed, the depression slightly deeper mesially. On clitellate specimens the appearance is much the same, the areas containing the male pores always depressed, the depression always deepest mesially though even here not especially deep. A median portion of xviii about in *aa* is white and may be slightly depressed but not as much so as the median portions of the male porophores.

No genital markings.

Internal anatomy.—All septa are present at least from 4/5 posteriorly ; 7/8-9/10 thickly muscular, 6/7 or 5/6-6/7 and 10/11-11/12 slightly muscular.

The gizzard is in v (9), large, and may reach a length of 3+mm. The oesophagus in vi-xiii is small and moniliform, slightly wider in xiii, the inner wall provided with irregular, white longitudinal ridges which are thickened in xii-xiii. Calciferous glands are three pairs, in xiv-xvi (6). Each gland is a vertically placed sac definitely constricted off from the gut dorsally and ventrally and markedly protuberant laterally, with flat anterior and posterior faces, reaching above and slightly below the levels of the dorsal and ventral faces of the gut, and dorsally into contact with the gland of the opposite side beneath the dorsal blood vessel. Glands of xiv are usually slightly smaller than those in xv and xvi. Each gland opens into the gut by a vertically placed, slit-like aperture that is of about the same height as the oesophageal lumen. Lamellae are rather thick, longitudinally placed, continuous from one pocket to the next around the region of septal attachment, and are not high. The intestine begins in xix (7), the valve anteriorly in xix or in a middle portion of the segment. The typhlosole is represented by a very low but definite, rather zigzagged ridge which begins in xxiii-xxv (3) and is unrecognizable behind ci (1). Supra-intestinal glands and intestinal caeca are lacking.

The dorsal blood vessel (single) is continued anteriorly onto the pharyngeal bulb. The ventral trunk divides into several branches in the region of the sub-pharyngeal ganglia. A supra-oesophageal trunk, adherent to the gut, is usually recognizable in vii-xiv. Extra-oesophageal trunks are first recognizable just behind the circumpharyngeal nervous commissures where they pass ventrally and then posteriorly for a short distance almost parallel to the nerve cord, passing dorsally on the anterior face of 4/5 and into v high in the coelomic cavity, occasionally reaching up to the level of the dorsal face of the gizzard. In vi the trunks pass, close to the median line, onto the ventral face of the gut to which they adhere, anteriorly in x or posteriorly in ix apparently passing into the ventral face of the gut and from thence posteriorly unrecognizable or perhaps represented by the lateralmost of a series of longitudinal vessels

in a well developed plexus that may cover the ventral face of the gut. A lateroparietal trunk on each side passes from a postprostatic region (behind xxx in one specimen) into xiii and on the anterior face of 13/14 is continued upwards to join the lateralmost longitudinal vessel in the ventral plexus (2 specimens). In one worm a second lateroparietal vessel from an anterior region passes into the posterior vessel just as the latter rises from the ventral parietes in xiii. In still another specimen the anterior lateroparietal is not continued into xiii but passes up on the anterior face of 12/13 to the lateral face of the gut. In another specimen the anterior lateroparietal passes into xvi at least without connection with the posterior lateroparietal on the right side while the left posterior lateroparietal passes into xii and then on anterior face of 12/13 up to a point above the level of the dorsal face of the gut where it turns ventrally to pass into the gut wall ventrolaterally. No subneural. The last pair of hearts is in xii (6). Hearts of x-xii open dorsally into the supra-oesophageal trunk. In xii a thread-like posterior cord passes from the heart to the dorsal trunk but no blood has been seen in this cord in any of the specimens. Similar cords have been identified rather dubiously in x-xi. If these cords are functional vessels the hearts of x-xii are latero-oesophageal. Hearts of ix open into the dorsal trunk. All hearts of ix-xii open into the ventral trunk. Paired vessels opening into the ventral trunk on the anterior faces of the septa are present in v-viii but have not been traced to the dorsal trunk.

Nephridia have not been found in the anteriormost segments. In v-xiii the excretory organs are represented by a pair of (single ?) tubules vertically placed on the anterior faces of the septa, the size increasing posteriorly but small even in xiii. In xiii the ducts of these organs apparently pass, close to the ventral parietes, across the coelomic cavity to the posterior face of 12/13 near to the region of attachment of the ovary. Nephrostomes were not found on the anterior face of 12/13. In xii the ducts apparently pass to the parietes at *j* and then laterally. In the anterior segments the ducts have been traced to the ventral parietes just in front of the septa but no further. These small anterior nephridia are usually poorly preserved and often with an appearance suggesting that portions are lacking. From xiv (6) posteriorly there is in each segment a pair of transversely placed excretory structures which appear at first glance to be meganephridia, (reaching from *a* to or beyond the midlateral line) the size increasing gradually from xiv to xix and from then on for some distance fairly uniform. Nephrostomes were not found though careful search was made in each specimen dissected. When preservation is favourable each of these structures appears to consist of four to six (or more ?) closely crowded, transversely placed, large micronephridia with very slender ducts that pass to the parietes and then run for varying distances mesially or laterally on the integument. In xix of one specimen five ducts pass into the parietes a short distance median to the margin of the cluster, but the duct of the sixth micronephridium passes to the parietes slightly behind the others and then runs laterally instead of mesially and for a longer distance before penetrating into the body wall. Clusters of transversely placed, large micronephridia are present, so far as can be determined, posteriorly to

the region of xcv. From thence posteriorly excretory structures appear to be less well preserved and any characterization is impossible. In the posteriormost segments there is a pair of excretory structures just behind each septum, each organ adherent to the septum or attached to the septum or the parietes by a mesentery, and reaching laterally to or beyond the midlateral line. Mesially from each organ a very slender and rather long neck passes to and through the septum with a small funnel on the anterior face near to the nerve cord. Nephrostomes have been definitely identified as far forward as in the sixty-fifth (1) or one hundred and third (1) segment from the hind end but from this region anteriorly are usually unrecognizable or only doubtfully so as a result of poor preservation and inclusion within masses of coelomic coagulum. The nephridia however appear to be meganephric for some distance anteriorly, *i.e.*, they are similar in appearance to the meganephridia behind even though funnels are not seen, occasionally a funnel or funnel-like structure can be recognized and one such was seen as far forwards as segment cxxxiv.

The male funnels of x and xi are characterized by a brilliant spermatozoal iridescence even in aclitellate specimens but there is little coagulum in the coelomic cavities. Seminal vesicles are vertically placed, acinous bodies on the posterior faces of 10/11 and 11/12. The vasa deferentia of a side come into contact in a posterior portion of xiii and apparently unite under 13/14, in xviii passing into the ental end of the prostatic duct. Prostates are tubular, looped, with small central lumen, the glands shortly elliptical in transverse section, restricted to xviii or with ental end reaching slightly into xix. The prostatic duct is small, 1½-2 mm. long, with muscular sheen, straight or looped, occasionally slightly thickened ectally.

Penial setae are lacking. In the smallest aclitellate specimens separation of the longitudinal musculature median to the prostatic duct reveals in what may be a setal gap, a vertically placed column of tissue that appears to be a degenerate setal follicle. This contains no setae in the specimens examined.

The spermathecal duct is much shorter than the ampulla but is definitely coelomic in part and clearly marked off from the ampulla (occasionally slightly bulbous), circular in cross section, the wall fairly thick and with slight muscular sheen, the lumen fairly large and approximating to circular in section entally but slit-like ectally. When the spermathecal duct is dissected out from the parietes a transversely placed, elliptical aperture with smooth margin is left in the epidermis and the annular lip of the spermathecal pore remains on the ventral end of the duct. The single diverticulum is digitiform to very slightly club-shaped, only very slightly narrowed just prior to its entrance into the median face of the duct (28). A stalk can scarcely be said to be present although the lumen is slightly narrowed prior to passing into the duct, the spermatozoal iridescence within the apparently simple lumen continued to or almost to the duct.

Remarks.—Juvenile specimens are 80-120 mm. long, 1-1½ mm. thick except at the gizzard region which may be a trifle thicker. Spermathecal pores are unrecognizable or are minute and about on *c*. Male pores

were not identified. The *a* setae on xviii may be present but *b-d* or *e* are lacking, pits representing apertures of follicles from which setae have dropped out may be recognizable. A minute pit about on *b* of specimens on which other pits are unrecognizable may be a rudiment of the male pore. Specimens referred to as aclitellate are longer, with definite male pores and markings and are either presexual or postsexual.

In x and xi on each side and attached to the gut midlaterally there is a horizontally placed, shelf-like protuberance of white tissue with an iridescent appearance. Somewhat similar but non-iridescent ridges are present at the sides of the gut in vii-ix.

Perichaeta pellucida Bourne 1894 was rather briefly characterized in an introductory portion of a paper on the development of setae and nephridia. The types were not preserved and the type locality was not mentioned. Later it was discovered (oral communication, *vide* Stephenson 1923, p. 250) that the types of *Megascolex imperatrix* (the other species with which the paper just mentioned is primarily concerned) were obtained at Coonoor. It is possible that types of *pellucida*, apparently studied at about the same time, were also secured from Coonoor. In 1925 Stephenson gave a more extended description of two "sexually mature worms" from Ootacamund, also in the Nilgiris, that were identified as *pellucida*, in spite of certain small differences. Aside from these two accounts nothing further has been made available hitherto with regard to the species.

Bourne's worms are distinguished, so far as can be determined from the limited information available, from the Coonoor worms described above as follows: (1) greater length, (2) location of the first dorsal pore on 5/6 instead of 9/10, (3) presence of dorsal pores on the clitellum, (4) intestinal origin in xix rather than xviii, (5) absence of a typhlosole, and (6) absence of micronephridia. (1) Difference in length of specimens cannot be considered at present as valid evidence for specific distinctness in this connection, especially in view of the fact that Bourne sometimes gave measurements of living and fully extended specimens. (2) Difference in location of first dorsal pore is of minor importance at most and may be of little if any value in the present discussion. (3) This is of no importance at present, Bourne's specimens may not have been fully clitellate. (4) Probably of little value even if correct,—an anterior extension of the first portion of the intestine may conceal the oesophageal valve and the posteriormost portion of the oesophagus from casual inspection. (5) This may be more of a difference in interpretation or definition than a valid distinction. The typhlosole in the Coonoor worms is admittedly rudimentary and in a small, softened and possibly somewhat macerated intestinal portion of one specimen is actually unrecognizable. (6) If real this is of taxonomic value but of sufficient importance to warrant generic rather than specific distinction. Bourne however failed to describe the excretory organs of adult specimens, merely noting that "There are no micronephridia" It is fairly obvious that Bourne thought micronephridia were lacking in both adult and embryonic stages of *pellucida* though the embryonic nephridial tubules of vii-xi especially mentioned and figured are probably not meganephridia, at least in the ordinary sense. With regard to the embryonic forms all that Bourne

says is that nephrostomes in *pellucida* embryos " become better developed up to a certain stage " than in *imperatrix* embryos. We do not know to what region of the body this statement applies or to what stages in development or even whether the nephrostomes were thought to persist throughout development and into adult life along the whole axis of the animal. The clustered micronephridia described above are certainly not of the *imperatrix* type and if present in Bourne's worms might well have been mistaken for meganephridia as in Stephenson's specimens. To summarize : the Coonoor worms cannot be distinguished from Bourne's *pellucida* by any important characteristics of specific value and the single apparent distinction of real taxonomic significance is of sufficient importance to warrant generic separation. At present it scarcely seems possible that two species belonging to two distinct genera and probably from the same place would be so much alike. It would appear to be more probable that Bourne like Stephenson failed to perceive the micronephridial characteristics of the excretory structures. The Coonoor worms have accordingly been referred to *pellucida*. To fix the species Coonoor is designated the type locality and the specimens described above are designated as types (neotypes).

Diagnosis.—Male pores minute, transversely placed slits in *be*, each pore at or near the centre of a transversely placed area of shortly elliptical outline, the male porophores slightly depressed, the depression deepest mesially. Spermathecal pores on the anterior margins of viii and ix slightly behind 7/8 and 8/9, in *be*. Clitellum annular on xiii-xvii but extending laterally and dorsally onto xii and xix or xx. First dorsal pore on 9/10. Setae : 27-35/ii, 13-40/iii, 32-39/viii, 33-39/xi, 31-35/xxi, a few lacking ventrally on xviii. Length 180-330 mm. Diameter 4-4½ mm.

Spermathecal diverticulum shortly digitiform to slightly club-shaped, into median face of a duct that is much shorter than the ampulla.

Distribution.—Coonoor and Ootacamund, the Nilgiri Hills, South India.

IX. *PRIODOSCOLEX*, GEN. NOV.

INTRODUCTORY NOTE.

In a collection of earthworms received in exchange from Prof. C. R. N. Rao of Bangalore in 1924 were two representatives of an undescribed species belonging to a new genus. One of the specimens had been dissected. Some time ago permission to describe this as well as certain other portions of the material obtained from him was requested of Prof. Rao. Unfortunately no reply has ever been received to the request. As the new genus is of some interest because of certain similarities to *Priodochaeta* the writer has taken the liberty of presenting the account below without the desired permission. The author's thanks are extended to Prof. Rao for the specimens.

Priodoscolex, gen. nov.

Diagnosis.—Quadrithecal, spermathecal pores on viii and ix. Male pores on xviii. Female pores paired on xiv. All reproductive apertures

minute and superficial. Setae perichaetine. Clitellum saddle-shaped; on development of the clitellar glandularity intersegmental furrows disappear, dorsal pores are occluded and most of the setae are lost. (Unpigmented ?) All septa from 4/5 present. Gizzard in v. Calciferous glands reniform, vertically placed, six pairs, in xv-xvii; stalks from the two glands of a side in each segment unite midsegmentally, the common stalk opening through gut wall midlaterally by a minute aperture. Intestine begins in xix; typhlosole simple, lamelliform. Hearts latero-oesophageal, in x-xii. Subneural trunk present, joining a (right) latero-parietal trunk in the region of xiii-xvi. Excretory organs: two pairs of closed, exonephric (?) micronephridia (or clusters of micronephridia) on the parietes of iii (?), one pair of larger clusters on the parietes of iv (?), two pairs of large clusters close to the ventral parietes in iv and v, paired clusters of micronephridia on the anterior faces of the septa in vi-ix (and x-xi ?) and xii-xiii; from xiv posteriorly a transversely placed, presetal band of closed, exonephric micronephridia on each side, the band of two rows; in the posteriormost segments a single transversely placed row of 10-12 small, exonephric micronephridia on each side with a corresponding row of preseptal funnels. Holandric; seminal vesicles in xi and xii. Prostates tubular.

Genotype and only species.—*Priodoscolex montanus*, sp. nov.

Distribution.—Known only from the type locality of the type species, Nandydroog, Mysore State.

Remarks.—The generic definition is only tentative, much remains to be done by way of working out important taxonomic characteristics of the excretory system and possibly also of the vascular system. Furthermore, ascription of generic or specific value to taxonomic characteristics in a monospecific genus rests on analogy with polyspecific and unrelated genera. Finding of a second species is likely to necessitate modifications in both generic and specific diagnoses.

Priodoscolex montanus, sp. nov.

Material examined.—From Prof. C. R. N. Rao: 1 aclitellate (dissected) and 1 clitellate specimens labelled, " Nandydroog, S. I.".

External characteristics.—Length 255 mm. (clitellate specimen). The last segment is setigerous probably indicating that a posterior portion had been autotomized. The aclitellate specimen is 230 mm. long. Diameter *ca.* 3½ mm. Unpigmented (? alcoholic preservation). Intersegmental furrow 1/2 is quite unrecognizable and probably lacking. The united segments i-ii of about the same length as iii, the setae of the first apparent segment slightly nearer the posterior than the anterior boundary. Prostomium retracted.

On certain anterior segments, near the anterior margins there are minute pores or pore-like depressions that look like nephropores. These are located as follows: on iii, at *e*, *m* (and possibly also *i* ?) on the right side, *k* and *t* left side; on iv, *k* and *p* on the left side, at *h* and *l* on the right side; on v, at *h* on the left side; on vi, at *h* and *l* on the left side.

Setae are small, closely spaced anteriorly, especially so ventrally where some of the ventralmost setae may be displaced anteriorly or posteriorly so as to produce a zigzagged appearance of the transverse

setal line. Posteriorly the spacing is about the same on the dorsal and ventral sides. Anterior to the clitellum the midventral gap is small, only about 2-3 times the width of *ab*, the mid-dorsal gap larger. Posteriorly the mid-dorsal gap becomes smaller and may practically disappear but a definite midventral gap is retained to the last segment. Setae are lacking ventrally on xviii. Formulae : 2/i-ii, 64/viii, 80/xii 79/xxi (clitellate specimen) ; 10/i-ii, 70/viii, 84/xii, 81/xxi (aclitellate specimen).

The first dorsal pore is on 10/11 (2).

The clitellum is dark red, protuberant, saddle-shaped, with sharply demarcated ventral margin, extending from 12/13 to 19/20, with a faint reddening of the posterior portion of xii and an anterior portion of xx ; intersegmental furrows and dorsal pores lacking, setae invisible and probably mostly lacking though setal gaps in regular series are visible in the longitudinal musculature of xix from the coelomic face of the parietes. The midventral region between the margins of the clitellum is about 32 intersetal intervals wide, 33 setae present on xvi. Intersegmental furrows are clearly indicated midventrally on both specimens. On the aclitellate individual intersegmental furrows are only faintly indicated across the site of the clitellum, dorsal pores are occluded though sites are indicated and most of the setae appear to be lacking, although pit-like depressions of many of the former setal follicles are still recognizable.

Quadrithecal, spermathecal pores minute, superficial, diagonally placed, closely paired slits, on or close to *a* and slightly behind 7/8 and 8/9. Each pair of pores is located on an indistinctly demarcated and transversely placed area of epidermal modification (slight thickening ?) of shortly elliptical outline, the porophores apparently extending across the intersegmental furrows. The latter are lacking midventrally.

The female pores are on or close to *c*, and slightly nearer to the setal circle than to 13/14, on an area of slight epidermal modification that extends from 13/14 to the setal arc.

The male pores are minute and superficial, diagonally placed slits, about in *cf*, both pores towards the posterior margin of an indistinctly demarcated, transversely placed genital shield (area of epidermal thickening ?) of shortly and broadly elliptical outline, extending from 17/18 onto the posterior half of xviii and laterally on each side to a point about four intersetal intervals median to the ventral margin of the clitellum. The pores are about in line with the setal arcs of xviii (aclitellate specimen). From each male pore a slight groove runs anterolaterally for a short distance and then divides into two grooves, the lateral continued anterolaterally for a short distance and then turning mesially to unite with the corresponding groove of the other side at the midventral line. The median groove again opens into the other groove slightly lateral to the midventral line. On the aclitellate specimen there are seven or eight setae on each side between the lateral margins of the male shield and the sites of the ventral margins of the clitellum. These setae are lacking on the clitellate specimen though one or two setae are recognizable on each side on the ventralmost portion of the clitellum.

No genital markings.

Internal anatomy.—Septum 4/5 is transparent, membranous; 5/6-7/8 slightly muscular; 8/9-11/12 muscular.

The gizzard is in v and is tubular, about three mm. long. The oesophagus is slender, the inner wall in x-xviii provided with low, longitudinally placed, rather regular, white ridges. Calciferous glands are six pairs, two pairs in each of xv-xvii (2). The glands are large, reaching above the gut into contact with the dorsal blood vessel, reniform, the concave side mesially. Short stalks from each of the two glands of a side in a segment unite midsegmentally and the common duct then passes to the oesophagus midlaterally, opening into the gut lumen by a minute aperture. Lamellae are well developed and high, the lumen of each gland small. The intestine begins in xix, the oesophageal valve apparently relaxed but probably slightly behind 18/19. The typhlosole is first recognizable as a low but definite ridge, hemicircular in cross section in xxvii-xxxi, abruptly enlarged in xxxii from whence posteriorly it is lamelliform. Passing posteriorly the height decreases very gradually, the typhlosole unrecognizable behind cxcviii. Caeca and supra-intestinal glands are lacking.

The dorsal blood vessel (single) is continued onto the pharyngeal bulb. In xii-xiii there are paired supra-oesophageals, a single, median supra-oesophageal in x-xi. Extra-oesophageals were not seen. A subneural trunk is present (2) and is large and filled with blood posteriorly, but small anteriorly though still red and clearly visible. In one worm the subneural passes laterally in xix (right side) and then anteriorly into xiii where it turns dorsally and on the anterior face of 13/14 passes into the lateroparietal trunk. In the other specimen the subneural passes laterally in xvi (right side), thence into xv and into the lateroparietal trunk just in front of 15/16. The lateroparietal trunks are well lateral to the ectal end of the prostatic duct, large and filled with blood, unrecognizable posterior to xix, in xiii turning dorsally and passing upwards on the anterior face of 13/14 to the gut (into an extra-oesophageal ?). In one specimen the lateroparietal trunks apparently pass into the supra-oesophageals. The last pair of hearts is in xii (2). The hearts of x-xii bifurcate dorsally, the posterior branch passing into the dorsal trunk, the anterior bifurcation into the supra-oesophageal.

In segments iv and v on each side and close to the ventral parietes there is a large nephridial cluster. Anteriorly on each side three tubules or clusters are recognizable on the parietes, two in a transverse row (possibly) in iii, the third which is much larger than the others posterior and possibly in iv. In vi-ix and xii-xiii on the anterior faces of the septa and just lateral to the gut there are vertically placed tubules or clusters of tubules. From each of these clusters a duct (?) passes ventrally but can only be traced to the parietes behind the setal circles. Nephridia were not recognized in x-xi but may have been present in a sticky testicular coagulum adherent to the anterior faces of the septa. From xiv posteriorly on each side there is on the parietes anterior to the setal circle a transversely placed band of closed (?), exonephric (?), micronephridial tubules, possibly in two transverse rows (10-15 anteriorly ?). In the last ten to fifteen segments, on the anterior face of each septum and close to the ventral parietes, there is on each side a transverse row of about

ten (12 noted once) very small, iridescent, funnel-like structures. Necks from these funnels to the nephridia in the segments behind have not been found and if present must be very slender.

Male funnels are free in x and xi and iridescent in both specimens. Seminal vesicles are small, acinous, vertically placed on the posterior faces of 10/11 and 11/12. Prostates are tubular, with small but obvious lumen, central or slightly asymmetrical, the glands somewhat flattened and elliptical in transverse section, the surface with a finely granular appearance, confined to xviii or reaching into xix, brittle and easily fragmenting, five to six mm. long. The duct is slender, but with muscular sheen, about two mm. long, looped into an S-shape, slightly thickened ectally. The deferent duct passes into the ental half of the prostatic duct about one half mm. from the ental end.

Spermathecal ampullae possibly are much contracted though filled with a granular material and certainly are not sharply marked off externally from the ducts, recognizable only as slight swellings of the ental ends of the main spermathecal axes, the widened part much shorter than the apparent duct portions. Ectally the lumen is very small, gradually widened entally. (In an ental portion of the main axis which appears externally to be duct, the thickness of the wall is about the same as that of the ampulla.) The diverticulum which passes into the median face of duct just ental to the parietes, is less than half the combined lengths of duct and ampulla and comprises three regions: an ental, shortly ellipsoidal to ovoidal, simple seminal chamber, filled with sperm, a middle region in which the lumen gradually narrows ectally and which contains an opaque material that may have a spermatozoal iridescence and a stalk with a very narrow central lumen and thick wall.

Remarks.—Each of the types is somewhat distorted as a result of having been stretched and then pinned out before killing and hardening. Most of the internal organs had been removed from the anterior end of the aclitellate specimen prior to receipt here. The nephridia are imbedded in a sticky coelomic coagulum which is adherent to septa or parietes and are poorly preserved. Removal of the especially massive coagulum in the posteriormost segments may have resulted in destruction of necks leading from the funnel-like preseptal structures to the nephridia in the segment behind. Determination of characteristics of the excretory system under these circumstances and with only two specimens which must be preserved as types, is a matter of considerable difficulty and hence the uncertainty with regard to so many points of taxonomic importance.

In the Oligochaeta the first segment is usually not setigerous and setae may even be lacking on one or more additional segments. The presence of setae on the first segment would accordingly be very unusual though not to be ruled out of consideration on this account. If the first setigerous segment is to be considered the first segment the male pores would then be on xvii and the female pores on xiii, an unusual location in the Megascolecidae. There is some slight evidence to indicate that the first and second segments of an occasional species may be fused so that the first segment appears to be setigerous. For the present it is assumed that a similar process has occurred in *montanus* with the

fusion of i-ii by the disappearance of 1/2 and the retention of a few of the setae belonging to ii. The status of the species as a genotype of a new genus is not effected whichever happens to be the correct interpretation of the segmentation.

The aclitellate specimen with spermatozoal iridescence in the seminal chambers of the spermathecae and on the male funnels is regarded as in a postsexual aclitellate condition.

Diagnosis.—Male pores towards posterior end of a transversely placed genital shield of shortly and broadly elliptical outline extending from 17/18 onto the posterior half of xviii. A rather C-shaped groove with concave side posteriorly, on the anterior portion of the shield, connects the male pores, a short diagonally placed groove on each side opening anteriorly into the main groove just lateral to the midventral line and posteriorly slightly in front of the male pore. Spermathecal pores closely paired, on viii and ix, slightly behind the levels of 7/8 and 8/9 and on or close to *a*, each pair of pores on a transversely placed area of epidermal modification on which the intersegmental furrow is lacking. Female pores on or close to *c*, slightly nearer to the setae than to 13/14. Clitellum saddle-shaped, 12/13-19/20. First dorsal pore on 10/11. Setae lacking ventrally on xviii; 2-10/i-ii, 64-70/viii, 80-84/xii, 79-81/xxi. Length 230-255+ mm. Diameter 3½ mm.

Distribution.—Known only from the type locality, Nandydroog, a mountain about 1,475 feet high, about 40 miles north east of Bangalore. Elevation at which worms were secured unknown.

X. CONTRIBUTION TO A REVISION OF THE INDIAN SECTION OF THE GENUS *MEGASCOLIDES*.

INTRODUCTORY NOTE.

The Indian section of the Indo-Australasian-American genus *Megascolides* is a heterogeneous aggregate of seven species lacking that morphological unity which characterizes better known genera. The distribution is peculiar; four species in the extreme south (Travancore and Cochin), one in the northern portion of the Madras Presidency, one in Bombay Presidency, and one in the extreme north-east in Assam.

One species, *bergtheili* from the Himalayas, suspected of Octochaetine[1] affinities has been transferred recently to a new genus closely related to *Eutyphoeus* (Gates 1937). During a course of a study of the worms formerly included in the Octochaetine *Eudichogaster* it was noticed that two species of *Megascolides* have certain characteristics suggesting a possibility at least of some sort of relationship to the Octochaetine *Barogaster*. In addition it was found that no information is available with regard to the place of junction of male deferent and prostatic ducts in any of the Indian species of *Megascolides*. In absence of this information there is a possibility that some of these inadequately described species with tubular prostates might have Octochaetine affinities even though male pores are located on xviii, as for instance in *Barogaster*.

[1] Octochaetin is here used very loosely and merely to refer to that group of Indian worms formerly included in the Octochaetinae by Michaelsen and Stephenson. As has already been pointed out (Gates 1937 and 1939) the Octochatinae and Megascolecinae can no longer be recognized, at least as hitherto defined.

As much of the material as could be secured, again only types, has been examined and the results of this study may be briefly summarized as follows. Two species (from Bombay and Madras Presidencies) definitely suspected of having Octochaetine affinities are actually Barogasters and, for the present at least, only doubtfully distinguishable from the genotype, *B. barodensis*. At least three, if not all, of the species from the extreme south (Travancore and Cochin) can be isolated generically but here again specific distinctions are dubious. The single remaining species (from Assam) is almost certainly not a *Megascolides*. The prostates and distribution perhaps indicate affinities with the *Tonoscolex-Nelloscolex* group.

The author's thanks are extended to Dr. B. Prashad for the loan of specimens that made this study possible, and to Miss Chapman for the description and measurements of penial setae of *B. annandalei*.

Genus **Megascolides** McCoy.

Megascolides antrophyes Stephenson.

1924. *Megascolides antrophyes* Stephenson, *Rec. Ind. Mus.* XXVI, p. 130. (Type locality, Siju Cave, Garo Hills, Assam. Type in the Indian Museum.)

Material examined.—From the Indian Museum, 1 clitellate, dissected specimen labelled, " *Megascolides antrophyes* sp. nov. Siju Cave, 2,000 feet from entrance. Garo Hills, Assam. S. K. and B. N. C. February 1922. W 1151/1."

External characteristics.—The setae begin on ii and are fairly readily visible under the highest power of the binocular and with brilliant illumination. On viii, ix and some of the post clitellar segments recognition of setae is difficult because of the presence of equatorial circles of elevations that look like the tips of the setae, a ventral portion of each circle coinciding with the setal arc. Setae are mostly lacking (or invisible ?) on the clitellum and ventrally on xviii and xix.

The clitellum is annular, protuberant, reddish brown and extends from just in front of the setae of xiii to (probably) 17/18 ; intersegmental furrows lacking, dorsal pores lacking except for that of 13/14, one or more of the ventral setae of xvii possibly present.

Female pores have not been found, probably a single median pore.

The lateral margin of the narrow but high rim around the male field is at or near mid *bc*. The area within the rim appears to be slightly depressed. The " two low transversely oval papillae " are separated from each other except at the midventral line by a transverse furrow which is in line with 18/19. A narrow bridge at the midventral line connects the two papillae. At the lateral margin of the bridge is a fine, greyish translucent, crescent shaped line in the epidermis, the concave side facing laterally (no groove visible). At the posterior end of each line is a definite aperture. A marking at the anterior end of each line doubtless represents the male pore but an opening is not clearly visible, the male pores definitely smaller than the apertures on xix. The male pores as well as the pores of xix are about on *a*.

The spermathecal apertures are in *aa*, on the anterior margins of viii and ix, between a presetal secondary furrow and the anterior inter-

segmental furrow, each pore perhaps a trifle nearer to *a* than to the other pore of its segment, surrounded by a narrow, slightly raised, annular lip.

Internal anatomy.—The gizzard at first appears to be just anterior to 6/7 and hence in vi, but 5/6 appears to be represented by an exceedingly delicate, funnel-shaped membrane closely adherent to the gizzard but attached to gut just at or behind the posterior end of the gizzard. The gut in xi-xiii is unusually slender and rod-like. Calciferous glands of xiii are vertically ovoidal. From the dorsal extremity of each gland a very fine and short stalk (?) passes into the dorsal wall of the gut just lateral to a mid-dorsal line. These stalks are fragile and may be blood vessels but no blood is present while the large blood vessels carrying blood to and from the glands are filled with blood and quite readily recognizable. No other connection to the gut was found. The glands of xii are lobed, a fairly large, horizontally ovoidal dorsal lobe, a nearly spheroidal smaller ventral lobe, and possibly a third even smaller and still more ventral lobe. In xi, on one side, and attached by a delicate stalk to the dorsal face of the gut just in front of 11/12 is a moniliform body of three, nearly spheroidal lobes, possibly a rudimentary calciferous gland. The intestine begins in xiv. No intestinal caeca or glands found, but the gut is lacking in a region extending from about xxx to xlvi or xlvii. A pair of large, blood filled vertical commissures is present in xii and xiii in addition to the hearts. A large mass of nephridial tubules is present at each side of the gizzard (in v ?). In each of the clitellar segments just lateral to the nerve cord on each side there is a conspicuous rather rosette-like cluster of tubules. In the post-clitellar region excretory organs, when visible, are one pair per segment of (parietal ?) micronephridial (?) tubules.

The male funnels in x and xi are represented by small spots of iridescence on the ventral parietes of x and xi. Seminal vesicles were not found. The prostates are flattened, band or strap-like, the margins deeply incised mesially (ventrally) but with only one deep lateral (dorsal) incision. A central lumen is unrecognizable in sections exposed by fragmentation of the brittle gland. The duct is about 1 mm. long and nearly straight. From the parietes just in front of the ectal end of the duct a fine blood vessel (?) passes along the duct to the prostate gland but a vas deferens was not seen.

The prostatic ducts pass into a shortly elliptical transversely placed thickening of the body wall that projects slightly into the coelomic cavity. In xix there is a somewhat similar but more conspicuous protuberance which is slightly grooved midventrally, the nerve cord within the groove.

Remarks.—The difficulty of determining important taxonomic characteristics of digestive, circulatory and excretory systems from a single individual one mm. thick, poorly preserved, damaged as a result of previous dissection, with the restrictions imposed by the value of the specimen as a type, can only be appreciated by one who has attempted something of the sort. These circumstances explain the incompleteness of the account above and the indefiniteness and qualifications of certain statements.

Ovaries were not found and enumeration of segments internally proved difficult. Determining the segmental numbers by positions of the spermathecae enabled recognition of the first muscular septum as 6/7, in agreement with Stephenson. A delicate membrane which appears to be 5/6 is, however, present and apparently attached to the gut behind the gizzard. The coelomic cavities of postclitellar segments are partially filled with a rather sticky coagulum. Removal of this coagulum may have resulted in damage to or loss of excretory organs.

The prostates are friable and broken. As a central lumen is unrecognizable in the sections thus exposed the glands probably are racemose. The elongately flattened, strap-like shape is similar to that of certain South Indian species of *Notoscolex* as well as of the North Indian *Tonoscolex.*

The distribution, seminal grooves, calciferous glands and several other characteristics of minor importance appear to be more suggestive of affinities to the *Nelloscolex-Tonoscolex* group than to any South Indian form.

Genus **Barogaster** Gates.

1939. *Barogaster*, Gates, *Rec. Ind. Mus.* XLI, p. 160. (Genotype *Eudichogaster barodensis* Stephenson 1914.)

The three species of *Barogaster* can be distinguished from each other at present only somewhat doubtfully, and chiefly by characteristics of the penial setae.

With the discovery of a *Barogaster* in a northern portion of the Madras Presidency it would appear as if the distribution of the genus may be of a horizontally band-like type straight across the Indian Peninsula like that of *Eutyphoeus* but further south.

Key to species of **Barogaster**

1.	*a.* Penial setae present	2.
	b. No penial setae	*prashadi.*
2.	*a.* Penial setae ornamented near tip with transverse rows or circles of fine spines ..	*barodensis.*
	b. Penial setae with no ornamentation of circles of fine spines	*annandalei.*

Barogaster annandalei (Stephenson).

1921. *Megascolides annandalei* Stephenson, *Rec. Ind. Mus.* XXII, p. 757 (Type locality Dowlaishweram, Godaveri district, Madras Presidency. Types in the Indian Museum.)

1923. *Megascolides annandalei*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 196.

Material examined.—From the Indian Museum : 5 clitellate specimens labelled, "*Megascolides annandalei* Steph. Types. Dowlaishweram, Godaveri district 29.viii.18. Dr. N. Annandale. W 562/1."

External characteristics.—Length 95-115 mm. Diameter four to five mm. The prostomium is retracted, prolobous, the posterior end marked off from i by a definite transverse groove. A slight but equally distinct groove extends across the whole length of i along the mid-dorsal line.

Setae begin on ii ; on xxii $ab<cd<bc<aa$.

The clitellum is annular, extending from 12/13 to 17/18, (possibly lacking ventrally on a portion of xvii on one or two specimens); intersegmental furrows and dorsal pores lacking, setae present. Transversely placed groove-like depressions ventrally on two specimens at approximate sites of intersegmental furrows may be contraction artefacts or may indicate incompleteness of development or slight regression of clitellar glandularity.

Spermathecal pores are minute and superficial, on *b*. Intersegmental furrow 7/8 is usually lacking ventrally (in *aa*) and certainly appears, on some of the specimens at least, to be dislocated anteriorly (region of *ab*) just in front of the spermathecal pores. The apertures are in line with the undislocated portion of 7/8 as well as the midventral portion when the latter is recognizable.

The single female pore is median, just in front of the setal arc of xiv.

Male pores are minute and superficial, about on *b*, each pore on a small and slight elevation which may have the appearance of a rather flattened cone. Between the male pores segment xviii is slightly depressed.

Genital markings are probably as in *barodensis* but on these specimens are represented by tiny, transversely placed, opaque and white patches of shortly elliptical to spindle-shaped outline. The margins of the markings are rather indistinct but the opacity of the patches, after removal of the cuticle, is rather conspicuous against the yellowish background of the rest of the worm. Postclitellar markings are in two transverse rows on xviii between the male pore lines, one row presetal, and one postsetal, the numbers approximately as follows: 6-5, 4-4, 3-4, 4-3 or 4, 4-5 (the first number presetal, the other postsetal in each case). In addition, on the last specimen there are two further presetal markings on xviii nearer to 17/18 than the usual row and one or possibly two markings just in front of 17/18 in the left half of *aa*. Further (but slightly smaller ?) markings are probably present on two or possibly three of the specimens in the region between the spermathecal pore lines, on the posterior margin of vii and the anterior margin of viii.

Internal anatomy.—The oesophagus is rather wide in iv. The two gizzards are in v-vi (3). In vii-ix the oesophagus is narrow, widened from x posteriorly. The inner wall in vii through x is provided with numerous low, white, longitudinal ridges, in xi-xiv with fewer and larger but also longitudinal ridges. Calciferous glands are paired in xi and xii, each gland a vertically placed, rather ovoidal sac, constricted off from the oesophagus, pendent well below the level of the ventral face of the gut and not reaching above the level of the dorsal face of the gut. A very short stalk passes from the dorsal pole into the dorso-lateral aspect of the oesophagus, the opening roughly circular, the openings of a side about one half mm. apart. The lamellae are few, mostly horizontal, small, but rather thick, attached mesially and to the anterior and posterior walls of the sac, the lateral wall without such attachments. The valve is at the region of attachment of septum 14/15 but the portion of the intestine in xv is slightly narrower than that behind and deeply constricted off posteriorly by 15/16. The typhlosole begins abruptly in xxvii (?, 1) or the region of xxviii-xxix (?, 1) and is continued through

the last grid segment. From xv to the beginning of the typhlosole there is a very low but definite white ridge. The typhlosole is zigzagged rather regularly and in one specimen the ventral margins of the folds appear to be united alternately as in *Eutyphoeus*. The grid begins in lxi (1) or lxxxvi and extends through six+(posteriorly damaged specimen) or ten segments. On the ventral face of the grid there are visible on each side of the typhlosole several ridges rather regularly zigzagged in a longitudinal direction, the height of the ridges decreasing gradually in a lateral direction, the medianmost ridge on each side not as high as the typhlosole. At fairly regular intervals the ridges come into contact with each other and unite, producing a grid-like or honey-comb appearance when the grid is stretched laterally. In at least the type the grid region is recognizable, without opening the gut, as a whitening of the dorsal wall. As a result of septal constrictions the whitened area has an appearance of being marked off into supra-intestinal glands.

The dorsal blood vessel (single) is continued anteriorly to the pharyngeal bulb. A supra-oesophageal vessel is present between 7/8 and 12/13 or 13/14. Extra-oesophageals are first recognizable just anterior to 4/5 and pass posteriorly ventrolateral to the gut, and in xi onto the ventral face of the gut where they turn onto the median faces of the calciferous glands of that segment. A short vessel passing on the ventral face of the gut from the median face of the anterior gland to the median face of the posterior gland and in the form of an arc of a parenthesis with the concave side laterally, may be a posterior continuation of the extra-oesophageal. No subneural trunk. Lateroparietal trunks not found. Hearts of x-xii bifurcate dorsally, one branch of each heart passing into the dorsal trunk, the other branch (in xi and xii), after uniting with a vessel from the dorsal pole of the calciferous gland, opening into the supra-oesophageal trunk. The anterior branches of the hearts of x open directly into the supra-oesophageal. Hearts of ix join the dorsal trunk only. Hearts of ix-xii open into the ventral trunk.

A vertically placed mass of closely crowded parietal nephridia is present on each side of iii. Preseptal funnels on the enlarged median nephridia of posterior segments were not found in two specimens probably as a result of poor condition. In the third specimen preseptal funnels are definitely present.

Male funnels of x and xi are large but have practically no spermatozoal iridescence. Seminal vesicles were not found in x and if present were imbedded in hardened coagulum that filled the coelomic cavity. The male deferent ducts after dropping to the parietes in xi and xii pass straight laterally for a short distance before turning, almost at right angles, to pass posteriorly again, the posterior duct crossing the anterior duct in xii and turning posteriorly only some distance lateral to the anterior duct. Passing through xiii the ducts of a side gradually approach each other and come into contact but do not unite, opening into the anterior face of the prostatic duct within the parietes, one just above the other. The prostates extend through xviii-xix. The duct is slender, with muscular sheen, about $1\frac{1}{2}$ mm. long. Two penisetal follicles are present on each side, one passing into the parietes on the

median face of the prostatic duct, separated from the median follicle by a thin vertical band of (muscular ?) tissue. Discrete openings of penisetal follicles externally have not been found and presumably are lacking, the united prostatic and deferent ducts opening to the exterior together with the follicles.

The shaft of the penial seta is curved in a wide arc. An ectal portion is slightly widened and flattened and tapers to a bluntly squared ending. Ornamentation, at least of an ordinary toothed type, is lacking though a few very slight notches may be visible at the margins near the ectal end. On rolling the seta over these notches are found to correspond to transversely placed, very fine ridges that look as if they might be slight wrinkles. Measurements in mm. of the setae are shown below.

PENIAL SETAE.

—	Side.	Seta.	Stage.	Length.	Thickness at a level 10 micra from ectal margin.	Thickness at neck (1).	Maximum thickness.	Distance of level of maximum thickness from ectal margin.	Thickness at base.
Specimen 1		..	f	0·58	0·007	..	0·016	0·032	0·021
		..	r	0·46	0·010	..	0·019	0·015	0·015
		..	r	0·47	0·006	..	0·014	0·015	0·028
		..	f	0·63	0·007	..	0·015	0·030	..
		..	r	0·16	(3)	..	..	..	..
		..	f	0·58	0·009	..	(4)	..	0·020
		..	r	0·50	(3)	..	..	..	..
Specimen 2	r	*a*	f	0·59	0·007	0·012	0·017	0·035	0·010
		a	r	0·37	0·015	0·015	0·019	0·040	0·020
		b	f	0·63	(2)0·009	0·015	0·019	0·030	0·012
	l	*a*	f	..	(3)	..	..	..	..
		a	r	0·47	0·010	0·013	0·022	0·040	0·017
		b	f	0·62	(2)0·009	0·014	0·022	0·040	0·014

(*f*) functional seta.
(*r*) reserve seta.
(1) narrowest region behind thickened portion.
(2) no reserve seta in this follicle.
(3) tapering gradually from base to tip, no thickened ectal portion.
One follicle was lost, two follicles apparently have no reserve seta, one follicle has two reserve setae, and one seta, apparently functional (4) has no ectal widening.
(4) Measurements and description by Miss Chapman.

The spermathecal ampulla is slightly longer than the duct from which it is clearly demarcated. The duct has a muscular sheen and is slightly widened entally, elliptical in transverse section but shortening ectally to become almost circular within the parietes. The lumen is irregular due to the presence of several fairly high longitudinal ridges. One of these ridges may be higher than the rest and practically or completely cleft by a deep furrow. The diverticulum may be anteroposteriorly flattened or rather berry-shaped and is adherent to the median face of the duct, reaching nearly to the parietes to which it is connected by a short cord. The diverticulum opens into the entalmost portion of the duct by a single aperture, the ridged wall fairly thick for a diverticulum and containing spermatozoa in an arborescent mass, the ends of the branches enlarged as if contained within small, ellipsoidal chambers.

The longitudinal musculature is uninterrupted over sites of the genital markings.

Remarks.—Although two specimens are characterized as " dissected " above, only one referred to as the type, had been dissected anterior to the clitellum. The other although opened by a mid-dorsal incision had never been pinned out from the clitellar region anteriorly. This specimen was so brittle that an attempted dissection was most unsatisfactory. A third specimen was soaked in water for several hours and then dissected completely. (An ordinary museum specimen of earthworm is often in poor condition even for taxonomic study. Strongly contracted so that external structures are distorted, the cuticle firmly adherent in such a way that certain important external characteristics are unrecognizable, the integument discoloured yellow or brown by the alcohol which often makes the bodywall transparent so that other important external characteristics are unrecognizable even after removal of the cuticle. Often with the appearance of good preservation externally a specimen may be brittle and extremely difficult to dissect. Though the integument is hard the intestine may be macerated. As a result even careful handling results in rupture of the bodywall. Use of formalin obviates some of these difficulties. Specimens in the author's collection are still in good condition after fifteen years of formalin preservation though somewhat softened. Some slight softening is advantageous and certainly preferable to brittleness.)

B. annandalei is distinguished from *B. barodensis* by the restriction of the postclitellar genital markings to xviii, the arrangement of those markings in a presetal and postsetal row, and by the absence of ornamentation of circles of teeth on penial setae.

Diagnosis.—Male pores on *b*. Spermathecal pores on *b*, on anterior margin of viii (?). Genital markings tiny transversely placed areas of translucence, in one presetal and one postsetal transverse row on xviii in *bb*. Additional markings occasionally present in *bb* on the posterior margin of vii and the anterior margin of viii. Clitellum 12/13 to 17/18. Setae : $ab<cd<bc<aa$, $dd>\frac{1}{2}$ C. First dorsal pore on 12/13. Prostomium prolobous, a mid-dorsal groove across the whole length of i. Length 95-115 mm. Diameter 4-5 mm.

Holandric, seminal vesicles in ix and xii. Penial setae 0·58-0·66 mm. long, thickness 10 micra from tip 0·007-0·009, maximum thickness

(at 0·032-0·040 mm. from ectal end) 0·016-0·022, at neck 0·012-0·015, at base 0·010-0·021 mm. shaft curved in a wide arc, an ectal portion slightly widened, flattened and tapering to a bluntly squared ending. Spermathecal duct shorter than the ampulla and with longitudinal ridges on inner wall, diverticulum opening into median face of duct entally by a single aperture, lumen arborescent with several small seminal chambers. Longitudinal musculature uninterrupted over sites of genital markings.

Distribution.—Known only from the type locality, Dowlaishweram, Godaveri district, Madras Presidency.

Barogaster prashadi (Stephenson).

1920. *Megascolides prashadi*, Stephenson, *Mem. Ind. Mus.* VII, p. 202. (Type locality Sakawari, Satara district, Bombay Presidency. Type in the Indian Museum.)

1923. *Megascolides prashadi*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 201.

Material examined.—From the Indian Museum: 1 clitellate specimen labelled, "*Megascolides prashadi* Steph. Type. Sakawari, on the way to Mahableshwar, Satara district, Bombay. 4.vii.17. Dr. B. Prashad. W 291/1".

External characteristics.—A short posterior portion of four to six segments is unusually slender, and with an appearance of being a regenerate, possibly not normal.

Setae begin on ii; lacking or invisible ventrally on xvii-xviii. On the left side of xix *a* is present though retracted into the tissue of the genital marking and scarcely visible, *b* of the same side clearly visible at the anterior margin of the genital marking cushion, ventral setae of the right side unrecognized but possibly retracted and invisible. All ventral setae of xx are present.

The clitellum is annular, probably lacking ventrally on xvii; intersegmental furrows and dorsal pores lacking, setae present.

Spermathecal apertures are tiny, almost minute, transversely placed slits, probably on site of 7/8, just lateral to *b*. A flat and rather band-like circumferential lip is marked off and on this lip the intersegmental furrow is lacking. The inner margin of the band, around the aperture, is clear white and thus contrasted to the more creamy appearance of the peripheral portion of the lip.

The single female pore is median and on or perhaps immediately in front of the setal arc of xiv.

Male pores are minute, circular, open, at sites of *b*, on xviii, located on a transversely placed area of marked epidermal thickening. The area is narrowed mesially, widened laterally, reaching into *bc* but indistinctly delimited laterally.

Genital markings are probably, as in *barodensis*, tiny, transversely placed, slightly depressed areas of greyish translucence but all that can be definitely recognized now are rather indistinctly demarcated and transversely placed depressions. These are located on areas presumably of marked epidermal thickening, (papillae according to Stephenson). One such area with bluntly rounded lateral margins extends the whole length of xvii and laterally reaches slightly into *bc*. On this area and along the setal arc are seven markings. The cushion of xix is nearly symmetrical, reaching to *b* on the right side and slightly lateral to *b*

on the left side. With a *b* seta on its anterior margin this area may be regarded as primarily postsetal. A slight, transversely placed depression possibly contains five genital markings. Markings were not noted on the asymmetrical cushion of xx. Further markings, possibly four, are present on a posterior portion of viii just in front of 8/9.

Internal anatomy.—Gizzards are in v and vi, both equally well developed. There are two pairs of calciferous glands, in xi and xii. Each gland is constricted off from the gut, shortly stalked, pendent below level of the ventral face of the gut and opening into gut lumen by a small dorsolateral aperture. The typhlosole is fairly well developed and zigzagged, terminating posteriorly with a " grid " as in *barodensis*. The grid is a thickening of the roof of the gut on the ventral face of which there are visible closely crowded, low, longitudinal ridges. The grid begins *ca.* in lxx.

The dorsal blood vessel (single) is continued onto the pharyngeal bulb. A supra-oesophageal has not been found. Extra-oesophageals are present but cannot be traced. A subneural trunk is lacking. Hearts of x-xii bifurcate dorsally, one branch passing to the dorsal trunk, the other to the dorsal aspect of the oesophagus.

Parietal nephridia of iii are massed into a band as in *barodensis*. In the posteriormost segments each enlarged, median nephridium is provided with a slender neck which can be traced to the septum in front close to the region of the nerve cord. On the anterior face of the septum, just in front of each neck, is a macerated protuberance that looks like and probably is a funnel.

Male funnels of x and xi have a brilliant pink and yellow iridescence. Testes were not found. Male deferent ducts have not been traced nor identified posteriorly with certainty but it is quite obvious that no deferent duct rises from the parietes to pass into an ental portion of the prostatic duct. On the contrary what appear to be deferent ducts pass into the anterior face of the prostatic duct within the parietes. The prostatic duct is $1\frac{1}{4}$ mm. long, slender, with muscular sheen.

Just median to the prostatic duct is a definite though small gap in the longitudinal musculature, a similar gap further mesially. These gaps are so distinct that presence of penial setae might be suspected but no traces of follicles are recognizable.

The longitudinal musculature is uninterrupted over sites of the genital markings.

The spermathecal ampulla is a flattened, nearly empty sac, irregularly wrinkled and folded. The duct which is sharply marked off from and only a trifle shorter than the ampulla is relatively rather slender, with slight muscular (?) sheen, shortly elliptical (almost circular) in transverse section. The lumen is fairly large and irregular in cross section due to the presence of longitudinal ridges on the inner wall of the duct. The diverticulum is anteroposteriorly flattened and vertically placed, adherent to the median face of the duct entally, slightly longer than half the length of the duct, connected to the parietes by a cord of tissue from the ectal end. The cavity is divided up into several chambers by ridges on the inner wall and opens into the duct by a single aperture at the ental end. There is no spermatozoal iridescence.

Remarks.—The type is in poor condition. The intestine is macerated and in part lacking, having been removed in the previous dissection from 14/15 posteriorly for a short distance and from lxxi or thereabouts posteriorly. As a result characterization of typhlosole and grid is incomplete. Fortunately the cut made in removing the posterior portion of the gut passed through the second " grid " segment so that recognition of this peculiar and generically characteristic structure is possible. The vascular system cannot of course be adequately characterized from a unique specimen that must be preserved as a type.

The type obviously is a *Barogaster* but determination of the status of the species, *prashadi*, is more difficult. Differences from *barodensis* mostly appear to be trivial. Genital markings which might provide clues for specific distinction are scarcely recognizable perhaps as a result of the method of preservation. If *prashadi* is really a penisetal this characteristic will satisfactorily distinguish the species from the penisetal *barodensis*. Although unknown from any Indian species, discharge of penial setae after sexual maturity has been recorded from certain South African forms by Pickford. The presence of distinct gaps in the longitudinal muscles just median to the prostatic duct at sites where penisetal follicles should be located if present as in *barodensis* may indicate that such discharge had taken place in the type of *prashadi* prior to collection. But in these circumstances should we not expect to find the follicles which are to produce the next season's functional setae ? Or does absence of these follicles indicate only that the gaps in the musculature mark sites of follicles of setae lost permanently prior to attainment of sexual maturity ?

XI. *TRAVOSCOLIDES, GEN. NOV.*

INTRODUCTORY NOTE.

A group of four south Indian species of *Megascolides* from Travancore and Cochin, with reservations as so one form, are distinguished from other Indian species hitherto included in the genus by important characteristics of excretory and digestive systems. The same characteristics probably also distinguish these species not only from the Australasian and American forms of *Megascolides* but also from other Indian *Megascolecid* genera. Thus distinguished the group appears to deserve generic status.

Travoscolides, gen. nov.

Diagnosis.—Male pores (combined apertures of prostatic ducts and penisetal follicles) on xviii, in or close to *ab*. Female pores paired on xiv. Quadrithecal, spermathecal pores on or close to *a*, on or near 7/8-8/9. All reproductive apertures minute and superficial. Clitellum annular (intersegmental furrows, dorsal pores and setae ?). First dorsal pore on 11/12. Setae lumbricine ; ventral setae of xviii penial and in closely paired follicles. Prostomium prolobous ? Pigmentation ?

Septa present from 5/6. Gizzard in v. Calciferous glands four pairs in x-xiii, rather reniform, concave side mesially, reaching below level of ventral face of gut and mesially, opening by short and slender stalks from ventral ends into gut slightly lateral to midventral line. Intestine begins in xv ? Typhlosole simple, lamelliform (from xxiv-xxv to lxiv-cl). Hearts latero-oesophageal in x-xiii. Supra-, extra-oesophageal and lateroparietal trunks ? Excretory organs : closed (?), (enteronephric or exonephric ?) micronephridia in vertically placed clusters on anterior faces of 5/6-13/14 ; from xv posteriorly closed (?), (enteronephric or exonephric ?) micronephridia on posterior faces of the septa. Holandric, seminal vesicles in xi-xii. Prostates tubular. Male deferent ducts opening into ental ends of prostatic ducts ? Spermathecae with elongately sausage-shaped ampullae and very short ducts, diverticulum disc-shaped, shortly stalked and with arborescent lumen.

Genotype.—Megascolides chengannures Aiyer 1929. This species is designated as the genotype in view of the fact that it alone is known from more than one specimen. Also the types are probably in better condition than those of other species.

Distribution.—Known only from two localities in Travancore and Cochin and up to elevations of perhaps 2,300 feet.

Remarks.—Negative characteristics not mentioned in the diagnosis are absence of a subneural trunk and of genital markings.

Relationships of the calciferous glands to the gut and the (apparent) restriction of the micronephridia to septal locations distinguish *Travoscolides* from all other Indian genera.

The Australasian and American sections of the genus *Megascolides* are heterogeneous aggregates of inadequately characterized species the relationships of which are most dubious. Not all of the literature is available locally (and in particular a recent paper on American Megascolecids of the Pacific Coast) but, so far as can be determined at present *Travoscolides* is distinguished from *Megascolides* by nephridial characteristics, the presence of calciferous glands or by the segmental location of those glands. Revision of Australasian and American forms will probably reveal additional differences of less importance.

The definition above is of course only tentative and contains several statements that usually are of specific value only.

Excretory organs are apparently always septal, in preseptal clusters in v-xiii, discrete and postseptal from xv posteriorly. The postseptal nephridia appear in part to be enteronephric and in part exonephric but condition of the worms is such as to prevent more than a guess at the nature of the endings of the tubules.

Pheretima, another purely micronephridial genus, also has septal nephridia but these are open, enteronephric and located on both sides of the septa. Numerous integumentary nephridia are also present.

At present the four species can be distinguished from each other, and somewhat doubtfully, only by the penial setae. Although adequate specific diagnoses are impossible a key, based on penisetal characteristics, is presented herewith.

Key to species of Travoscolides.

1.	*a.* Penial setae about 0·3 mm. long	2.
	b. Penial setae 0·57-0·82 mm. long	3.
2.	*a.* Shaft terminates ectally with a hair-like spine hooked to one side	*cochinensis.*
	b. Shaft does not terminate in a spine ..	*chengannures.*
3.	*a.* Ectal termination of shaft simple and bluntly rounded, ornamentation of scattered teeth ..	*duodecimalis.*
	b. Ectal termination " bayonet-shaped ", flattened and markedly hollowed, no ornamentation	*pilatus.*

Travoscolides chengannures (Aiyer).

1929. *Megascolides chengannures* Aiyer, *Rec. Ind. Mus.* XXXI, p. 54. (Type locality Chengannur, Travancore, South India. Types ? One cotype or paratype in the Indian Museum.)

Material examined.—From the Indian Museum: 1 aclitellate, undissected specimen labelled, " *Megascolides chengannures* Aiyer. Type. Chengannur. 15.xi.26. K. S. P. Aiyer. W 1514/1".

External characteristics.—The prostomium appears to be prolobous, broad, demarcated posteriorly by a fairly deep, transverse groove. From the groove forming the posterior margin of the prostomium several short furrows run posteriorly on i, two of these near the mid-dorsal line slightly better developed than the others.

Quadrithecal, spermathecal pores minute and superficial, on viii-ix, on or close to *a*, on very slight protuberances, on presetal secondary annuli and about equidistant from the intersegment furrows and the presetal secondary furrows.

The *a* setae of viii and ix, right *a* and *b* and left *a* of vii are lacking.

The first dorsal pore is probably on 11/12.

Paired female pores.

A transversely placed and slightly depressed, indistinctly demarcated area of translucence extends from 18/19 to just behind the setae of xvii and reaches laterally on each side about to mid *bc*. On this area are two slightly raised opaque patches extending anteroposteriorly between levels of 17/18 and 18/19 and reaching from a lateral portion of *aa* into a median portion of *bc*. Close to the median margin of each patch and about on the *a* line is a definite, (seminal ?) groove with anterior and posterior ends curved laterally. Male pores (combined openings of prostatic ducts and penisetal follicles) are probably represented by minute pits in *ab*, on the setal arc just lateral to the grooves and possibly connected with the grooves by slight furrows, the pits on tiny, rather conical but basally undemarcated protuberances.

Internal anatomy.—Calciferous glands are anteroposteriorly flattened, slightly reniform with the concave side mesially and against the gut, the dorsal poles not reaching above the level of the dorsal face of the gut, the ventral ends reaching well below the level of the ventral face of the gut and curved towards the median plane. From the ventral end of each gland a short, slender stalk passes to the ventral aspect of the gut slightly lateral to the median plane. Openings of the calciferous glands were not recognized and probably are small. The oesophagus has something of an appearance of a valve, the walls in contact mesially,

at 13/14. No valve is recognizable posteriorly and if present must have been so relaxed as to present an appearance like that of the intestine. The section of the gut in xiv is not quite as wide as that in xv. The typhlosole begins abruptly in xxiv-xxv and is low, simply lamelliform, in part zigzagged rather regularly, terminating abruptly in cxlix. A very slight ridge passes anteriorly from the typhlosole into xv. Intestinal caeca and supra-intestinal glands are lacking.

The dorsal blood vessel (single) is continued forwards at least to the front end of the gizzard. No subneural. Supra-oesophageal and extra-oesophageal trunks were not found but may be present. Hearts of x-xiii bifurcate dorsally, one branch passing to the dorsal trunk the other branch uniting with a large vessel from the calciferous gland, the united vessel passing mesially and midsegmentally across the gut to unite with a similar vessel from the other side. (After removal of the dorsal trunk and hearts there is visible a large blood filled vessel passing midsegmentally straight across the gut from the calciferous gland of one side to that of the other.) This apparently intercalciferous vessel may only represent a pair of branches from a supra-oesophageal trunk, but the latter is totally unrecognizable and in the median plane above the gut there is visible only colourless, transparent tissue with no resemblance to a blood vessel.

From vi-xiii nephridia are in paired, vertically placed clusters flattened against the anterior faces of the septa. In v the cluster on each side is much enlarged and alongside the gizzard, attached only to 5/6 by a short cord from the posterior (dorsal ?) pole. From xv posteriorly the nephridia are not clustered but are attached separately to the posterior faces of the septa. From the point of septal attachment of each tubule an opaque thread on or in the very delicate septum may pass mesially towards the gut. Occasionally these threads appear to run dorsally along the septum close to the intestine. Similar threads may however pass along the septum peripherally. In the posterior-most segments a cluster of nephridia is present on the parietes in region of *ab*. Ducts of some of these tubules apparently pass to and through the septum and to the parietes some distance in front of the septum.

In a sheet of connective tissue that passes from the parietes to the ental end of the prostatic duct there are two opaque, white, thread-like cords that probably are deferent ducts. On the median face of the prostatic duct within a slight gap in the longitudinal musculature there are two small penisetal follicles, the ental ends of the follicles just visible at the level of the coelomic surface of the integument, the two follicles probably separated by a longitudinal strand of tissue. A seta probably from the *a* follicle is about 0·33 mm. long, maximum thickness *ca.* 0·015 mm. Midway between base and tip the setal shaft is widest and at that region with a slight resemblance to a nodulus. Ental to the nodulus the shaft is curved but ectally is nearly straight. Near the ectal end one side is flattened, the opposite side convex and with a trace of a very slight, longitudinally placed groove at the tip. No terminal spine.

The spermathecae are elongately sausage-shaped. A very short portion just prior to entrance into the parietes slightly narrowed, with thick wall and narrow lumen probably is a duct. Attached to the

anterior face of the duct and in contact with the parietes is a flattened, disc-like diverticulum with slightly incised margin. No spermatozoal iridescence is recognizable. On microscopic examination the diverticulum appears to be incompletely separated into two lobes in which there are recognizable four and seven slightly brownish or yellowish (as contrasted to the white diverticular wall) translucent areas of shortly elliptical outline. With high power, striations are recognizable that indicate the presence of spermatozoa—in arborescent masses, the ellipsoidal chambers marked off by ridges or folds from the inner wall of the diverticulum.

In coelomic cavities of the last few segments there are several brown discs.

Remarks.—If spermatozoa are present in the spermathecal diverticula the worm is presumably in a postsexual aclitellate stage. If functional penial setae are discharged after sexual maturity the seta described above may not be fully developed.

As there are no other specimens of this species in the Indian Museum dissection was not completed, in particular the spermathecal and prostatic ducts were not traced through the parietes to the probable sites of the apertures.

Distribution.—Known only from the type locality, Chengannur, Travancore.

Travoscolides? cochinensis (Michaelsen).

1910. *Megascolides cochinensis* Michaelsen, *Abh. Nat. Ver. Hamburg*, XIX (5), pp. 9 and 56. (Type locality Foot of Nelliampathis Hills, Cochin State! Type in Hamburg Museum ?)

1923. *Megascolides cochinensis*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 198.

Remarks.—This species is known only from a " sehr stark erweichtes, im Innern fast mazeriertes Exemplar" Even if the specimen could have been obtained for study, after thirty years of further softening, it is possible if not probable that definite evidence as to the generic status of the species would be unobtainable.

Michaelsen notes that the gizzard is doubtfully in vii, calciferous glands " scheinen zu fehlen", excretory organs are micronephric " im Vorderkörper ", and that the first dorsal pore is on 9/10. Aside from this information of dubious value, there is nothing in the anatomy or distribution to contraindicate generic identity with other species now referred to *Travoscolides*. On the contrary an elongately sausage-shaped main spermathecal axis with little or no external demarcation of duct and ampulla (*vide* pl. fig. 5) at present seems to be characteristic of *Travoscolides* and therefore may be regarded as positive evidence for the generic identification just suggested.

No mention is made by Michaelsen of septa 5/6 and 6/7. If 6/7 were adherent to 7/8 as is actually the case in one of the specimens just examined it would then appear as if the gizzard were just in front of 7/8 for with maceration 5/6, which is membranous and delicate in better preserved specimens, would probably be unrecognizable. In one of the specimens just examined calciferous glands are rather fragile and ruptured even on careful manipulation. In a more advanced stage of

maceration it is possible that jolting incident on the trip from India to Germany would have been sufficient to destroy the glands so as to leave no recognizable evidence of their former presence.

In these circumstances provisional transfer of *cochinensis* to *Travoscolides* does not appear to be unreasonable. The small, unornamented penial setae suggest close relationship to *chengannures*.

Travoscolides duodecimalis (Stephenson).

1915. *Megascolides duodecimalis* Stephenson, *Mem. Ind. Mus.* VI, p. 65. (Type locality Parambikulam, Cochin State, South India. Type in Madras Museum ?)

1923. *Megascolides duodecimalis*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 198.

Remarks.—Apparently distinguished from *chengannures* by the intestinal origin in xvi, and the larger penial setae, from *pilatus* by the paired male porophores, the ornamentation and different shape of tips of the penial setae.

Distribution.—Known only from the type locality, Parambikulam, Cochin.

Travoscolides pilatus (Stephenson).

1915. *Megascolides pilatus*, Stephenson, *Mem. Ind. Mus.* VI, p. 68. (Type locality Parambikulam, Cochin, South India. Type in the Indian Museum.)

1923. *Megascolides pilatus*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 200.

Material examined.—From the Indian Museum : 1 aclitellate dissected specimen labelled, " *Megascolides pilatus* Steph. Type Parambikulam, 1,700-2,300 feet. Cochin State. 16-24.xi.1914. F. H. Gravely. ZEV 6919/7".

External characteristics.—Spermathecal pores are probably on *a* just behind 7/8 and 8/9.

Male pores are unrecognizable but are to be located on a transversely placed area of epidermal thickening (?) extending anteroposteriorly from 17/18 to 18/19 and laterally on each side nearly to *c*, slightly wider posteriorly than anteriorly. Penial setae of the right side are protuberant from the region of *ab* and presumably mark the site of the male pore.

Internal anatomy.—The typhlosole begins about in xxiv, is unrecognizable behind lxiv (at least 85 mm. from hind end) and is low, simply lamelliform. The typhlosole is continued anteriorly from xxiv as a very low white ridge.

No subneural vessel. Parietal nephridia posteriorly, if present, are not recognizable as such. In a strongly contracted specimen in poor condition as in the present worm septal nephridia might be adherent to the parietes with septal connection unrecognizable.

Prostates are juvenile. Seminal vesicles and male funnels not found. Male deferent ducts cannot be traced.

Spermathecae are probably juvenile. The ampulla and duct are of about the same length, the ampulla slightly wider, and distinguished from the duct by the greater width of the lumen. A disc-shaped body on the anterior face of the septum close to the parietes with a stalk that passes through the septum and into the anterior face of the duct ectally is almost certainly a diverticulum though gelatinized so that a structure

is unrecognizable. The diverticulum is practically invisible from the spermathecal side of the septum though readily visible anteriorly.

Remarks.—Until mature and preferably clitellate specimens have been studied the species cannot be satisfactorily characterized. For the present *pilatus* seems to be distinguished from *chengannures* by the unpaired male genital shield, possibly also by the intestinal origin in xvi and by the larger and ornamented penial setae. Further information is necessary as to development of the penial setae and variability in their length, shape and ornamentation before the latter characteristics can be safely used for discriminating between these two species.

Distribution.—Known only from the type locality, Parambikulam, Cochin.

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FURTHER NOTES ON CRUSTACEA DECAPODA IN THE INDIAN MUSEUM.

X. On Two Species of Hermit Crabs from Karachi.

By B. Chopra, *D.Sc.*, *F.N.I.*, and K. N. Das, *M.Sc.*, *Zoological Survey of India, Calcutta.*

In connection with his work on the spermatogenesis of certain Indian crabs and hermit crabs, Dr. Vishwa Nath of the Zoology Department of the Punjab University sent to us for identification a small collection that he had made at Karachi on the Arabian Sea coast of India, in September, 1938. In addition to the specimens that he needed strictly for his own work, Dr. Vishwa Nath also made, at the request of one of us, a general collection, chiefly of crabs, for the Indian Museum. The collection for the most part consists of species of crabs that are already known to occur commonly in Indian waters, but the two species of hermit crabs that he brought back have proved of special interest; one is new to science, and the second, in addition to being somewhat rare, is recorded from India for the first time. The present note deals with these two hermit crabs only.

The specimens that Dr. Vishwa Nath needed for his cytological work had necessarily to be dissected for the removal of gonads, but this was done with as little injury to the animals as possible. Wherever practicable one or more examples were left undissected also. The collection on the whole is very well preserved.

We are grateful to Dr. Vishwa Nath for giving us an opportunity of examining his collection, as also for presenting a lot of valuable material to the Indian Museum.

Family Paguridae.

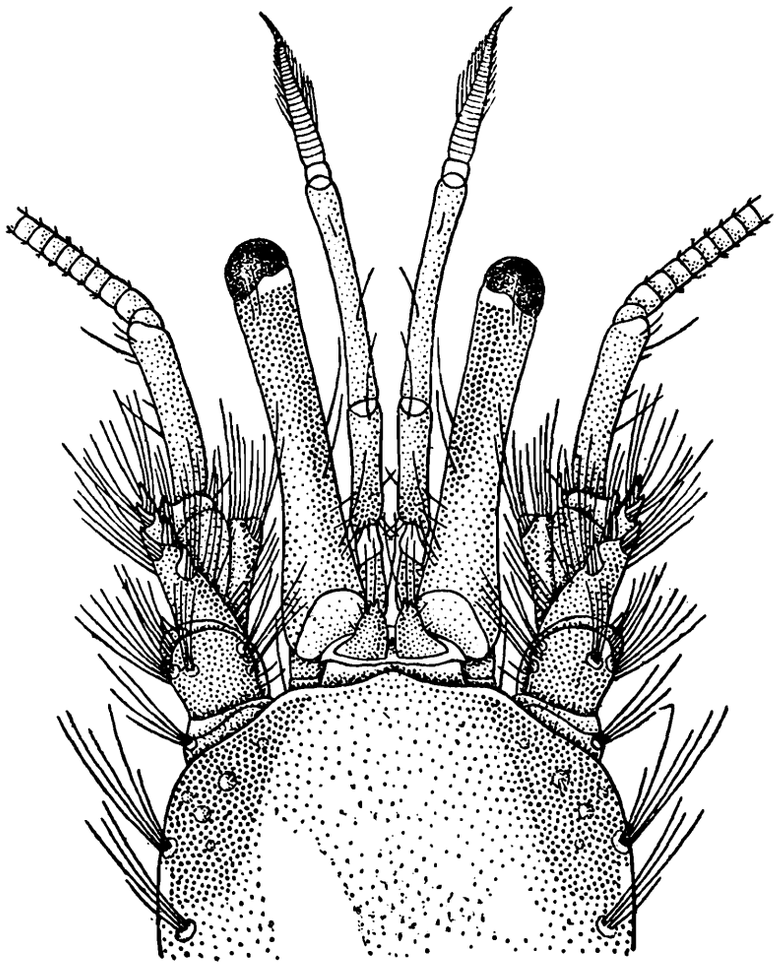
Clibanarius nathi[1], sp. nov.

The new species is represented in the collection by three examples only.

The greatest breadth of the carapace is about two-thirds of its length in the median line. The portion in front of the cervical groove is rectangular in shape, and the antero-lateral angles are markedly rounded, more so than the postero-lateral. The surface of the carapace is coarsely punctate, especially in the anterior half. All the margins, and particularly the lateral and the posterior margins of the posterior half of the carapace, are thickly beset with long, yellowish silky hairs. The rostrum (text-fig. 1) is very small, scarcely extends to the base of the ophthalmic scales, and is somewhat more prominent than the antero-lateral angles of the carapace. The frontal margin is slightly concave

[1] The species is named after the distinguished cytologist Dr. Vishwa Nath, who collected it.

on either side between the rostrum and the antennal angle, and from the latter point sharply slopes backwards and outwards to form the rounded antero-lateral margins. In the largest of the three specimens the rostrum and the antennal angles are less prominent than in the other two examples.

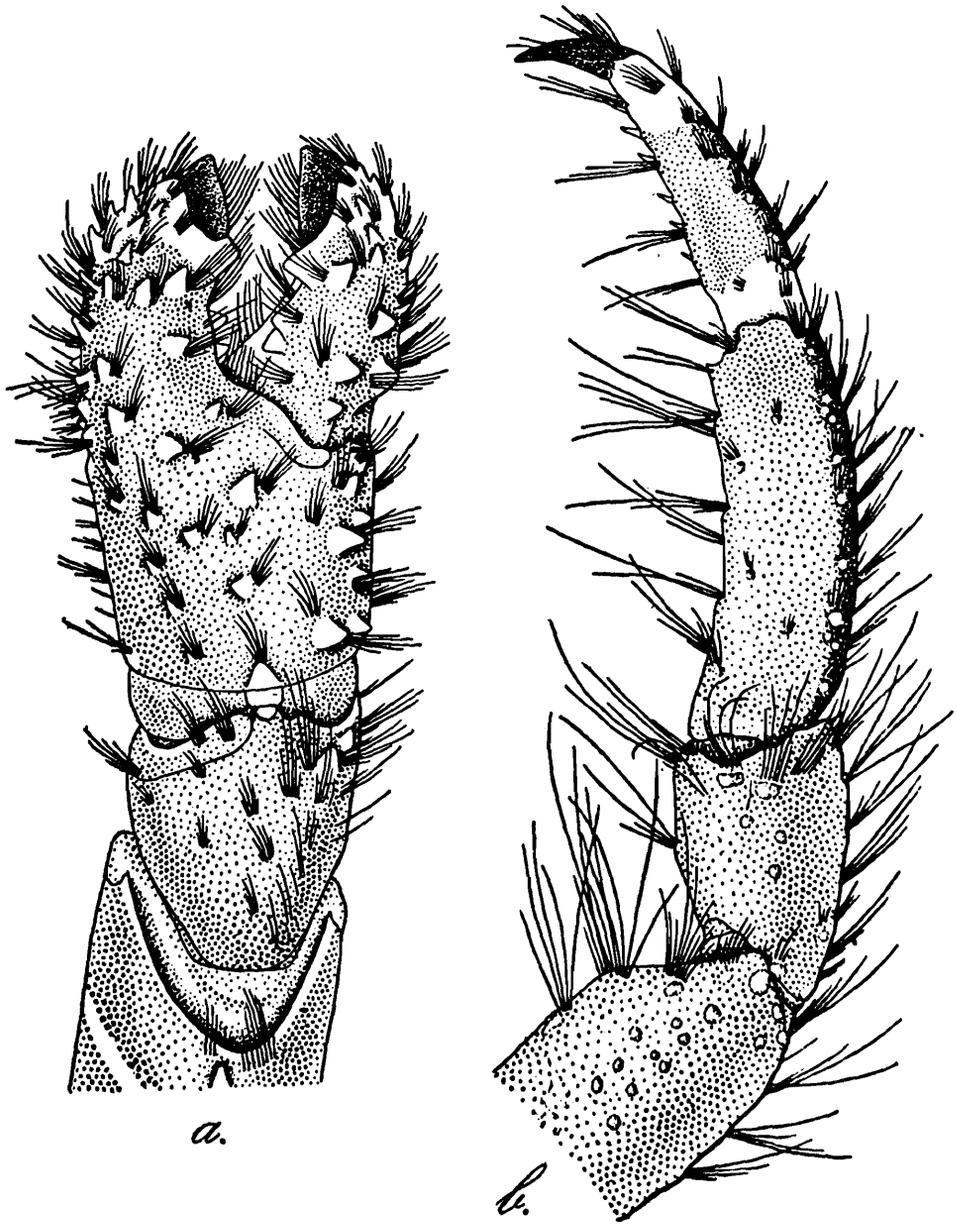


TEXT-FIG. 1.—*Clibanarius nathi*, sp. nov.
Anterior part of carapace, with eyes, antennae, etc.: × 8.

The eye-stalks are long and slender and the terminal cornea occupies a very small portion of the stalk. The eye-stalks are as long as the anterior border of the carapace and extend as far as the antennal peduncles. They are slightly shorter than the peduncle of the antennule, extending up to about two-thirds the length of the distal peduncular segment. The right eye is shorter than the left. There are a few long setae on the stalk, especially in the proximal half. The ophthalmic scales are well developed and lie close to one another; they bear three or four small teeth and some long setae on the anterior margins. The antennal peduncle is rather thickly setose and the acicle is similarly covered with setae. The latter extends up to the distal end of the second peduncular segment. This segment is distally broadened, has a lobe on its inner side, and a fairly prominent spine at its outer distal angle. The acicle also has a few sharp spines distally. The antennal flagellum is almost as long as the carapace.

The chelipeds (text-fig. 2*a*) are similar and subequal in size. They are considerably stouter and shorter than the next two legs, and are thickly studded on the hand with sharply-pointed, almost spine-like

tubercles, interspersed with stiff setae. The merus is flattened and has some scale-like markings only on its outer and upper surface and two sharp spinules at the far end of the outer lower border. The carpus has three or four tubercles on its inner border, increasing in size from the proximal to the distal end, the last one being very prominent. The hand, including the fingers, is thickly covered with sharp tubercles on its upper and outer surface, and there are a few similar tubercles on the other side also. The fingers open in a horizontal plane. They are broadly spooned at the tips, which are corneous. There is only a small gap left when the fingers meet. The under surface of the palm also is tuberculate, but the tubercles are rather low and blunt. All over the cheliped there are stiff setae, arising mostly in tufts.



TEXT-FIG. 2.—*Clibanarius nathi*, sp. nov.

a. Left cheliped, upper and outer view : × *ca*. 10.

b. Third leg of the left side : × *ca*. 8.

The second and third pairs of legs are longer on the right side than on the left. There are some low tubercles on the outer surface of the

merus, carpus and propodus of the third leg (text-fig. 2*b*) on both the sides, in addition to the stiff hairs, arising mostly in bundles, that are present on both the margins of all the segments. The merus of the second leg has a sharp spinule at the distal end of its lower border; this is more prominent on the right leg than on the left and is sometimes double. The carpus in both the pairs has a spine at the distal end of the upper border. The propodus of both the legs of the second pair and of the right leg of the third pair is subcylindrical, while that of the left leg of the third pair is markedly flattened and is somewhat carinate near its upper margin. The dactylus is flattened in both the pairs and bears 5-7 sharp spinules along its lower margin, the distalmost spinule being the largest of the series. The black corneous tip is prominent and is bent downwards. The dactylus, including the tip, is almost equal to the propodus in length.

The colour of the specimens preserved in weak formalin is rather characteristic. The anterior part of the animal is flesh-red in colour. In two specimens the anterior half of the cephalothorax is whitish, with a few reddish spots, including two prominent ones at the anterolateral angles; in the third example the ground colour in this part is reddish, obscurely speckled with white, and the spots are somewhat darker. The eye-stalks, antennular and antennal peduncles, the chelipeds and legs are all flesh-red, the chelipeds being deeper in colour than the other parts. The antennal acicles and the ophthalmic scales are tipped with white, and there is a white ring just behind the black cornea. The terminal segment of the antennal peduncle has a narrow, white, longitudinal stripe along its upper border. The tubercles on the chelipeds and sometimes the low tubercles on the third leg are also tipped with white. The dactylus of the second and third legs on both the sides has two prominent, broad, yellowish-white rings, one just in front of the propodal joint, and the other at the distal end, immediately behind the dark tip. The distal ends of the fingers of the chelipeds are markedly lighter in colour than the rest of the claw while the tips are black. The setae are brownish and the silky hairs on the margins of the carapace light yellowish.

The measurements, in millimetres, of the three specimens (I—III) in the collection are given below.

	I	II	III
Median length of gastric region of carapace	6·5	6·0	6·8
Median length of posterior part of carapace	5·5	5·0	6·0
Anterior breadth of carapace	4·9	4·5	5·0
Greatest breadth of carapace	7·8	7·2	8·0
Length of eye (stalk and cornea)	5·0	4·4	5·0
Length of antennular peduncle	5·4	4·9	5·5
Length of antennal peduncle	5·0	4·5	5·0

	2nd Right Leg			2nd Left Leg			3rd Right Leg			3rd Left Leg		
	I	II	III	I	II	III	I	II	III	I	II	III
Length of merus	7·0	6·0	7·2	6·2	5·8	6·5	6·3	..	6·5	5·5	5·0	6·0
Length of carpus ..	4·5	4·0	4·7	4·5	3·8	4·5	4·0	..	4·3	4·0	3·8	4·6
Length of propodus ..	7·1	6·0	7·0	6·4	5·5	6·5	7·0	..	6·5	5·4	4·8	5·0
Length of dactylus (including claw).	6·5	..	6·5	6·0	5·2	6·0	6·0	..	5·5	5·0	4·5	4·8

Locality.—The three specimens on which the foregoing description is based were collected by Dr. Vishwa Nath at low tide from the Rocky Ledge on the south coast of Manora Island, Karachi, in September, 1938.

Type-specimens.—C 2326/1, Zoological Survey of India (*Ind. Mus.*).

Clibanarius nathi seems to resemble rather closely *C. cruentatus* (M.-Edw.)[1], of which a single incomplete specimen from Mergui is preserved in the collection of the Indian Museum. This specimen has been fully described by de Man[2] and Alcock[3]. It is now altogether faded, the red colour having disappeared completely, but the characteristic white spots can be clearly made out. The arrangement of the white spots on the gastric region of the carapace is exactly as described by de Man. In our new species this part of the carapace is generally yellowish-white and has some reddish spots, of which the two at the antero-lateral angles are the most conspicuous. The two prominent white rings on the dactyli of the 2nd and 3rd legs in *C. nathi* have not been described in Milne-Edwards' species, either by Alcock or by de Man, nor can any trace of these be made out in the Mergui specimen that we have examined. In Filhol's[4] figure of *C. cruentatus* also no white rings are shown on the dactyli, though the arrangement of the white spots on the carapace is well brought out. The large white spots on the walking legs, present in *C. cruentatus*, are not seen in our species. In addition to these colour differences, there are some other points also in which the two species differ. In Milne-Edwards' species the eye-stalks are stout and are as long as, or even slightly longer than, the antennular peduncles; in the Karachi examples they are less stout and are shorter than the peduncles of the antennules. The carpus of the cheliped, in *C. cruentatus*, is smooth, except for a terminal spine at the distal end of the inner margin; in our species there are three or four tubercles in this position, the last two of which are quite large and conspicuous. Further, in our species the palm and the fingers are more densely spinose than in *C. cruentatus*. In the Mergui specimen of Milne-Edwards' species, that we have seen, the inner surface of the palm is quite smooth; in *C. nathi* it is distinctly tuberculate.

[1] Milne-Edwards, H., *Ann. Sci. Nat. Zool.* (3) X, p. 62 (1848).
[2] de Man, J. G., *Journ. Linn. Soc.* XXII, pp. 250-252 (1888).
[3] Alcock, A., *Cat. Ind. Mus. Decapod Crust.* Pt. II, fasc. 1, p. 50 (1905).
[4] Filhol, H., *Miss. de l'ile Campbell Zool.* III, p. 424, pl. lii, fig. 4 (1886).

The new species also shows a certain amount of resemblance to *C. carnifex* Heller[1] from the Red Sea, but in this the eyes are longer than the antennular peduncles, the antennal acicle extends up to the middle of the third peduncular segment and the inner and the lower surfaces of the hand are smooth. The comb-shaped arrangement of the teeth on the upper margin of the palm, so characteristic of Heller's species, is not seen in the Karachi form.

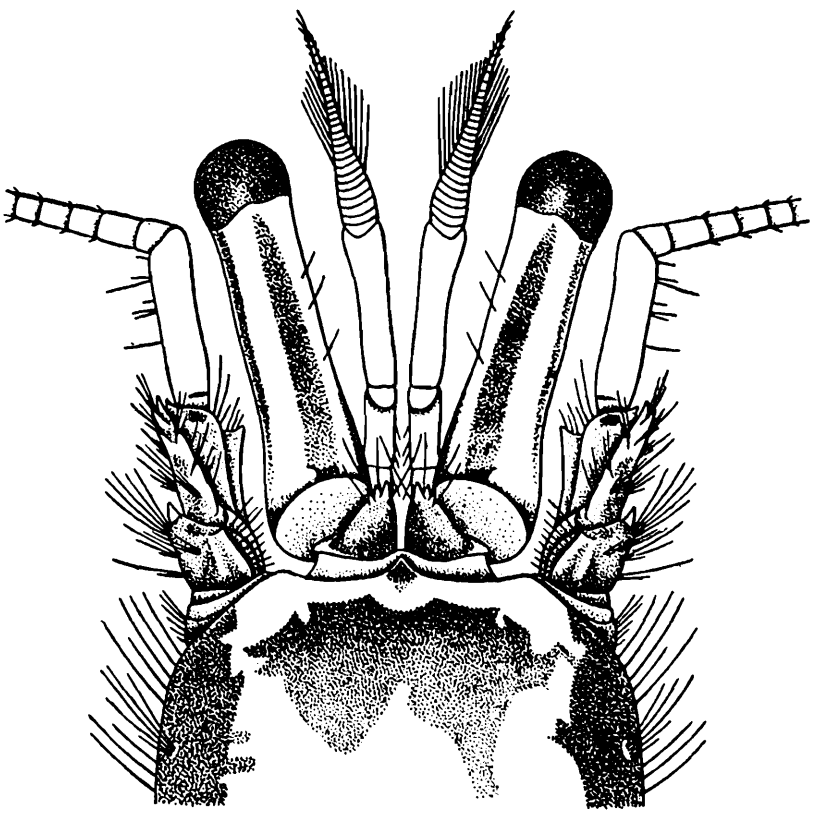
C. virescens (Krauss)[2] has colour rings on the dactyli of 2nd and 3rd legs similar to those in the present species, but, in addition to several other differences, the general colour in this species is green or olive-green.

Clibanarius signatus Heller.

1861. *Clibanarius signatus*, Heller, *Sitzs k. Akad. Wien* XLIV, p. 252.
1905. *Clibanarius signatus*, Alcock, *Cat. Ind. Mus. Decapod Crust.* Pt. II, fasc. 1, p. 160 (Ref. only).
1906. *Clibanarius signatus*, Nobili, *Ann. Sci. Nat. Zool. Paris* IV, p. 115 (key only).
1937. *Clibanarius signatus*, Buitendijk, *Temminckia* II, pp. 266, 267 (key only).

There is a fine series of 17 female specimens of this species in the Karachi collection. Some of these are preserved in spirit, while others are in weak formalin, but the colour is very well preserved in all of them.

The specimens agree very closely with the fairly detailed description given by Heller, and though we had no named examples to com-



TEXT-FIG. 3.—*Clibanarius signatus* Heller.
Anterior part of carapace, with eyes, antennae, etc. : × 15.

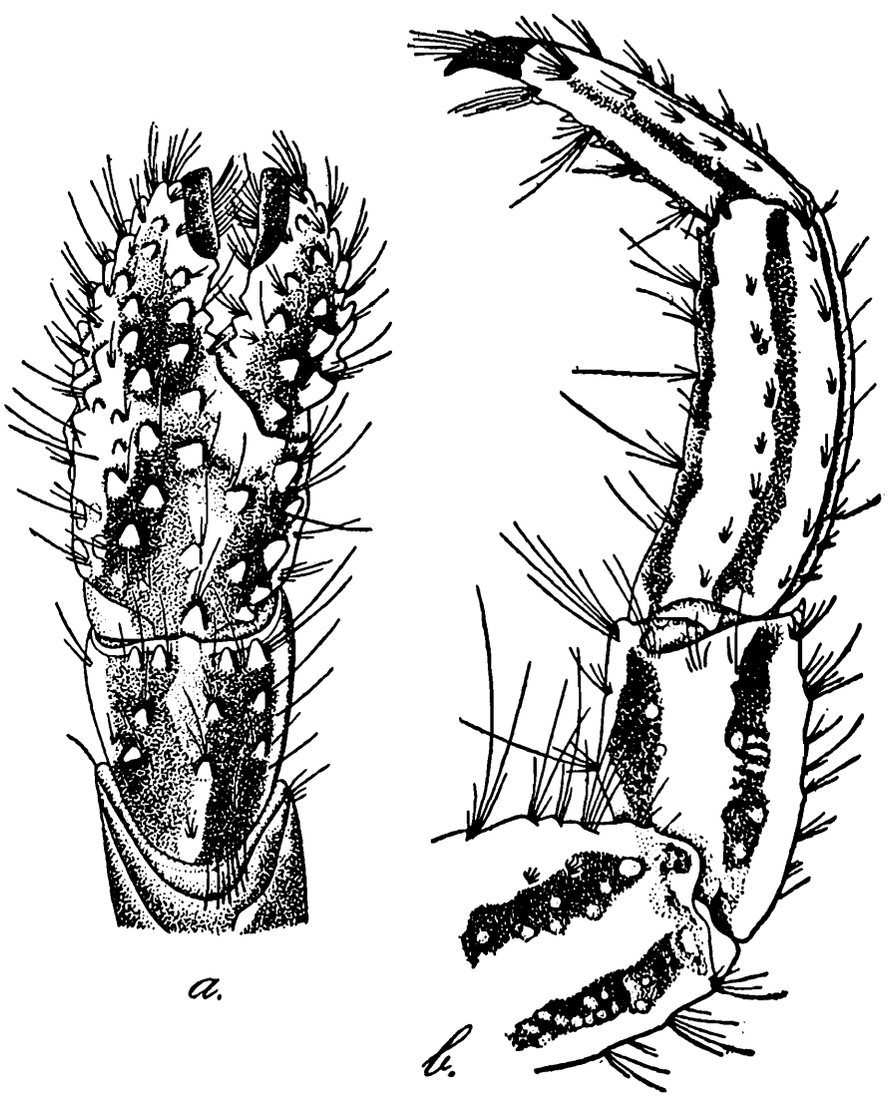
pare our material with, there seems little doubt that the Karachi specimens are referable to Heller's species. *C. signatus* has a very charac-

[1] Heller, C., *Sitz. k. Akad. Wien* XLIV, p. 250 (1861).
[2] Krauss, F., *Sudafrik. Crust.*, pp. 56, 57, pl. v, fig. 3 (1843).

teristic colouration and the colour in our examples agrees very closely with Heller's account.

The anterior part of the carapace (text-fig. 3) is rectangular in shape, all the four sides being more or less straight, the posterior angles rounded and the anterior somewhat more sharply cut. The greatest breadth of the carapace is about two-thirds of its length in the median line. The gastric region is markedly punctate and has a somewhat sparse growth of yellowish hairs on its lateral margins. In the posterior part the margins of the carapace are thickly beset with fine silky hairs of a lighter colour. The minute rostrum is pointed and the anterior border of the carapace on either side of it is practically straight. The antennal angles are hardly marked. From the base of the antennae the margins slope outwards and backwards and are continued as more or less straight lateral borders.

In large examples the eye-stalk (including the small cornea) is almost as long as the anterior margin of the carapace, measured between the



TEXT-FIG. 4.—*Clibanarius signatus* Heller.

a. Left cheliped, upper and outer view : × 15.

b. Third leg of the left side : × 15.

outer margins of the basal segments of the two antennal peduncles, but is distinctly longer than the straight frontal margin of the carapace.

In small specimens the eye-stalks are somewhat shorter. The eyes extend considerably beyond the antennal peduncles. The ophthalmic scales lie close to one another and have three small spinules on their anterior margins. The basal joints and the acicle of the antennal peduncle are sparsely hairy and the acicle extends only a little beyond the second segment of the peduncle.

The chelipeds are subequal and are shorter, but stouter, than the next two legs. The upper surface of the wrist and hand is studded with sharp tubercles interspersed with long, stiff hairs. The distalmost tubercle on the inner border of the upper surface of the wrist is appreciably larger than those preceding it. There is a spinule at the distal end of the outer lower border of the arm. The hand is flattened. The fingers are broad near the base, are toothed on the inner margins and leave an appreciable gap when they meet. The tips are broad and spooned. The palm is very characteristically swollen on the underside. The lower surface of all the joints is smooth.

The right legs are longer than those on the left side, and the second pair is distinctly longer than the third. The merus is considerably flattened and the carpus bears a sharp spinule at the distal end of its upper border. The propodus is subcylindrical, except that of the left leg of the third pair, in which it is flattened. The dactylus of the third leg, on both the sides, is slightly shorter than the propodus. The dactyli of the third pair of legs are somewhat flattened laterally and bear some minute spinules along the lower margin.

The colour markings are of a very distinctive pattern and in our specimens agree for the most part very closely with Heller's description. The ground colour of the cephalothorax is, however, yellowish-white, as described by Nobili[1], and not greenish as mentioned by Heller. The red markings on the carapace differ in extent in different specimens; in a few examples these are rather small and a great deal of the ground colour is visible, while in others the carapace is more red than yellow. A narrow, transverse streak of white is, however, always present immediately behind the front. The ophthalmic scales are red, with generally a narrow anterior border of white. The antennal and the antennular peduncles are also streaked and spotted with red. The longitudinal red stripes on the eye-stalks, mentioned by Heller, are very prominent, and the corneas are almost jet black. The chelipeds are of a darker red colour than the other legs and are obscurely streaked with yellowish-white along some of the margins. There is, however, in all the specimens a more or less prominent whitish area near the outer, lower margin of the palm, extending almost to the tip of the fixed finger. All the tubercles are white. The corneous tips of the fingers are black, but immediately behind the black tips there is a narrow white area. The walking legs, as described by Heller, are yellowish-white and bear very prominently on all the segments four or five red, longitudinal stripes, extending to the end of the dactylus. The tips of the dactyli are black. There are no transverse colour rings on the dactyli.

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[1] Nobili, G., *Ann. Sci. Nat. Zool. Paris* IV, p. 115 (1906).

The colour markings are better seen in specimens preserved in spirit than those in formalin; in the latter the red has become less distinct, and the black at the tips of the fingers and the dactyli has become brown.

Measurements, in millimetres, of a medium-sized specimen are given below.

Median length of gastric region of carapace	3·7
Median length of posterior part of carapace	3·0
Anterior breadth of carapace	2·8
Maximum breadth of carapace	4·5
Length of eye-stalk and cornea	2·5

	2nd Right Leg	2nd Left Leg	3rd Right Leg	3rd Left Leg
Length[1] of merus	3·2	3·0	3·0	2·7
Length of carpus	2·1	2·0	2·1	2·0
Length of propodus	3·0	2·9	3·0	2·6
Length of dactylus	2·7	2·5	2·7	2·5

Locality.—Clibanarius signatus was so far known from the Red Sea only. The present specimens were collected by Dr. Vishwa Nath at low water on the Rocky Ledge, on the south coast of Manora Island, Karachi, in September, 1938. This record extends the range of the species eastwards very considerably.

The specimens are registered as C2327/1 in the books of the Zoological Survey of India.

[1] Length of the segments is measured along the upper margins.

NOTES ON FISHES IN THE INDIAN MUSEUM.

XL. On Fishes of the Genus *Rohtee*[1] Sykes.

(Plate IV.)

By Sunder Lal Hora, *D. Sc., F.R.S.E., F.N.I., Assistant Superintendent*, and K. S. Misra, *M.Sc., Laboratory Assistant, Zoological Survey of India, Calcutta.*

In an earlier note, one of us[2] discussed the systematic position of *Matsya argentea*, a species discovered by Day[3] among Col. Tickell's "Volume of beautiful coloured drawings of Burmese fishes with their descriptions", and attention was directed to two other freshwater fishes, *Leiocassis fluviatilis* and *Rohtee cunma* described by Day[4] from the same source. Of these, the taxonomy of *Rohtee cunma* has been involved in great confusion, particularly as Day described its dorsal spine as "not serrated" In the fishes of the genus *Rohtee*, however, Sykes[5] characterised the dorsal "with the first complete ray serrated posteriorly". Vinciguerra[6], on the nature of the dorsal spine alone, doubted the inclusion of *R. cunma* in the genus *Rohtee*, but adduced evidence to show that it may be a synonym of *R. cotio* (Ham.). Day's account of the dorsal spine also led Hora[7] to treat *R. cunma* in a separate group of *Rohtee* and to assign it to *Parabramis* Bleeker. Among the fishes collected by Mr. D. E. B. Manning, Divisional Forest Officer, Tavoy Division, Tavoy, Burma, we have found specimens which agree with *R. cunma* in all respects,

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[1] Some authors prefer the use of *Osteobrama* Heckel (Russegger's *Reisen in Europa, Asien und Africa*, etc., pt. 1, p. 1033, 1842) to *Rohtee* Sykes (*Ann. Mag. Nat. Hist.* IV, p. 364, 1840), but Hora (*Rec. Ind. Mus.* XXII, p. 187, 1921) and Mukerji (*Journ. Bombay Nat. Hist. Soc.* XXXVII, p. 69, 1934) have shown that *Rohtee* has priority over *Osteobrama*. Jordan (*Genera of Fishes*, pp. 210, 211, 1919) also had pointed out that *Osteobrama* is a synonym of *Rohtee*.

The first species described by Sykes under *Rohtee* is *R. ogilbii* but this has been shown by Hora (*Rec. Ind. Mus.* XXXIX, p. 312, 1937) to belong to *Mystacoleucus* Günther (*Cat. Fish. Brit. Mus.* VII, p. 206, 1858). If *R. ogilbii* is to be regarded as the type of the genus *Rohtee* then *Mystacoleucus* will have to be treated as a synonym of *Rohtee*, and in that case the species now included under *Rohtee* should bear the generic designation *Osteobrama*. Jordan (*loc. cit.*, p. 210), whose main object in writing the *Genera of Fishes* was the fixation of the types for the various genera, however, named *R. vigorsii* Sykes as the orthotype of the genus *Rohtee* and if this is accepted then the present-day nomenclature of these fishes remains intact. In this paper we have followed Jordan and adopted the name *Rohtee* with *R. vigorsii* as its orthotype and have excluded *R. ogilbii* from it as it has a precumbent predorsal spine.

[2] Hora, S. L., *Rec. Ind. Mus.* XLI, pp. 401-406 (1939).

[3] Day, F., *Fish. India Suppl.*, p. 807 (1888); *Faun. Brit. Ind. Fish.* I, p. 292, fig. 102 (1889).

[4] Day, F., *Fish. India Suppl.*, pp. 805, 807 (1888); *Faun. Brit. Ind. Fish.* I, pp. 164, 343 (1889).

[5] Sykes, W. H., *Trans. Zool. Soc. London* II, p. 364 (1841).

[6] Vinciguerra, D., *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, p. 188 (1890).

[7] Hora, S. L., *Rec. Ind. Mus.* XXXIX, pp. 313, 314 (1937).

except that their dorsal spine is minutely serrated along the posterior border. Since the type of the species was obtained from Moulmein, an adjacent locality, we have no doubt that our specimens represent Day's *R. cunma.* A study of these examples has enabled us to confirm Vinciguerra's tentative conclusion that *R. cunma* is probably synonymous with *R. cotio* (Ham.).

An examination of the extensive material of *Rohtee* in the collection of the Indian Museum and a detailed study of the literature on this group of fishes has shown that considerable confusion prevails regarding the taxonomy of some of the species and that a very wide interpretation has been assigned to *Rohtee cotio* (Ham.). We propose to define the specific limits and the geographical range of each of the species represented in the material examined by us.

Key to the species of Rohtee *Sykes.*

I. With four well defined barbels—

A. More than 20 branched rays in anal fin; more than 60 scales along lateral line .. .. *R. feae.*

B. Less than 20 branched rays in anal fin; less than 60 scales along lateral line—

1. A. 3/17; L. l. 59 .. .. *R. neilli.*
2. A. 3/11; L. l. 44 .. .. .. *R. bakeri.*

II. With two rudimentary maxillary barbels—

1. A. 3/21-27; L. l. 73-85 .. .. *R. vigorsii.*
2. A. 3/16-18; L. l. 68-70 .. .. *R. dayi,* sp. nov.

III. Without barbels—

A. Less than 20 branched rays in anal fin (A. 3/16-17); abdominal edge keeled throughout .. .. *R. belangeri.*

B. More than 20 branched rays in anal fin; abdominal edge keeled only between pelvic and anal fins—

1. Generally more than 10½ scales between lateral line and pelvic fin; A. 3/28-33; L. l. 57-70 .. *R. cotio.*
2. Less than 10½ scales between lateral line and pelvic fin; A. 3/25-31; L. l. 42-60 .. *R. cotio* var. *cunma.*

Rohtee ogilbii Sykes is not included in the above key as Hora[1] has shown that it belongs to the genus *Mystacoleucus* Günther. In the collection of the Indian Museum this species is represented from the Deccan, Poona, Kurnool and the Coorg State, and would thus seem to be generally distributed along the Western Ghats.

Rohtee feae (Vinciguerra).

1877. *Rohtee cotio,* Day (in part, *nec* Hamilton), *Fish. India,* p. 587.

1878. *Osteobrama cotio,* Anderson (*nec* Hamilton), *Zool. Res. Yunnan Exped.* I, p. 869.

1889. *Rohtee cotio,* Day (in part, *nec* Hamilton), *Faun. Brit. Ind. Fish.* I, p. 340.

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[1] Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 312, text-figs. 1, 2 (1937).

1890. *Osteobrama Feae*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (2), IX, p. 183, pl. x, fig. 10.

1890. *Osteobrama Alfrediana*, Vinciguerra (*nec* Cuvier & Valenciennes) *ibid.*, p. 188.

1929. *Rohtee feae*, Prashad & Mukerji, *Rec. Ind. Mus.* XXXI, p. 205.

In the old collection of the Indian Museum we have found specimens belonging to *Rohtee feae* which had been assigned to *R. cotio* (Cat. No. 891 from Tagoung, Yunnan, collected by Dr. J. Anderson) and *R. microlepis belangeri* (Cat. No. 897, Burma, purchased from Dr. F. Day). Day seems to have confused *R. feae* with *R. cotio*, and for this reason he described the barbels of the latter as "absent or very rudimentary" In *R. cotio* the barbels are always absent; while small, but well defined, barbels are always present in *R. feae*.

According to Vinciguerra, in typical examples of *R. feae* the scales along the lateral line vary from 72 to 75, but in one specimen from the Myitkyina District and 3 specimens from Kalewa, Upper Chindwin Drainage, we found fewer scales, about 63 to 69. This difference is still more marked in the number of scales in transverse series. In typical examples there are $14\frac{1}{2}$ to $16\frac{1}{2}$ rows between the lateral line and the base of pelvic fin, while in the examples referred to above this number varies from 11 to 13. These differences in scale counts are sufficient to recognise varieties, but the material at our disposal is not enough at present to justify such a course, especially on account of the marked variations exhibited by the few specimens that we have examined.

The two examples, one from Mandalay and the other from Bhamo, referred by Vinciguerra to *Osteobrama alfrediana* were stated to be closely allied to *O. feae* but differed from it in having fewer scales, in the position of the dorsal fin, in having more rays in the anal fin and in possessing longer barbels. In our opinion Vinciguerra's *O. alfrediana* corresponds with the examples of *R. feae* with comparatively fewer scales referred to above, and treating the differences as individual variations, we have, for the time being, referred Vinciguerra's *O. alfrediana* to the synonymy of his *O. feae*.

Rohtee feae is found in Burma and Yunnan; it has so far been recorded from the Myitkyina District (Prashad & Mukerji), and from Bhamo, Mandalay and Kokarait (Vinciguerra). We have also examined specimens of this species from Kalewa, Upper Chindwin Drainage, collected by Mr. R. C. Raven, Vernay-Hopwood Chindwin Expedition, and Tagoung, Yunnan (Anderson).

In the collection of the Indian Museum the species is represented from the following localities :—

Burma	Purchased from Dr. F. day	1 specimen.
Bhamo, Burma	Genova Mus. (Fea Coll.)	2 specimens.
Myitkyina Dist., Upper Burma.	Dr. B. N. Chopra	3 specimens.
Kalewa, Upper Chindwin Drainage.	Mr. H. C. Raven ..	3 specimens.
Tagoung, Yunnan ..	Dr. J. Anderson ..	2 specimens.

We give below a table of measurements, number of anal rays and scale counts of nine specimens of *R. feae* from different localities :—

Measurements in millimetres, number of anal rays and scale counts.

	Burma.	Bhamo.	Myitkyina Dist.			Kalewa.		Tagoung.	
Standard length	155·4	67·0	81·5	153·5	156·0	100·0	108·0	114·0	132·0
Length of head	36·2	18·0	21·0	36·0	37·0	23·0	26·5	27·5	32·0
Depth of body	79·0	31·0	41·5	77·0	75·5	42·3	46·0	62·5	68·3
Width of body	18·0	5·5	10·0	21·5	22·0	8·0	8·0	12·5	14·5
Diameter of eye	12·0	7·0	8·8	12·5	12·5	9·0	9·0	10·0	10·5
Length of snout	11·0	5·0	5·5	10·2	11·0	7·0	8·0	8·0	9·3
Interorbital width..	15·5	5·0	8·0	16·0	16·0	8·2	8·5	11·5	13·0
Length of dorsal spine	44·0	20·0	20·0	D[1].	44·5	D.	31·5	D.	35·0
No. of scales along L. l.	77	73	74	73	63	66	69	72	76
No. of scales between L. l. and V. ..	16½	16	16	14½	11	12	13	16½	16½
No. of predorsal scales	39	37	38	D.	34	34	34	38	38
No. of rays in anal fin	3/26	3/28	3/27	3/27	3/28	3/27	3/27	3/28	3/29

Rohtee neilli Day.

1877. *Rohtee neilli*, Day, *Fish. India*, p. 586, pl. cxlvi, fig. 5.
1889. *Rohtee neilli*, Day, *Faun. Brit. Ind. Fish.* I, p. 340.
1937. *Rohtee duvaucelii*, Hora (*nec* Cuvier and Valenciennes), *Rec. Ind. Mus.* XXXIX, p. 17 (Tunga R., at Shimoga).
1937. *Rohtee neilli*, Hora, *Rec. Ind. Mus.* XXXIX, p. 19 (Coorg State).

Rohtee neilli was described by Day from the Bhavani River at the base of the Nilgiri Hills. We have examined one of the typical specimens from the Bhavani River which is now preserved in the collection of the Indian Museum. The species was recorded by Hora from the Cauveri River in Coorg State, and we have found that a very young specimen recorded by Hora from the Tunga River at Shimoga as *Rohtee duvaucelii* also belongs to this species. In the collection of the Indian Museum, *R. neilli* is represented from the following localities :—

Bhavani River, Nilgiri Hills, Madras.	Purchased from Dr. F. Day	1 specimen.
Sunkesula, Madras	Madras Fisheries Department.	3 specimens.
Cauveri River, Coorg State.	Mr. C. R. Narayan Rao ..	3 specimens.
Tunga River, Shimoga, Mysore.	Dr. H. S. Rao	1 specimen.
Mutha-Mula River, Poona	Mr. A. G. L. Fraser	1 specimen.

[1] D. indicates that the structure is damaged.

We give below a table of measurements, number of anal rays and scale counts of the specimens of *R. neilli* from different localities as listed above :—

Measurements in millimetres, number of anal rays and scale counts.

	Bhavani River.	Sunkesula.			Cauveri River.			Tunga River.	Mutha-Mula River.
Standard length	94·5	62·0	65·5	70·0	53·2	69·5	83·0	42·5	78·0
Length of head	25·0	17·0	17·0	18·0	15·0	18·0	22·0	12·0	19·0
Depth of body	34·5	25·0	26·2	28·5	17·0	25·5	D.	15·0	27·5
Width of body	10·5	8·5	9·0	9·5	6·8	7·5	12·5	5·3	10·0
Diameter of eye	11·3	7·5	7·5	8·0	6·9	8·0	14·0	5·5	7·5
Length of snout	5·8	4·4	4·4	4·5	4·0	5·0	6·0	3·5	5·0
Interorbital width	5·5	3·4	3·8	4·3	3·3	4·0	4·6	2·5	4·5
Length of dorsal spine ..	D.	16·5	16·0	16·5	13·0	16·0	20·5	12·5	22·0
No. of scales along L. l. ..	59	57	57	58	57	55	56	55	D.
No. of scales between L. l. and V.	7½	8	8	8	8	8	8½	7½	D.
No. of predorsal scales.. ..	21	21	21	20	21	22	21	22	20
No. of rays in anal fin	3/17	3/17	3/17	3/16	3/16	3/18	3/17	3/17	3/16

Rohtee bakeri Day.

1877. *Rohtee Bakeri*, Day, *Fish. India*, p. 586, pl. cxlvii, fig. 1.
1889. *Rohtee bakeri*, Day, *Faun. Brit. Ind. Fish.* I, p. 340.

Rohtee bakeri is represented by a single specimen in the collection of the Indian Museum ; it is one of Day's original specimens collected in Travancore. So far as we are aware this remarkable species, with fewer scales and only 11 branched rays in the anal fin, is restricted to the extreme southern part of Peninsular India.

We give below a table of measurements, number of anal rays and scale counts of the only specimen of *R. bakeri* examined by us :—

Measurements in millimetres, number of anal rays and scale counts.

Standard length	68·3
Length of head	19·0
Depth of body	22·0
Width of body	8·0
Diameter of eye	7·3
Length of snout ..	5·0
Interorbital width	4·0
No. of scales along L. l.	44
No. of scales between L. l. and V.	5½
No. of predorsal scales	15
No. of rays in anal fin	3/11

Rohtee vigorsii Sykes.

1841. *Rohtee Vigorsii*, Sykes, *Trans. Zool. Soc. London*, II, p. 364, pl. lxiii, fig. 3.
1844. *Leuciscus Duvaucelii*, Cuvier & Valenciennes, *Hist. Nat. Poiss.* XVII, p. 77 (figured as *Leuciscus Alfredianus* on pl. cccIxxxviii) and not *L. duvaucelii* described on p. 95.
1849. *Abramis Vigorsii*, Jordon, *Madras Journ. Litt. & Sci.* XV, p. 319.
1853. *Systomus Vigorsii*, Bleeker, *Verh. Bat. Gen.* XXV, p. 62.
1868. *Osteobrama cotio*, Günther (*nec* Hamilton), *Cat. Fish. Brit. Mus.* VII, p. 323.
1868. *Osteobrama rapax*, Günther, *ibid.*, p. 324.
1877. *Rohtee Vigorsii*, Day, *Fish. India*, p. 587, pl. cxlvii, fig. 3.
1889. *Rohtee vigorsii*, Day, *Faun. Brit. Ind.* Fish. I, p. 341.

Though *Rohtee ogilbii* is the first species described by Sykes in his genus *Rohtee*, Jordan[1] regarded *R. vigorsii* as the orthotype of the genus. The latter species was described by Sykes from " the Beema river, at Pairgaon " and on account of its long anal fin and small scales it has often been confused with *R. cotio*. The two species can, however, be distinguished readily by their general facies, especially by the form of the dorsal profile, and the nature of the dorsal spine. In *R. vigorsii* there is a distinct concavity from the snout to over the nape, while in *R. cotio* the profile is concave just over the nape. The dorsal spine is very strong in *R. vigorsii*, while it is weak in *R. cotio*. The other main differences in the two species are given in the key on page 156.

Leuciscus duvaucelii (=*L. alfredianus*) has generally been regarded as a subspecies of *R. cotio*, but the study of the relevant literature has convinced us that it is a synonym of *R. vigorsii*. Though in describing the species Cuvier and Valenciennes gave Nepal as its locality, in an introductory paragraph to *Cyprinus cotio*, *Leuciscus duvaucelii* and *L. rhomboidalis* on page 76 they stated that :

" M. Agassiz dit qu'il connaît des brèmes de l'Inde. On doit, en effet, rapporter à ce groupe la description suivante tirée de M. Buchanan. Je n'ai pas vu ce poisson, mais il nous en est venu de Bombay une autre espèce, voisine de celui de Buchanan.

" Les figures des dessins chinois, si souvent citées par Lacépède, représentent aussi une brème."

The above note hardly leaves any doubt as to the provenance of *L. duvaucelii*, a species allied to *Cyprinus cotio ;* it was not found in Nepal but in Bombay. Further, the type specimen of *L. duvaucelii* is stated to be over 10 inches in length which also indicates that it cannot belong to *R. cotio*, but may belong to the Deccan form, *R. vigorsii*. Moreover, in *L. duvaucelii* the dorsal spine is stated to be strong whereas in *R. cotio* it is comparatively weak. Our studies have shown that the typical form of *Rohtee cotio*, with small scales, is not found in Peninsular India where it is replaced by the variety *cunma* (*vide infra*, p. 169). Cuvier and Valenciennes' figure, labelled as *L. afredianus*, though bearing a general similarity to *R. cotio*, shows a form with very small scales. In view of the above considerations, we have no hesitation in assigning *L. duvaucelii* to the synonymy of *R. vigorsii*. It may be noted that in the fin formula of *L. duvaucelii* " A. 36 " is probably a misprint for " A. 26 ", or " A. 30 ". In *R. vigorsii* the anal rays do not exceed 30 in number.

[1] Jordan, D. S., *Genera of Fishes*, p. 210 (1919) ; for further details see foot-note 1 on page 155.

Enquiries were made from Dr. J. Pellegrin regarding the precise diagnosis and provenance of Cuvier and Valenciennes' type of *L. duvaucelii*, but he replied that the type could not be found in the collection of the Museum National d'Histoire Naturelle, Paris. He further informed us that Alfred Duvaucel, the French Naturalist, who died in Madras in 1824, made his collections of fishes in Bengal, Sylhet and the Indian Peninsula. This information also supports our contention that *L. duvaucelii* was described from a specimen obtained in Bombay and not in Nepal.

We are in entire agreement with Day[1] that *Osteobrama cotio* and *O. rapax* (characterised by long anal fin and small scales) described by Günther in his *Catalogue* should be treated as synonyms of *R. vigorsii*.

In the collection of the Indian Museum, *R. vigorsii* is represented by a large number of specimens from Deolali, Poona, Deccan and the Kistna River. A damaged specimen from Orissa (Cat. No. 889) and two other specimens from Kistna river (Cat. No. 888) identified by Day as *R. cotio*, are also referred to this species.

In the collection of the Indian Museum *R. vigorsii* is represented from the following localities :—

Deccan	Purchased from Dr. F. Day	1 specimen.
Darna R., Deolali ..	Mr. A. G. L. Fraser ..	1 specimen.
Mutha-Mula R., Poona ..	Mr. A. G. L. Fraser	Several specimens.
Mutha-Mula R., Poona	Mr. C. V. Kulkarni ..	3 specimens.
Kistna River	Purchased from Dr. F. Day	2 specimens.
Orissa	Purchased from Dr. F. Day	1 specimen.

We give below a table of measurements, number of anal rays and scale counts of the specimens of *R. vigorsii* from different localities as noted above :—

Measurements in millimetres, number of anal rays and scale counts.

	Deccan.	Deolali.	Poona.					Kistna River.		Orissa.
Standard length ..	115·0	133·0	46·0	115·0	120·0	131·0	150·0	66·0	106·0	74·0
Length of head ..	30·5	37·0	12·5	30·5	32·0	35·0	45·0	10·0	26·5	20·0
Depth of body ..	40·5	46·0	18·0	41·5	41·0	47·1	58·0	25·0	37·0	26·3
Width of body ..	10·5	15·3	4·3	13·2	12·9	15·0	18·0	7·0	10·0	7·1
Diameter of eye ..	10·0	10·3	4·3	9·2	11·0	10·2	12·0	6·5	8·0	7·1
Length of snout ..	9·0	8·8	3·5	8·6	9·0	9·0	13·0	5·5	7·5	6·0
Interorbital width ..	6·5	7·0	2·8	5·7	5·0	6·5	7·5	4·0	5·5	4·2
Length of dorsal spine. ..	D.	35·0	12·5	30·5	D.	D.	D.	D.	D.	D.
No. of scales along L. l. ..	85	73	D.	83	79	81	78	78	74	74
No. of scales between L. l. and V.	11½	11	D.	11½	11	11	11	11½	11½	11
No. of predorsal scales. ..	37	34	D.	35	34	34	34	34	33	34
No. of rays in anal fin. ..	3/27	3/21	3/22	3/22	3/24	3/24	3/23	3/23	3/27	3/25

[1] Day, F., *Fish. India*, p. 587 (1877).

Rohtee dayi, sp. nov.

1877. *Rohtee Belangeri* Day (in part), *Fish. India,* p. 587.
1889. *Rohtee belangeri,* Day (in part), *Faun. Brit. Ind. Fish.* I, p. 342.

D. 4/8 ; A. 19-21 (3/16-18) ; P. 16-17 ; V. 9 ; L. 1. 68-70.

In *Rohtee dayi* the body is much compressed and both the dorsal and the ventral profiles are greatly arched ; the form is that of a trapezoid. The rise in the dorsal profile is more sharp posterior to the head, which is short and bluntly pointed anteriorly. The length of the head is contained from 4·1 to 4·3 times in the standard length. The greatest width of the head is contained about 1·7 times and its height at occiput from 1·1 to 1·2 times in its length. The eyes are large and lateral in position ; the diameter of the eye is contained from 2·6 to 2·9 times in the length of the head, from 0·6 to 0·8 times in the length of the snout and from 0·7 to 1·2 times in the interorbital width. The eyes are proportionately larger in younger specimens. The mouth is small and somewhat directed upwards and forwards ; its gape does not extend to the anterior border of the eye. There are two minute maxillary barbels, which are liable to be overlooked if not properly searched.

The greatest depth of the body is below the commencement of the dorsal fin and is contained from 2·1 to 2·3 times in standard length. The caudal peduncle is almost as high as long. The body is covered with small, closely set scales ; there are 68-70 scales along the lateral line, $13\frac{1}{2}$ to $14\frac{1}{2}$ rows between the lateral line and the base of the pelvic fin and 28-30 scales in front of the dorsal fin.

The commencement of the dorsal fin is almost equidistant between the base of the caudal fin and the tip of the snout or is somewhat nearer to the former than to the latter ; its last denticulated spine is moderately strong and about $1\frac{1}{2}$ times as long as head. Towards the end the spine is devoid of serrations, is flexible and filamentous. The pectoral fins are placed low, pointed above, and slightly shorter than the head ; they almost reach the base of the pelvic fins. The pelvic fins are similar to the pectorals, but do not extend to the base of the anal fin. The anal fin is considerably higher anteriorly and is moderately long. The caudal fin is deeply forked.

The colour is bleached in all the three examples, but there is a marked indication of a black band behind the gill-cover.

Type-specimen.—Cat. No. 902, Zoological Survey of India, Indian Museum, Calcutta.

Distribution.—Godavari river ; ? Deccan.

Remarks.—*Rohtee dayi* is proposed for two specimens from the Godavari river and one other specimen, presumably from the Deccan, identified by Day as *R. belangeri* and *R. ogilbii* respectively. In these examples the ventral surface in front of the pelvic fins is rounded, and the dorsal spine is moderately strong. Moreover, they possess two rudimentary maxillary barbels. In the small size of its scales and the length of the anal fin, *R. dayi* shows a superficial resemblance to *R. belangeri,* but the two species can readily be distinguished by the nature of their ventral edge.

Measurements in millimetres, number of anal rays and scale counts.

	Godavari.		Locality ?.
Standard length	92·5	112·0	127·5
Length of head	22·5	26·0	29·5
Width of head	13·3	15·5	18·0
Height of head	19·0	22·5	25·0
Height of body	43·0	48·0	57·0
Width of body	11·0	13·0	16·0
Diameter of eye	8·5	10·0	10·0
Length of snout	5·5	7·0	8·0
Interorbital width	6·0	10·0	12·0
Length of dorsal fin	31·5	36·5	43·5
Length of pectoral fin	22·0	24·0	26·5
Length of pelvic fin	19·0	23·0	23·5
No. of scales along lateral line	68	68	70
No. of scales between lateral line and v. ..	14	14½	13½
No. of predorsal scales	28	30	29
No. of rays in anal fin	$\frac{3}{15}$	$\frac{3}{15}$	$\frac{3}{15}$

Rohtee belangeri Cuvier & Valenciennes.

1844. *Leuciscus Belangeri*, Cuvier & Valenciennes, *His. Nat. Poiss.* XXII, p. 99.
1858. *Systomus microlepis*, Blyth, *Journ. As. Soc. Bengal* XXVII, p. 289.
1860. *Osteobrama microlepis*, Blyth, *Journ. As. Soc. Bengal* XXIX, p. 158.
1863. *Smiliogaster Belangeri*, Bleeker, *Atl. Ichth. Cyprinidae* III, p. 33.
1868. *Osteobrama microlepis*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 325.
1868. *Smiliogaster belangeri*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 328.
1871. *Rohtee microlepis*, Day, *Journ. As. Soc. Bengal* XL, p. 139.
1877. *Rohtee Belangeri*, Day (in part), *Fish. India*, p. 587, pl. cxlvii, fig. 4.
1878. *Osteobrama microlepis*, Anderson, *Zool. Res. Yunnan Exped.* I, p. 869.
1889. *Rohtee belangeri*, Day (in part), *Faun. Brit. Ind. Fish.* I, p. 342.
1890. *Osteobrama Belangeri*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, p. 318.
1921. *Rohtee belangeri*, Hora, *Rec. Ind. Mus.* XXII, p. 188, fig. 2*a*.
1929. *Rohtee belangeri*, Prashad & Mukerji, *Rec. Ind. Mus.* XXXI, p. 204.

Rohtee belangeri can be readily distinguished from all the other species of the genus by the fact that the whole of its abdominal edge is trenchant and sharp, whereas in other species it is sharp only between the bases of the pelvic and anal fins. On this character alone it was placed by Bleeker[1] in a separate genus *Smiliogaster*, which is now regarded as a synonym of *Rohtee*. The relationships of these forms could be better expressed by treating *Smiliogaster* as a subgenus of *Rohtee*.

Cuvier and Valenciennes described this species from the fresh waters of Bengal, but we think there must have been some inaccuracy about the locality label. This fish has not since been found in Bengal waters[2], but is very common in Burma and the adjacent territories[3]. Day recorded it from the Godavari, and we have examined two specimens from Godavari (Cat. No. 902) referred by him to this species. In these

[1] Bleeker, P., *Nat. Tijdschr. Neder.-Indie* XX, p. 428 (1859).

[2] Day in his *Fishes of India* (p. 588) refers to 'Bengal specimens' of *R. belangeri*, though in the habitat of the species no mention is made of Bengal. Presumably Day refers to the type-specimens which he may have examined in the Paris Museum.

[3] It may be noted that Hora's specimens from the Manipur Valley in Assam were collected from the Chindwin Drainage System which forms part of the Irrawaddy System.

examples the ventral surface in front of the pelvic fins is rounded and they possess two rudimentary maxillary barbels. Another specimen (No. 2698), determined by Day as *R. ogilbii*, is similar to the above-mentioned Godavari examples, but unfortunately it bears no locality label though from the specific name given to it by Day it can be inferred that the example may have been collected in South India. These specimens possess fewer scales along the lateral line (68-70 *versus* 70-78) and also between the lateral line and the base of the pelvic fins ($13\frac{1}{2}$-$14\frac{1}{2}$ *versus* $15\frac{1}{2}$-$18\frac{1}{2}$). The number of predorsal scales is also less (30 *versus* 31-34). In view of the above noted differences we regard the Godavari examples as representing a distinct species which we have described above as new, *R. dayi*, sp. nov.

In 1871, Day doubted the specific validity of Cuvier and Valenciennes' *Leuciscus belangeri* and recognised *Systomus microlepis* Blyth as a valid species. Though he gave the habitat of the species as " The Godavery river, and throughout Burma," he seems to have described it from the examples collected in Burma ; this is clear from the fact that the anal fin formula is given as $\frac{3}{18}$ and the scales along the lateral line as 71-73. In the description of *R. belangeri* in the *Fishes of India* he included the characters of the Godavari specimens (A. 3/17-18 ; L. l. 68-73 ; 14 rows of scales between L. l. and base of pelvic fins, etc.), which we have now referred to a new species.

In giving the distribution of *Osteobrama belangeri*, Vinciguerra states that " La specie si trova nel Bengala e in Birmania, Anderson la raccolse nel fiume Godavery " Anderson collected two specimens of this species, which are now preserved in the collection of the Indian Museum, in Yunnan and not from the Godavari river as stated by Vinciguerra.

In the collection of the Indian Museum *R. belangeri* is represented from the following localities[1]:—

Indo-China	? ..	2 specimens.
Tagoung, Yunnan ..	Dr. J. Anderson	2 specimens.
Burma ..	?	3 specimens.
Indawgyi Lake, Myitkyina District.	Dr. B.N. Chopra	1 specimen.
Mandalay	Purchased from Dr. F. Day.	5 specimens.
Mandalay Market	Dr. N. Annandale	2 specimens.
Prome	Purchased from Dr. F. Day.	3 specimens.
Pegu ..	Purchased from Dr. F. Day.	1 specimen.
Rangoon . ..	Genova Mus. (Fea Coll.)	1 specimen.
Rangoon . ..	Mr. V. Ball ..	1 specimen.
Rangoon . ..	Prof. F. J. Meggitt	1 specimen.
?	Purchased from Dr. F. Day.	1 specimen.

We give below a table of measurements, number of anal rays and scale counts of the specimens of *R. belangeri* from different localities.

[1] Hora (*Rec. Ind. Mus.* XXII, p. 189, 1921) obtained two specimens of this species from the Manipur Valley (Loktak Lake and Khurda stream), but we could not find them in the collection now.

Measurements in millimetres, number of anal rays and scale counts of Rohtee belangeri *Cuvier & Valenciennes.*

	Indo-China.		Tagoung, Yunnan.		Myitkyina District.	Mandalay.		Prome.	Pegu.	Rangoon.	
Standard length	110·0	127·0	175·0	192·5	231·5	189·0	220·0	82·5	107·5	60·0	136·3
Length of head	27·0	29·3	40·0	45·3	62·0	44·5	50·0	23·0	27·0	18·5	32·5
Depth of body ..	56·5	60·0	77·0	82·0	106·0	68·0	83·0	37·0	50·0	35·5	59·0
Width of body	16·5	16·5	25·5	27·5	40·0	22·3	30·0	10·0	13·0	10·0	18·0
Diameter of eye	9·6	10·0	12·5	13·7	18·0	13·0	16·0	8·0	9·8	9·0	10·5
Length of snout	7·0	7·5	10·0	11·5	18·0	10·3	13·5	5·5	8·0	6·0	8·0
Interorbital width	11·0	12·5	18·0	19·0	27·5	16·0	20·0	8·0	10·0	7·5	12·5
No. of scales along L. l. ..	76	75	78	78	78	78	73	73	77	70	77
No. of scales between L. l. and V.	18½	17	16½	16½	16½	16½	16½	16½	16½	15½	16½
No. of predorsal scales ..	33	33	34	33	33	34	32	33	32	31	34
No. of rays in anal fin ..	3/18	3/17	3/18	3/17	3/19	3/18	3/18	3/17	3/17	3/17	3/17

Rohtee cotio (Hamilton).

1822. *Cyprinus (Cabdio) cotio*, Hamilton, *Fish. Ganges*, pp. 339, 393, pl. xxxix, fig. 93.

According to Hamilton, *Rohtee cotio* is common in the ponds and ditches of Bengal, grows to about four inches in length and is full of bones. From the literature we find that a very wide interpretation has been given to this species and in the collection of the Indian Museum there are specimens belonging to *R. feae*, *R. vigorsii*, etc., which had been assigned by earlier workers to *R. cotio*. To a certain extent the cause of this confusion can be traced to *Leuciscus duvaucelii* Cuv. & Val., the precise specific limits of which have been elucidated above (*vide supra*, p. 160); its type was obtained from Bombay, but in the description it was wrongly stated to have come from Nepal. In view of the confusion of *L. duvaucelii* with *R. cotio* widely divergent forms, with and without barbels, with comparatively small and very small scales, etc., came to be included in the latter species.

Though in its diagnostic features, *R. cotio* is a very variable species, its most salient features are a very long anal fin, small scales, absence of barbels and a rounded abdominal edge in front of the pelvic fins. The scales are somewhat deciduous and irregularly arranged. The number of scales along the lateral line varies from 57 to 70, and that of the scales between the lateral line and the base of the pelvic fins from $10\frac{1}{2}$ to 13. The number of branched rays in the anal fin varies from 28 to 33. For variation in proportions, etc., reference may be made to the table of measurements, scale counts and number of fin rays given below.

We have examined a very large number of specimens of *R. cotio* in the collection of the Indian Museum, and find that it is distributed in Assam (Brahmaputra Drainage), Bengal, Bihar, Central Provinces and the Punjab. The following list gives the localities of the specimens examined by us and definitely assigned to *R. cotio* (*sensu stricto*):—

Sibsagar, Assam	Mr. S. E. Peal	2 specimens.
Tangrai, D. S. Ry., Assam	Mr. B. H. Singh .	28 specimens.
Mangaldai, Assam	Dr. S. L. Hora ..	1 specimen.
Tezpur, Assam	Drs. B. Prashad and S. L. Hora.	4 specimens.
Cachar, Assam	Purchased ..	8 specimens.
Siliguri, Bengal	Messrs. G. E. Shaw and E. O. Shebbeare.	1 specimen.
Maltipur, Bengal	Dr. S. L. Hora ..	2 specimens.
Pulta Waterworks, Calcutta.	Pulta Survey ..	5 specimens.
Calcutta ..	Purchased from Dr. F. Day.	1 specimen.
Saraghat, Bihar	Mr. R. A. Hodgart	3 specimens.
Champaran, Bihar ..	Messrs. McKenzie and Walker.	1 specimen.
Purneah, Bihar ..	Museum Collector ..	2 specimens.
Bhagalpur, Bihar ..	Mr. D. D. Mukerji ..	1 specimen.

Santal Parganas, Bihar	Dr. H. A. Hafiz ..	1 specimen.
Deoli, C. P. ..	Col. Biddulph	1 specimen.
Jubbulpore, C. P. ..	Purchased from Dr. F. Day.	1 specimen.
Orissa	Purchased from Dr. F. Day.	2 specimens.
?	Purchased from Dr. F. Day.	1 specimen.
Lahore, Punjab ..	Purchased from Dr. F. Day.	1 specimen.
Amritsar, Punjab ..	Mr. G. C. L. Howell ..	1 specimen.
Ludhiana, Punjab	Acad. Nat. Sci. Philadelphia.	1 specimen.
Sursutta R., Punjab ..	Acad. Nat. Sci. Philadelphia.	6 specimens.

We give below a table of measurements, number of anal rays and scale counts of specimens of *Rohtee cotio* (Ham.) from different localities.

Measurements in millimetres, number of anal rays and scale counts of Rohtee cotio (*Hamilton*).

	Calcutta.	Pulta.		Sibsagar.	Tengrai.	Bhagalpur.
Standard length	55·0	45·0	35·0	71·0	52·5	75·0
Length of head	12·5	10·3	8·2	17·0	15·0	18·5
Depth of body	21·5	17·0	13·0	34·3	22·5	35·0
Width of body	5·0	5·0	4·0	7·2	5·5	8·0
Diameter of eye . ..	5·5	4·5	3·5	7·5	5·5	8·0
Length of snout	3·0	3·0	2·1	5·0	4·5	4·0
Interorbital width	4·0	3·3	2·3	5·0	3·6	5·0
Length of dorsal spine	D.	D.	9·4	D.	15·0	D.
No. of scales along L. l ..	59	58	60	62	70	62
No. of scales between L. l. and V.	11	10½	11½	13	13	11½
No. of predorsal scales ..	24	24	24	27	27	29
No. of rays in anal fin ..	3/32	3/31	3/33	3/32	3/30	3/31

Measurements in millimetres, number of anal rays and scale counts of Rohtee cotio (*Hamilton*)—contd.

	Purneah.		Santal Parganas.	Orissa.	Jubbulpore.	Amritsar.	Sursutta River.
Standard length ..	81·5	78·0	40·5	61·0	59·0	70·0	43·0
Length of head ...	19·0	19·0	10·0	14·5	15·0	18·0	12·0
Depth of body ..	36·0	35·0	15·5	23·5	25·5	30·5	18·3
Width of body ..	9·0	9·5	4·5	6·0	6·0	8·0	4·5
Diameter of eye ..	8·0	8·0	4·5	6·3	6·5	7·0	4·5
Length of snout ..	4·3	5·0	2·8	4·0	4·0	5·0	3·0
Interorbital width ..	4·3	4·5	3·0	4·0	4·0	5·4	3·0
Length of dorsal spine ..	D.	21·5	D.	15·0	D.	18·5	D.
No. of scales along L. 1.	62	62	58	65	70	61	62
No. of scales between L. 1. and V.	11	11½	10½	11½	12½	11½	11
No. of predorsal scales ..	28	D.	24	29	28	27	25
No. of rays in anal fin ..	3/32	3/30	3/28	3/31	3/31	3/28	3/38

Rohtee cotio var. **cunma** Day.

Plate IV, figs. 1—9.

1860. *Osteobrama cotio*, Blyth (*nec* Hamilton), *Journ. As. Soc. Bengal* XXIX, p. 158.
1877. *Rohtee cotio* var. *Alfrediana*, Day (*nec* Cuvier & Valenciennes), *Fish. India*, p. 587, pl. cxlvii, fig. 2.
1888. *Rohtee cunma*, Day, *Fish. India Suppl.*, p. 807.
1889. *Rohtee cunma*, Day, *Faun. Brit. Ind. Fish.* I, p. 343.
1889. *Rohtee cotio* var. *alfrediana*, Day (*nec* Cuvier & Valenciennes), *Faun. Brit. Ind. Fish.* I, p. 341, fig. 109.
1889. *Rohtee cunma*, Day *Faun. Brit. Ind. Fish.* I, p. 343.
1890. *Osteobrama cotio*, Vinciguerra (*nec* Hamilton), *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, p. 186.
1921. *Rohtee alfrediana*, Hora (*nec* Cuvier & Valenciennes), *Rec. Ind. Mus.* XXII, p. 188.
1924. *Rohtee roeboides*, Myers, *Amer. Mus. Novitates*, No. 150, p. 3 (1924).
1929. *Rohtee alfrediana*, Prashad & Mukerji (*nec* Cuvier & Valenciennes), *Rec. Ind. Mus.* XXXI, p. 203.
1934. *Rohtee duvaucelii*, Mukerji (*nec* Cuvier & Valenciennes), *Journ. Bombay Nat. Hist. Soc.* XXXVII, p. 71.

As indicated in the introduction, Day's wrong description of the nature of the dorsal spine in *Rohtee cunma* was mainly responsible for

our lack of knowledge regarding the precise systematic position of this variety in spite of the fact that Col. Tickell had found it to be common at Moulmein. From the number of specimens which can now be assigned to this form, it seems that it is the commonest form of *Rohtee* in Burma and Peninsular India. It differs from *Rohtee cotio* in having somewhat larger and more regularly arranged scales (L. l. 42-58 *versus* 57-70; predorsal 18-24 *versus* 24-28; between lateral line and pelvics $7\frac{1}{2}$-$9\frac{1}{2}$ *versus* $10\frac{1}{2}$-13) and fewer rays in the anal fin (28-34 *versus* 31-36). In all other respects, except that the variety *cunma* probably grows to a somewhat larger size, the two forms are very similar, and there seems no doubt that they must have become differentiated not very long ago. Even now there is no hard and fast dividing line between the two forms, but it is significant that while *cotio* is found only in northern India, *cunma* is found in Burma and Peninsular India. The distribution of the two forms indicates that *cunma* is probably a more generalised type.

In the collection of the Indian Museum the variety *cunma* is represented from the following localities :—

Tavoy, Lower Burma ..	Mr. D. E. B. Manning	6 specimens.
Irrawaddy, Burma ..	Purchased from Dr. F. Day.	2 specimens.
Rangoon, Burma ..	Purchased from Dr. F. Day.	2 specimens.
Mandalay, Burma ..	Purchased from Dr. F. Day.	1 specimen.
Bhamo, Burma ..	Mr. Coggin Brown ..	8 specimens.
Indawgyi Lake, Burma ..	Dr. B. N. Chopra ..	9 specimens.
Mali Hka R., Myitkyina District, Burma.	Lt.-Col. R. W. Burton ..	1 specimen.
Kaung Hein, Chindwin Drainage.	Amer. Mus. Nat. Hist. ..	1 specimen.
Manipur Valley, Chindwin Drainage.	Dr. S. L. Hora ..	7 specimens.
Deccan	Purchased from Dr. F. Day.	1 specimen.
Darna R., Deolali, Bombay Presidency.	Mr. A. G. L. Fraser ..	3 specimens.
Poona, Bombay Presidency	Mr. A. G. L. Fraser ..	73 specimens.
Sabari R., tributary of Godavari R.	Mr. M. N. Datta ..	2 specimens.
Orissa	Purchased from Dr. F. Day.	1 specimen.
Sind	Purchased from Dr. F. Day.	1 specimen.

We give below two tables of measurements, number of anal rays and scale counts of specimens of *R. cotio* var. *cunma* from Burma and Peninsular India respectively.

Measurements in millimetres, number of anal rays and scale counts of specimens of Rohtee cotio *var.* cunma *Day from Burma.*

	Tavoy.					Irrawady.	Rangoon.	Mandalay.	Bhamo.	Indawgyi L.	Mali Hka R.	Kaung Hein.	Manipur.
Standard length	116·5	90·0	89·0	79·0	68·0	82·0	87·0	115·5	70·0	105·5	101·5	64·0	45·0
Length of head	27·0	22·5	22·0	18·5	17·5	20·0	20·5	27·0	19·0	28·3	27·8	16·0	12·0
Depth of body	57·0	40·5	40·7	35·5	29·5	35·0	37·0	51·0	29·0	43·0	43·0	24·5	15·0
Width of body	15·0	11·0	10·7	9·0	7·0	8·7	9·0	13·0	8·0	12·7	11·5	7·0	5·3
Diameter of eye	10·0	8·5	8·5	7·5	7·0	8·1	8·1	10·0	7·0	10·1	9·9	7·0	5·0
Length of snout	8·5	7·0	7·0	5·0	4·9	5·5	5·8	8·0	5·0	9·0	7·0	5·0	3·0
Interorbital width ..	7·0	6·0	6·0	5·0	4·3	5·5	5·5	7·0	4·0	7·0	6·5	5·0	3·0
Length of dorsal spine ..	D.	28·5	29·0	25·5	22·5	D.	D.	33·0	D.	D.	30·0	D.	D.
No. of scales along L. l. ..	46	44	45	42	42	48	45	53	45	48	49	44	48
No. of scales between L. l. and V.	7½	7½	7½	7½	7½	8½	7½	8½	7½	8½	8½	7½	8½
No. of predorsal scales ..	20	19	19	19	18	20	19	20	19	19	20	19	20
No. of rays in anal fin ..	3/29	3/29	3/26	3/29	3/27	3/29	3/29	3/28	3/27	3/25	3/26	3/27	3/28

Measurements in millimetres, number of anal rays and scale counts of specimens of Rohtee cunma *Day from Peninsular India.*

	Deccan.	Deolali.	Poona.				Godavari R.	Orissa.
Standard length ..	70·0	35·0	80·0	72·0	71·0	68·0	48·0	55·0
Length of head ..	16·0	9·0	18·0	16·5	15·5	15·5	11·0	13·0
Depth of body ..	30·0	13·0	35·0	31·5	28·5	27·0	19·0	20·0
Width of body ..	6·5	4·0	11·5	8·5	7·5	9·0	5·5	4·0
Diameter of eye ..	6·5	4·3	7·1	6·5	6·5	6·5	5·0	5·0
Length of snout ..	4·0	2·5	5·5	4·7	4·5	4·5	3·0	3·0
Interorbital width ..	5·0	2·5	5·0	4·9	4·9	4·9	3·0	3·5
Length of dorsal spine ..	D.	D.	D.	D.	D.	20	14	D.
No. of scales along L. l. ..	56	55	55	60	55	58	56	55
No. of scales between L. l. and V.	7½	9½	9½	9½	8½	9½	9	9½
No. of predorsal scales ..	24	21	23	22	22	22	24	23
No. of rays in anal fin ..	3/29	3/29	3/30	3/28	3/28	3/28	3/31	3/31

General Remarks.

Recently one of us[1] discussed the systematics and geographical distribution of the fishes of the genus *Rohtee*, but unfortunately he was not then aware of the precise specific limits of *R. cunma*. It is now possible to say that *Rohtee*-like fishes without a serrated dorsal spine included in the genus *Parabramis* Bleeker are restricted to the Amur System, North China, Kiao-Ho, Yangtse-Kiang and Hainan, while *Rohtee* is found in Yunnan, Burma and India. Anderson[2] recorded two species of *Rohtee* (=*Osteobrama*) from Tagoung in Yunnan, *viz.*, *R. cotio* (Ham.) and *R. microlepis* (Blyth) (=*R. belangeri*). We have examined Anderson's specimens and find that those assigned to *R. cotio* belong to *R. feae*. Thus the two species of *Rohtee* from Yunnan are the same as are to be commonly found in Burma.

In dealing collectively with the fishes of the genus *Rohtee*, it is of interest to note the great similarity between the forms found in Peninsular India on the one hand and in Burma on the other. Though there is only one species, *R. cotio* (*sensu stricto*), found throughout Northern India, in Peninsular India we have 5 species and in Burma 3 species. One form, *R. cotio* var. *cunma*, is common to both Peninsular India and Burma, and among the species found in both the regions we have forms with and without barbels. The geographical distribution of *Rohtee* thus affords a striking instance of the great similarity between the fauna of Southern India and Burma. In this connection attention may also be invited to the similar distribution[3] of *Mystacoleucus* Günther, an allied genus with a procumbent, predorsal spine.

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[1] Hora, S. L., *Rec. Ind. Mus.* XXXIX, pp. 314, 315 (1937).
[2] Anderson, J., *Zool. Res. Yunnan Exped.* I, p. 869 (1878).
[3] Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 314 (1937); *ibid.* XLI, pp. 401-406 (1939).

SUMMARY.

A revision of the fishes of the genus *Rohtee* Sykes, based on the material preserved in the collection of the Indian Museum, is given. A key to various species is given and notes are added to elucidate the taxonomy of each. One new species, *R. dayi*, is described from the Godavari River.

The specimens of the various species in the collection of the Indian Museum are listed, and tables of measurements and counts of anal fin rays and scales are given to indicate individual variations.

Geographical distribution of the genus is discussed and attention is directed to the great similarity between the species found in Burma and Yunnan on the one hand and in Peninsular India on the other. Reference is also made to the parallelism between the distribution of the genera *Rohtee* and *Mystacoleucus*.

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EXPLANATION OF PLATE IV.

Rohtee cotio var. *cunma* Day.

FIG. 1.—Lateral view of a specimen from Tavoy, Burma. $\times\frac{2}{3}$.

FIG. 2.—Dorsal surface of head and part of body of same. $\times\frac{2}{3}$.

FIG. 3.—Ventral surface of head and part of body of same. $\times\frac{2}{3}$.

FIG. 4.—Dorsal fin to show nature of serrations along posterior border of dorsal spine. $\times 1\frac{1}{3}$.

FIG. 5.—Pharyngeal bone and teeth. $\times 5\frac{1}{3}$.

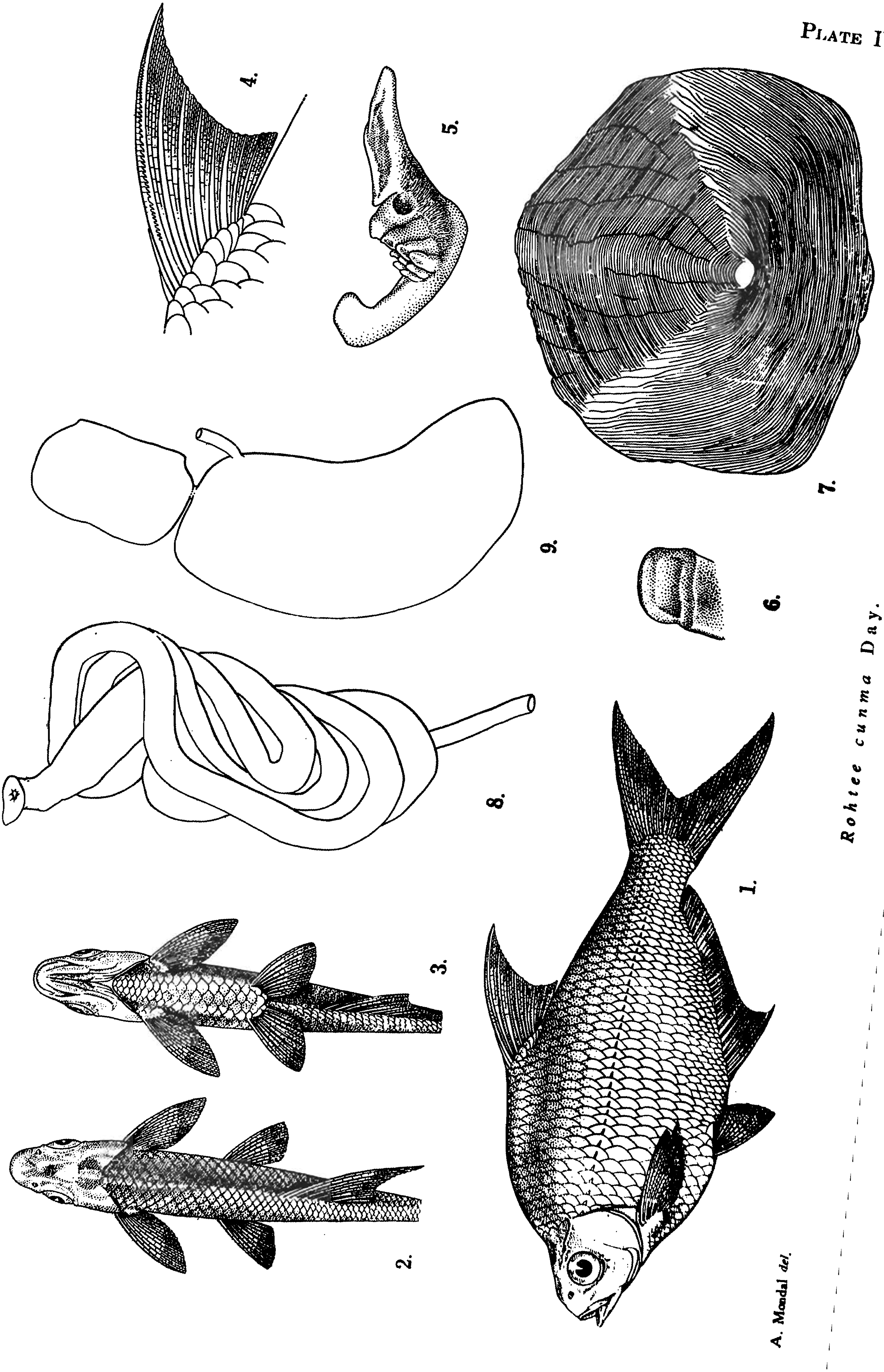
FIG. 6.—Crown of a pharyngeal tooth. $\times 20$.

FIG. 7.—Scale from below the dorsal fin. $\times 8$.

FIG. 8.—Alimentary canal. $\times 3$.

FIG. 9.—Air-bladder. $\times 3$.

PLATE IV.



Rohtee cunma Day.